Volume III

Greenbriar Development Project
Sacramento, California

Draft Environmental Impact Report

Appendices G–P

State Clearinghouse Number 2005062144

Prepared for:

City of Sacramento
Environmental Planning Services

and

Sacramento Local Agency Formation Commission

July 2006

EDAW

Volume III

Greenbriar Development Project
Sacramento, California

Draft Environmental Impact Report

Appendices G–P

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July 2006

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NOISE MODELING DATA AND REPORTS

RUN NAME: W. ELVERTA RD WEST OF POWERLINE RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 460 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 56.50
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	70.3

DO YOU WANT A HARD COPY? (Y/N)RUN NAME: POWERLINE RD NORTH OF ELKHORN BLVD

RUN NAME: W. ELVERTA RD EAST OF POWERLINE RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 640 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 57.93
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	87.5

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: POWERLINE RD SOUTH OF W. ELVERTA RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 390 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 55.78
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	63.0

DO YOU WANT A HARD COPY? (Y/N)

Existing Conditions (2005)

RUN NAME: POWERLINE RD NORTH OF W. ELVERTA RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 250 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 53.85
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	0.0	0.0	0.0

DO YOU WANT A HARD COPY? (Y/N)

```
RUN NAME: ELKHORN BLVD BTWN LONE TREE RD AND SR 99/70 (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
     7.38    1.20     0.91
H-TRUCKS
     1.71    0.28     0.21

ADT: 458   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 56.48
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0     70.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: POWERLINE RD BTWN ELKHORN BLVD AND DEL PASO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
     7.38    1.20     0.91
H-TRUCKS
     1.71    0.28     0.21

ADT: 1160   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 60.51
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0     60.5    129.9

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN POWERLINE RD AND LONE TREE RD (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
     7.38    1.20     0.91
H-TRUCKS
     1.71    0.28     0.21

ADT: 210   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 53.09
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0      0.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: POWERLINE RD NORTH OF ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
     7.38    1.20     0.91
H-TRUCKS
     1.71    0.28     0.21

ADT: 1250   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 60.84
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0     63.6    136.5

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: POWERLINE RD SOUTH OF DEL PASO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20    8.49
M-TRUCKS
    7.38     1.20     0.91
H-TRUCKS
    1.71     0.28     0.21

ADT: 930   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 59.56
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0     52.3    112.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: E. COMMERCE PKWY BTWN ELKHORN BLVD AND DEL PASO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20    8.49
M-TRUCKS
    7.38     1.20     0.91
H-TRUCKS
    1.71     0.28     0.21

ADT: 1730   SPEED: 40   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 61.11
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0     66.3    142.2

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD EAST OF E. COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20    8.49
M-TRUCKS
    7.38     1.20     0.91
H-TRUCKS
    1.71     0.28     0.21

ADT: 13670   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 71.23
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  67.5    144.9    311.9    671.7

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN SR 99/70 AND E. COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20    8.49
M-TRUCKS
    7.38     1.20     0.91
H-TRUCKS
    1.71     0.28     0.21

ADT: 17270   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 72.24
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  78.8    169.3    364.5    784.9

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: SR99/70 BTWN W ELVERTA RD AND ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 40500   SPEED: 65   ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 77.19
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 246.2    524.7   1127.7   2427.8

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: SR99/70 NORTH OF W ELVERTA RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 32000   SPEED: 65   ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 76.16
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 211.4    448.9    964.0   2075.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: DEL PASO RD BTWN WYNDVIEW DR AND EL CENTRO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 40   SPEED: 25   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 40.37
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0      0.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: DEL PASO RD BTWN POWERLINE RD AND WYNDVIEW DR
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 40   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 45.89
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0      0.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: POWERLINE RD BTWN ELKHORN BLVD AND DEL PASO RD
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 1172   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 60.56
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0     61.0    130.8

DO YOU WANT A HARD COPY? (Y/N)
```

Baseline No Project Conditions

```
RUN NAME: W. ELVERTA RD EAST OF POWERLINE RD
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 646   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 57.97
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0     88.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: INTERSTATE 5 WEST OF SR99/70 I-5 SPLIT
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 76000   SPEED: 65   ACTIVE HALF WIDTH (FT): 88
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 78.10
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 378.7    798.2   1711.0   3681.7

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: SR99/70 BTWN ELKHORN BLVD AND I-5 SPLIT
RUN DATE: OCTOBER 3, 2005
SCENARIO: EXISTING CONDITIONS (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING    NIGHT
    ---      -------    -----
AUTOS
    68.82    11.20      8.49
M-TRUCKS
     7.38     1.20      0.91
H-TRUCKS
     1.71     0.28      0.21

ADT: 47500   SPEED: 65   ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 77.88
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 273.1    583.2   1254.0   2700.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN SR99/70 AND E COMMERCE PKWY
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    68.82    11.20     8.49
M-TRUCKS
     7.38     1.20     0.91
H-TRUCKS
     1.71     0.28     0.21

ADT: 20620    SPEED: 45    ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 73.01
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  88.6    190.5    410.2    883.4

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: LONE TREE RD SOUTH OF ELKHORN BLVD
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    68.82    11.20     8.49
M-TRUCKS
     7.38     1.20     0.91
H-TRUCKS
     1.71     0.28     0.21

ADT: 1421    SPEED: 45    ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 61.40
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
   0.0      0.0     69.2    148.7

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN LONE TREE RD AND SR99/70 (JUST W)
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    68.82    11.20     8.49
M-TRUCKS
     7.38     1.20     0.91
H-TRUCKS
     1.71     0.28     0.21

ADT: 2103    SPEED: 45    ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 63.10
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
   0.0      0.0     89.8    193.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN POWERLINE RD AND LONE TREE RD (JUST W)
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    68.82    11.20     8.49
M-TRUCKS
     7.38     1.20     0.91
H-TRUCKS
     1.71     0.28     0.21

ADT: 212    SPEED: 45    ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT    GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 53.13
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
   0.0      0.0      0.0      0.0

DO YOU WANT A HARD COPY? (Y/N)
```

Baseline + Project + Meister Road Overpass

```
RUN NAME: W. ELVERTA RD EAST OF POWERLINE RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
    7.38    1.20      0.91
H-TRUCKS
    1.71    0.28      0.21

ADT: 760   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 58.68
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0      0.0      0.0     98.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: SR 99/70 BTWN W ELVERTA RD AND ELKHORN BLVD
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
    7.38    1.20      0.91
H-TRUCKS
    1.71    0.28      0.21

ADT: 86675   SPEED: 65   ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 80.49
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 405.3    869.8   1871.9   4031.4

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
    7.38    1.20      0.91
H-TRUCKS
    1.71    0.28      0.21

ADT: 6550   SPEED: 40   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 66.89
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  0.0     74.6    160.4    345.2

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCT 3
SCENARIO: BASELINE NO PROJECT

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY     EVENING   NIGHT
    ---     -------   -----
AUTOS
    68.82   11.20     8.49
M-TRUCKS
    7.38    1.20      0.91
H-TRUCKS
    1.71    0.28      0.21

ADT: 15470   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 71.76
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 73.2    157.3    338.7    729.4

DO YOU WANT A HARD COPY? (Y/N)
```

RUN NAME: LONE TREE RD SOUTH OF ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 8277 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 69.05
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	103.8	223.3	480.8

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD BTWN LONE TREE RD AND SR99/70 (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 15620 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 71.81
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
73.7	158.3	340.9	734.1

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD BTWN POWERLINE RD AND LONE TREE RD (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 4690 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 66.58
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	71.2	153.0	329.3

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: POWERLINE RD BTWN ELKHORN BLVD AND DEL PASO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 4830 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 66.71
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	72.6	156.0	335.8

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: SR 99/70 BTWN W ELVERTA RD AND ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.62	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 100195 SPEED: 65 ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 81.12
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
446.0	957.6	2061.2	4439.2

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.62	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 14140 SPEED: 40 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 70.23
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
58.0	124.4	267.6	576.3

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.62	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 20290 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 72.94
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
87.6	188.4	405.7	873.8

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD BTWN SR99/70 AND E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT + MEISTER RD OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.62	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 25620 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 73.95
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
102.3	220.1	473.9	1020.8

DO YOU WANT A HARD COPY? (Y/N)

```
RUN NAME: ELKHORN BLVD BTWN LONE TREE RD AND SR99/70 (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY    EVENING   NIGHT
    ---    -------   -----
AUTOS
    68.82   11.20    8.49
M-TRUCKS
     7.38    1.20    0.91
H-TRUCKS
     1.71    0.28    0.21

ADT: 22170   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 73.33
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  93.0    199.9    430.5    927.1

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: ELKHORN BLVD BTWN POWERLINE RD AND LONE TREE RD (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY    EVENING   NIGHT
    ---    -------   -----
AUTOS
    68.82   11.20    8.49
M-TRUCKS
     7.38    1.20    0.91
H-TRUCKS
     1.71    0.28    0.21

ADT: 13180   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 71.07
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  65.9    141.4    304.4    655.5

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: POWERLINE RD BTWN ELKHORN BLVD AND DEL PASO RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY    EVENING   NIGHT
    ---    -------   -----
AUTOS
    68.82   11.20    8.49
M-TRUCKS
     7.38    1.20    0.91
H-TRUCKS
     1.71    0.28    0.21

ADT: 11670   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 70.54
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
  60.8    130.4    280.7    604.5

DO YOU WANT A HARD COPY? (Y/N)
```

Baseline + Project No Overpass

```
RUN NAME: W. ELVERTA RD EAST OF POWERLINE RD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY    EVENING   NIGHT
    ---    -------   -----
AUTOS
    68.82   11.20    8.49
M-TRUCKS
     7.38    1.20    0.91
H-TRUCKS
     1.71    0.28    0.21

ADT: 2440   SPEED: 45   ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 63.74
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
   0.0      0.0     99.1    213.1

DO YOU WANT A HARD COPY? (Y/N)
```

RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 6710 SPEED: 40 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 66.99
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
0.0	75.8	163.0	350.8

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD EAST OF E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 18870 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 72.63
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
83.5	179.6	386.6	832.7

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: ELKHORN BLVD BTWN SR99/70 AND E COMMERCE PKWY
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 24150 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 73.70
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
98.4	211.6	455.7	981.6

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: LONE TREE RD SOUTH OF ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 17128 SPEED: 45 ACTIVE HALF WIDTH (FT): 6
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 72.21
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
78.3	168.4	362.5	780.6

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: MEISTER WAY BTWN LONE TREE AND SR 99/70 (ON PROJECT SITE)
RUN DATE: OCTOBER 3, 2005
SCENARIO: CUMULATIVE + PROPOSED PROJECT (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	67.76	11.06	8.38
M-TRUCKS	8.24	1.34	1.02
H-TRUCKS	1.71	0.28	0.21

ADT: 18900 SPEED: 35 ACTIVE HALF WIDTH (FT): 12
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 69.82
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
60.3	128.0	274.7	591.2

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: LONE TREE RD SOUTH OF ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: CUMULATIVE + PROPOSED PROJECT (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	67.76	11.06	8.38
M-TRUCKS	8.24	1.34	1.02
H-TRUCKS	1.71	0.28	0.21

ADT: 21870 SPEED: 45 ACTIVE HALF WIDTH (FT): 21
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 72.16
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
96.8	204.6	438.8	944.4

DO YOU WANT A HARD COPY? (Y/N)

Cumulative + Project Conditions (2005)

RUN NAME: ELKHORN BLVD BTWN LONE TREE RD AND SR 99/70 (JUST W)
RUN DATE: OCTOBER 3, 2005
SCENARIO: CUMULATIVE + PROPOSED PROJECT (2005)

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	67.76	11.06	8.38
M-TRUCKS	8.24	1.34	1.02
H-TRUCKS	1.71	0.28	0.21

ADT: 60940 SPEED: 45 ACTIVE HALF WIDTH (FT): 36
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 75.68
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
190.3	404.0	867.6	1867.5

DO YOU WANT A HARD COPY? (Y/N)

RUN NAME: SR 99/70 BTWN W ELVERTA RD AND ELKHORN BLVD
RUN DATE: OCTOBER 3, 2005
SCENARIO: BASELINE + PROJECT NO OVERPASS

TRAFFIC DISTRIBUTION PERCENTAGES

	DAY	EVENING	NIGHT
AUTOS	68.82	11.20	8.49
M-TRUCKS	7.38	1.20	0.91
H-TRUCKS	1.71	0.28	0.21

ADT: 101325 SPEED: 65 ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 81.17
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *

70 CNEL	65 CNEL	60 CNEL	55 CNEL
449.4	965.0	2077.2	4473.7

DO YOU WANT A HARD COPY? (Y/N)

```
RUN NAME: INTERSTATE 5 WEST OF SR 99/70 SPLIT
RUN DATE: OCTOBER 3, 2005
SCENARIO: CUMULATIVE + PROPOSED PROJECT (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    67.76    11.06     8.38
M-TRUCKS
     8.24     1.34     1.02
H-TRUCKS
     1.71     0.28     0.21

ADT: 102739   SPEED: 65   ACTIVE HALF WIDTH (FT): 88
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 79.60
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 472.0   1002.7   2153.2   4635.0

DO YOU WANT A HARD COPY? (Y/N)
```

```
RUN NAME: SR 99/70 BTWN ELKHORN BLVD AND I-5 SPLIT
RUN DATE: OCTOBER 3, 2005
SCENARIO: CUMULATIVE + PROPOSED PROJECT (2005)

    TRAFFIC DISTRIBUTION PERCENTAGES
    DAY      EVENING   NIGHT
    ---      -------   -----
AUTOS
    67.76    11.06     8.38
M-TRUCKS
     8.24     1.34     1.02
H-TRUCKS
     1.71     0.28     0.21

ADT: 64212   SPEED: 65   ACTIVE HALF WIDTH (FT): 40
SITE CHARACTERISTICS: SOFT   GRADE (PERCENT): .5

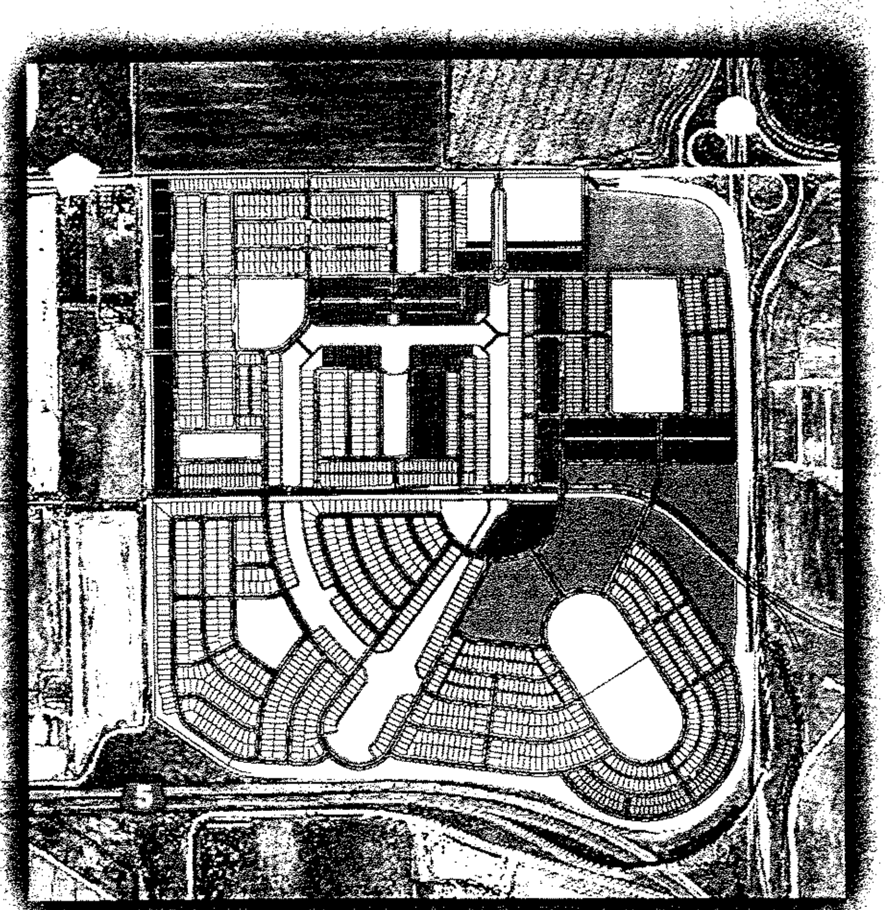
CNEL AT 50 FT FROM NEAR TRAVEL LANE CENTERLINE = 79.38
* * DISTANCE (FEET) FROM ROADWAY CENTERLINE TO CNEL * *
70 CNEL  65 CNEL  60 CNEL  55 CNEL
-------  -------  -------  -------
 342.5    733.7   1578.5   3399.3

DO YOU WANT A HARD COPY? (Y/N)
```

APPENDIX H

GREENBRIAR WATER STUDY

Greenbriar
Water Study



July 2005

Prepared by

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Greenbriar

Water Study

Sacramento, California

Prepared For:

City of Sacramento

July 2005

Prepared By:

WOOD RODGERS
ENGINEERING · PLANNING · MAPPING · SURVEYING
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PURPOSE

This water analysis is intended to assist in properly sizing the domestic transmission and distribution system for the Greenbriar Property. This analysis will confirm that the proposed water lines will be sized appropriately to meet or exceed the City of Sacramento's Water Distribution System Design Criteria.

STUDY AREA

Greenbriar is located within the North Natomas Vision Area and is currently outside the Sacramento City Limits. Request for annexation into the City is currently being processed. Greenbriar is located directly west of Highway 99 and north of Interstate 5. The development encompasses approximately 577 acres. The purpose of this study is to adequately size the transmission and distribution mains within the Greenbriar development. Land use for the Plan Area will consist of low, medium and high density residential, elementary school, parks, and commercially zoned properties. The existing land use consists of open agricultural fields with relatively gentle slopes.

Refer to **Figure 1** for the project location.

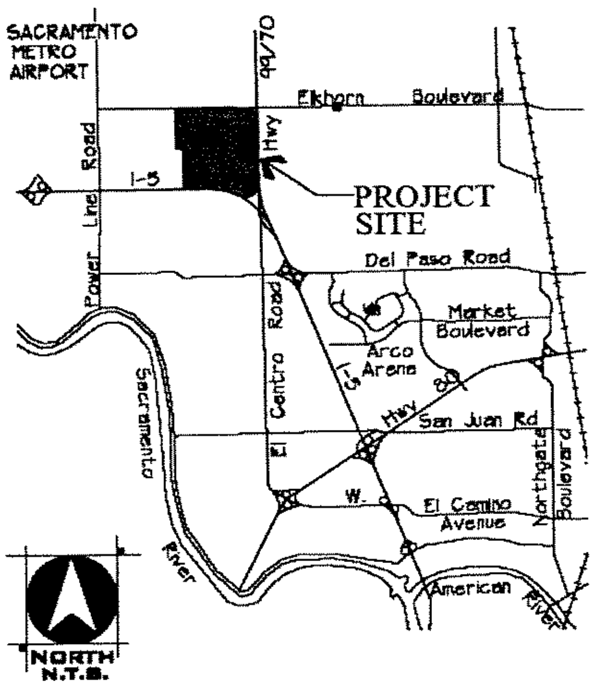


Figure 1 - Location Map.

ASSUMPTIONS

Assumptions used for this analysis are based on the proposed land use plan dated April 4, 2005 by Wood Rodgers, Inc.; the City of Sacramento's Department of Utilities staff; and the City of Sacramento's Water Distribution System Design Criteria.

Land Use

The Greenbriar development is proposed to consist of:

- 1,146 low density residential lots.
- 1,565 medium density residential lots.
- 1,012 high density residential lots.
- 26 acres of commercial.
- 49 acres of parks.

Figure 2 shows the proposed land use plan for Greenbriar.

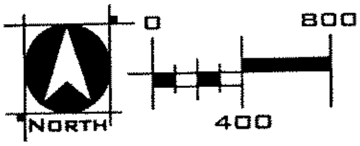
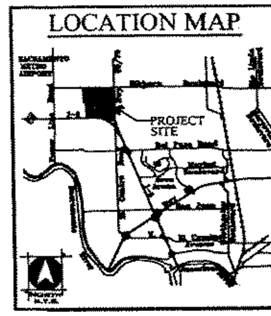


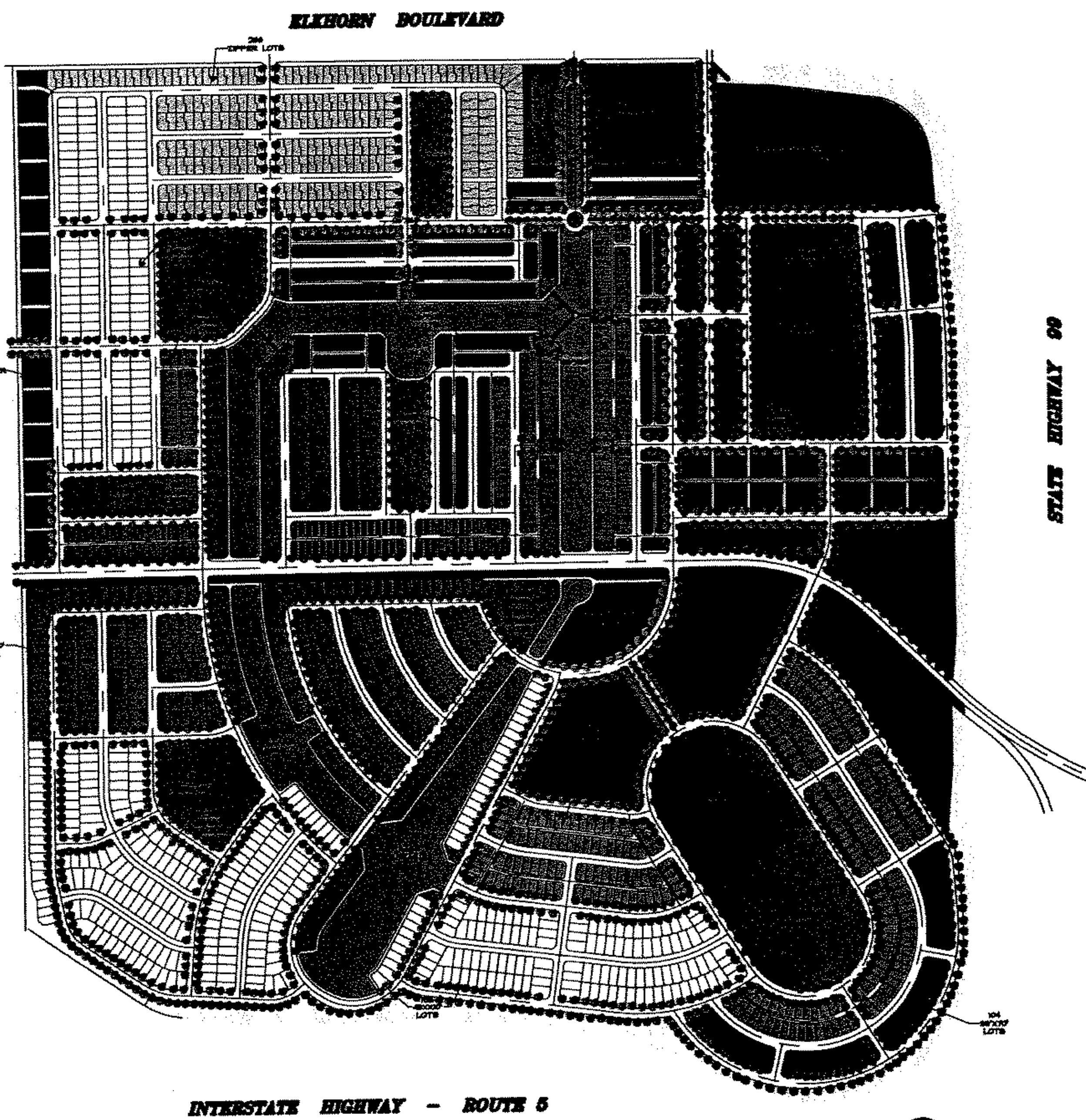
FIGURE 2. LAND USE PLAN

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY 2005





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Demand and Peaking Factors

The City's Water Distribution System Criteria were used to determine the proposed water use demands in the model. Peaking factors were used to simulate system-operating scenarios for the water distribution system analysis. Maximum Day Demands (MDD) were developed by applying a MDD factor of 1.8 to the Average Day Demand (ADD) estimates. The Peak Hour Demands (PHD) were developed by applying a PHD factor of 1.3 to the Maximum Day Demands (MDD). The demands were increased by 7.5% to account for system losses per City criteria. **Table 1** shows the ADD, MDD, and PHD used for the hydraulic modeling scenarios. Refer to **Appendix A** for complete demand projections.

Table 1 - Potable Water Demand Projections for Greenbriar.

Land Use Designation	Total		ADD Unit Water Demand		Demand (gpm)		
	Acres* (net)	Dwelling Units	gpm/ac	gpm/du	ADD	MDD	PHD
Low Density Residential	128	1,146	---	0.44	504	907	1179
Medium Density Residential	106	1,565	---	0.44	689	1240	1612
High Density Residential	45	1,012	2.48	---	112	202	262
Commercial	26	---	1.86	---	48	86	112
Parks/Landscape	84	---	2.60	---	217	391	508
Schools	10	---	1.55	---	16	29	37
Subtotal	399	3723			**1586**	**2855**	**3711**
7.5% System Losses					**119**	**214**	**278**
Totals					**1705**	**3069**	**3989**

*Acreage does not include street right of way.

Operational Requirements

The City of Sacramento has developed water distribution system design criteria to be used in the planning of new water distribution systems. These criteria apply to water studies that analyze subdivision level developments. The criteria help ensure adequate pressure and flow are available to serve customers on a daily basis and also during emergency fire situations. The criteria used in this study are listed in **Table 2**.

FIGURE 3. EXISTING DISTRIBUTION FACILITIES

GREENBRIAR

CITY OF SACRAMENTO

JULY 2005

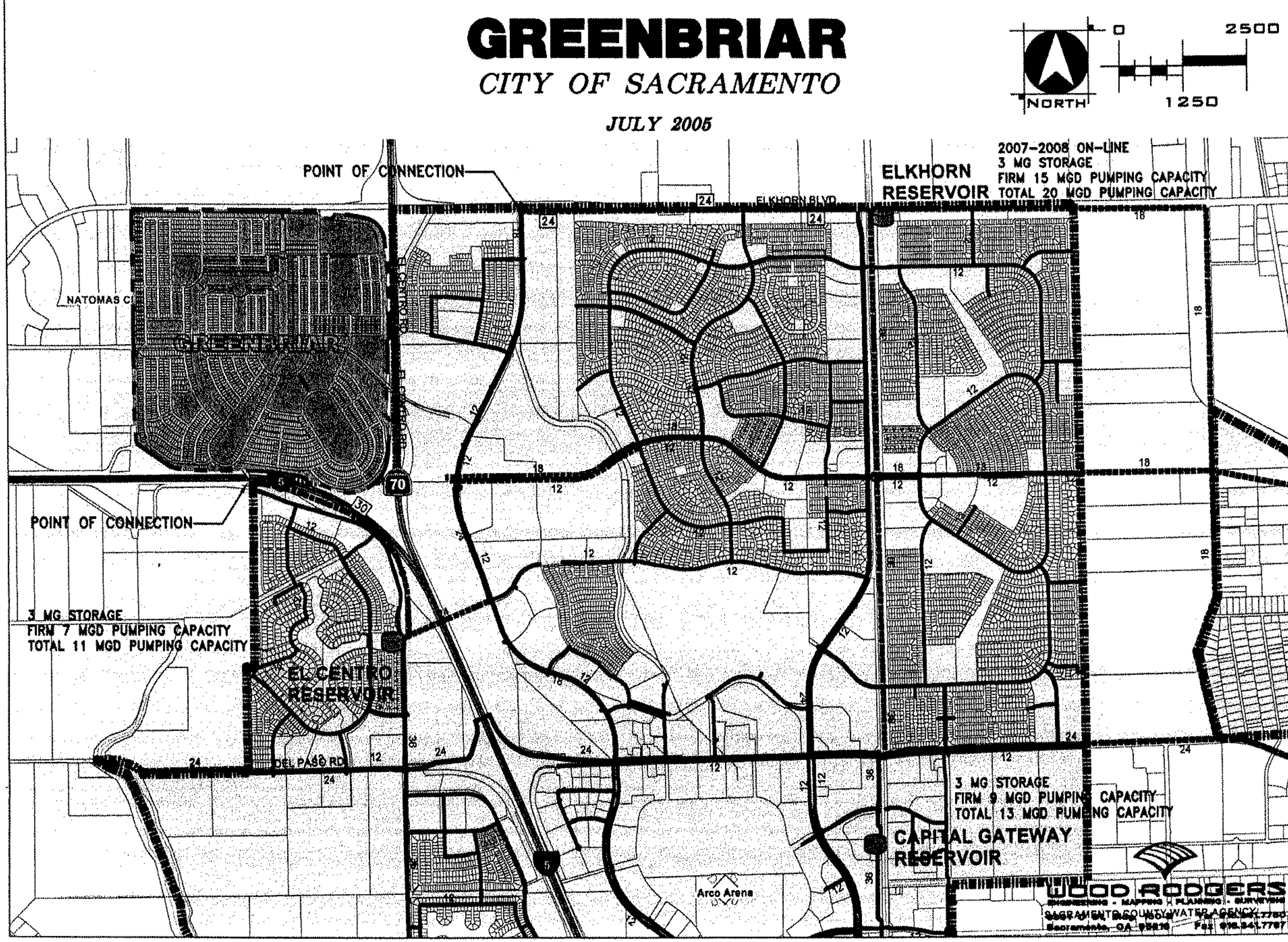


Table 3 - Boundary Conditions.

Point of Connection Location	Point of Connection ID	Hydraulic Grade Line (ft)		Pressure (psi)	
		MDD	PHD	MDD	PHD
Terminal End of Airport Connection	PUMP-105	91.4	91.2	30.1	30.0
Elkhorn Blvd and East Commerce Way	PUMP-107	96.7	95.9	30.6	30.2

Summary of Analysis

The water model was developed using MWH Soft, Inc. hydraulic modeling program, H_20NET version 6.0. An electronic copy of the water distribution model is available upon request.

The transmission and distribution system was laid out following the street centerline, creating a looped system. Pipe sizes range from 8-inch to 18-inch diameter with the larger diameter pipes looped around commercial and school sites to convey the higher fire flow requirements. Greenbriar was modeled independent of the surrounding developments. **Table 4** summarizes the model results for average day demands, maximum day demands, and peak hour demands.

Table 4 - System Hydraulic Modeling Scenario Results.

Demand Scenario	Greenbriar Demand (gpm)	Minimum System Pressure (psi)	Maximum System Velocity (fps)
Average Day	1,705	34	1.2
Maximum Day	3,069	31	2.2
Peak Hour	3,989	30	2.5

Figure 4 shows the layout of the proposed water system. A full size exhibit is located in **Appendix C**. Hardcopy results for the demand scenarios are located in **Appendix D**.

Fire Flow Results

Fire flow analyses were performed during maximum day demands. The fire flow demand requirements by land use are shown in **Table 2**. The fire flow analysis calculated the available fire flow at every required node in the system. **Table 5** lists the locations most sensitive to the fire flow demands.

Table 5 - Fire Flow Results During Maximum Day Demands.

Fire Flow Node	Required Fire Flow (gpm)	Total Plan Area Demand (gpm)	Minimum Pressure (psi)	Maximum Velocity (ft/sec)
GB-443	1,500	4,569	25	4.6
GB-313	2,000	5,069	23	5.8
GB-427	3,000	6,069	20	4.5

Hardcopy results for all scenarios are located in **Appendix D.**

Conclusions

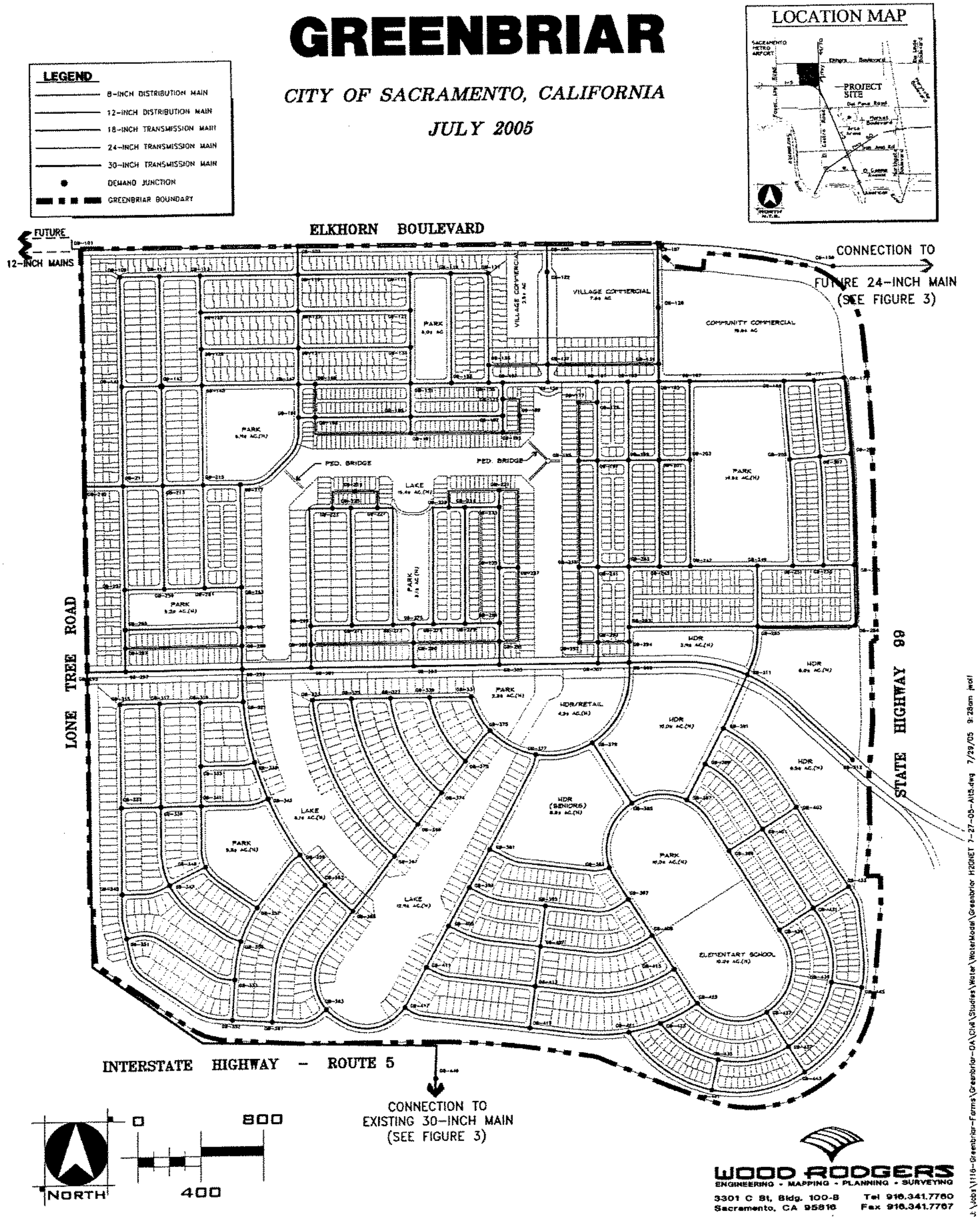
The City of Sacramento Water Distribution Design Criteria requirements were met for this water distribution system. There are several assumptions on which the hydraulic model is based. The model would require modification if any additional information becomes available that would affect the way water is delivered to the development.

FIGURE 4. DISTRIBUTION SYSTEM LAYOUT

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY 2005



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APPENDIX A

GREENBRIAR DEMAND SPREADSHEET

Greenbriar - Water Demand Spreadsheet

Model ID Label	Land Use Designation					Total Demand		
	Commercial	Parks/ Landscape	Schools	High Density Residential	Single Family Residential	ADD	MDD	PHD
	(acres)	(acres)	(acres)	(acres)	(units)	(gpm)	(gpm)	(gpm)
	1.86 gpm/acre	2.60 gpm/acre	1.55 gpm/acre	2.48 gpm/acre	0.44 gpm/unit			
	1.86	**2.600**	**1.55**	**2.48**	**0.44**			
GB-103		0.99				2.57	4.63	6.02
GB-105		0.99				2.57	4.63	6.02
GB-107						0.00	0.00	0.00
GB-108	7.81					14.53	26.15	33.99
GB-109					36	15.84	28.51	37.07
GB-111					20	8.80	15.84	20.59
GB-113					18	7.92	14.26	18.53
GB-115					30	13.20	23.76	30.89
GB-117					20	8.80	15.84	20.59
GB-119		1.48			14	10.01	18.01	23.42
GB-121					18	7.92	14.26	18.53
GB-122	6.32	1.15				14.75	26.54	34.50
GB-123					17	7.48	13.46	17.50
GB-125					29	12.76	22.97	29.86
GB-127					16	7.04	12.67	16.47
GB-128	11.60					21.58	38.84	50.49
GB-129					17	7.48	13.46	17.50
GB-131					28	12.32	22.18	28.83
GB-133					16	7.04	12.67	16.47
GB-135					14	6.16	11.09	14.41
GB-137					20	8.80	15.84	20.59
GB-139					20	8.80	15.84	20.59
GB-141					43	18.92	34.06	44.27
GB-143					26	11.44	20.59	26.77
GB-145					14	6.16	11.09	14.41
GB-147		3.42			6	11.53	20.76	26.98
GB-149					19	8.36	15.05	19.56
GB-151					22	9.68	17.42	22.65
GB-153		1.48			14	10.01	18.01	23.42
GB-155					8	3.52	6.34	8.24
GB-157					3	1.32	2.38	3.09
GB-159		0.13			6	2.98	5.36	6.97
GB-161					5	2.20	3.96	5.15
GB-163					11	4.84	8.71	11.33
GB-165					12	5.28	9.50	12.36
GB-167		3.70			6	12.26	22.07	28.69
GB-169					5	2.20	3.96	5.15
GB-171					10	4.40	7.92	10.30
GB-173		4.81			5	14.71	26.47	34.41
GB-175					2	0.88	1.58	2.06
GB-177					7	3.08	5.54	7.21
GB-179					12	5.28	9.50	12.36
GB-181					7	3.08	5.54	7.21
GB-183					24	10.56	19.01	24.71
GB-185					40	17.60	31.68	41.18
GB-187					22	9.68	17.42	22.65
GB-189					10	4.40	7.92	10.30
GB-191		0.13			21	9.58	17.24	22.41
GB-193		0.12			13	6.03	10.86	14.11
GB-195		0.12			13	6.03	10.86	14.11
GB-197					24	10.56	19.01	24.71
GB-199					24	10.56	19.01	24.71
GB-201					28	12.32	22.18	28.83
GB-203		3.70			14	15.78	28.40	36.93
GB-205		3.70			14	15.78	28.40	36.93
GB-207					28	12.32	22.18	28.83
GB-209					14	6.16	11.09	14.41
GB-210		3.70				9.62	17.32	22.51
GB-211					54	23.76	42.77	55.60
GB-213					26	11.44	20.59	26.77
GB-215		3.42			15	15.49	27.89	36.25
GB-217					14	6.16	11.09	14.41
GB-219					15	6.60	11.88	15.44
GB-221		0.23			19	8.96	16.12	20.96
GB-223		0.45			19	9.53	17.15	22.30
GB-225					12	5.28	9.50	12.36

Greenbriar - Water Demand Spreadsheet								
	Land Use Designation					Total Demand		
Model ID Label	Commercial	Parks/ Landscape	Schools	High Density Residential	Single Family Residential	ADD	MDD	PHD
	(acres)	(acres)	(acres)	(acres)	(units)	(gpm)	(gpm)	(gpm)
	1.86 gpm/acre	2.60 gpm/acre	1.55 gpm/acre	2.48 gpm/acre	0.44 gpm/unit			
	1.86	2.600	1.55	2.48	0.44			
GB-227					13	5.72	10.30	13.38
GB-229		1.55			13	9.75	17.55	22.82
GB-231					22	9.68	17.42	22.65
GB-233					14	6.16	11.09	14.41
GB-235					22	9.68	17.42	22.65
GB-237		0.12			14	6.47	11.65	15.14
GB-239		0.12			14	6.47	11.65	15.14
GB-241					28	12.32	22.18	28.83
GB-243					30	13.20	23.76	30.89
GB-245					28	12.32	22.18	28.83
GB-247					19	8.36	15.05	19.56
GB-249		3.70			20	18.42	33.16	43.10
GB-251					19	8.36	15.05	19.56
GB-253					28	12.32	22.18	28.83
GB-255		4.81			9	16.47	29.64	38.53
GB-257					25	11.00	19.80	25.74
GB-259					12	5.28	9.50	12.36
GB-261					13	5.72	10.30	13.38
GB-263					15	6.60	11.88	15.44
GB-265		1.58			20	12.91	23.23	30.20
GB-267		1.58			14	10.27	18.48	24.03
GB-269					22	9.68	17.42	22.65
GB-271					21	9.24	16.63	21.62
GB-273					12	5.28	9.50	12.36
GB-275		1.55			2	4.91	8.84	11.49
GB-277					12	5.28	9.50	12.36
GB-279					22	9.68	17.42	22.65
GB-281					11	4.84	8.71	11.33
GB-283					25	11.00	19.80	25.74
GB-285					30	13.20	23.76	30.89
GB-286					20	8.80	15.84	20.59
GB-287					20	8.80	15.84	20.59
GB-288					11	4.84	8.71	11.33
GB-289					8	3.52	6.34	8.24
GB-290					13	5.72	10.30	13.38
GB-291					19	8.36	15.05	19.56
GB-292					9	3.96	7.13	9.27
GB-293					16	7.04	12.67	16.47
GB-294				2.2		5.46	9.82	12.77
GB-295						0.00	0.00	0.00
GB-297						0.00	0.00	0.00
GB-299						0.00	0.00	0.00
GB-301						0.00	0.00	0.00
GB-303						0.00	0.00	0.00
GB-305						0.00	0.00	0.00
GB-307						0.00	0.00	0.00
GB-309						0.00	0.00	0.00
GB-311				6.75		16.74	30.13	39.17
GB-313				8.78		21.77	39.19	50.95
GB-315					18	7.92	14.26	18.53
GB-317					17	7.48	13.46	17.50
GB-319					11	4.84	8.71	11.33
GB-321					11	4.84	8.71	11.33
GB-323					26	11.44	20.59	26.77
GB-325					21	9.24	16.63	21.62
GB-327					17	7.48	13.46	17.50
GB-329					12	5.28	9.50	12.36
GB-331					5	2.20	3.96	5.15
GB-333					14	6.16	11.09	14.41
GB-335					12	5.28	9.50	12.36
GB-337					22	9.68	17.42	22.65
GB-339					19	8.36	15.05	19.56
GB-341		1.32			8	6.95	12.51	16.27
GB-343		1.32			5	5.63	10.14	13.18
GB-345					17	7.48	13.46	17.50
GB-347					20	8.80	15.84	20.59

Greenbriar - Water Demand Spreadsheet								
	Land Use Designation					Total Demand		
Model ID Label	Commercial	Parks/ Landscape	Schools	High Density Residential	Single Family Residential	ADD	MDD	PHD
	(acres) 1.86 gpm/acre	(acres) 2.60 gpm/acre	(acres) 1.55 gpm/acre	(acres) 2.48 gpm/acre	(units) 0.44 gpm/unit	(gpm)	(gpm)	(gpm)
	1.86	2.600	1.55	2.48	0.44			
GB-349					8	3.52	6.34	8.24
GB-351					25	11.00	19.80	25.74
GB-352		4.13			11	15.58	28.04	36.45
GB-353					19	8.36	15.05	19.56
GB-355					16	7.04	12.67	16.47
GB-357		1.32			10	7.83	14.10	18.33
GB-359		1.32			6	6.07	10.93	14.21
GB-361					19	8.36	15.05	19.56
GB-362					24	10.56	19.01	24.71
GB-363					13	5.72	10.30	13.38
GB-365		0.11			16	7.33	13.19	17.14
GB-367		0.10			22	9.94	17.89	23.26
GB-369					20	8.80	15.84	20.59
GB-371					16	7.04	12.67	16.47
GB-373					12	5.28	9.50	12.36
GB-375		2.42			3	7.61	13.70	17.81
GB-377				2.22	9	9.47	17.04	22.15
GB-379				9.46		23.46	42.23	54.90
GB-381				2.22	18	13.43	24.17	31.42
GB-383				2.22	8	9.03	16.25	21.12
GB-385				2.22		5.51	9.91	12.88
GB-387				2.49	4	7.94	14.28	18.57
GB-389					11	4.84	8.71	11.33
GB-391				6.72	7	19.75	35.54	46.20
GB-393		0.11			17	7.77	13.98	18.17
GB-395					18	7.92	14.26	18.53
GB-397		5.09			14	19.39	34.91	45.38
GB-399		5.09			11	18.07	32.53	42.29
GB-401					23	10.12	18.22	23.68
GB-403					13	5.72	10.30	13.38
GB-405		0.10			13	5.98	10.76	13.99
GB-407					26	11.44	20.59	26.77
GB-409					16	7.04	12.67	16.47
GB-411					20	8.80	15.84	20.59
GB-413					31	13.64	24.55	31.92
GB-415					16	7.04	12.67	16.47
GB-417		4.13			17	18.22	32.79	42.63
GB-419					13	5.72	10.30	13.38
GB-421		4.1			15	17.26	31.07	40.39
GB-423					13	5.72	10.30	13.38
GB-425			5.09		8	11.41	20.54	26.70
GB-427					13	5.72	10.30	13.38
GB-429			5.09		14	14.05	25.29	32.88
GB-431					26	11.44	20.59	26.77
GB-433		4.1			16	17.70	31.86	41.42
GB-435					20	8.80	15.84	20.59
GB-437					21	9.24	16.63	21.62
GB-439					21	9.24	16.63	21.62
GB-441					13	5.72	10.30	13.38
GB-443					14	6.16	11.09	14.41
GB-445					13	5.72	10.30	13.38
TOTAL	26	83	10	45	2,711	1586	2855	3711
DEMAND (gpm)	48	217	16	112	1,193			
			7.5% Unaccounted For Losses			119	214	278
				Total Demand		1705	3069	3989

APPENDIX B

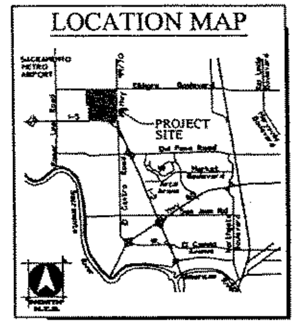
EXHIBITS - DISTRIBUTION SYSTEM CONNECTIONS

ALTERNATIVE 1 DISTRIBUTION SYSTEM CONNECTIONS

GREENBRIAR

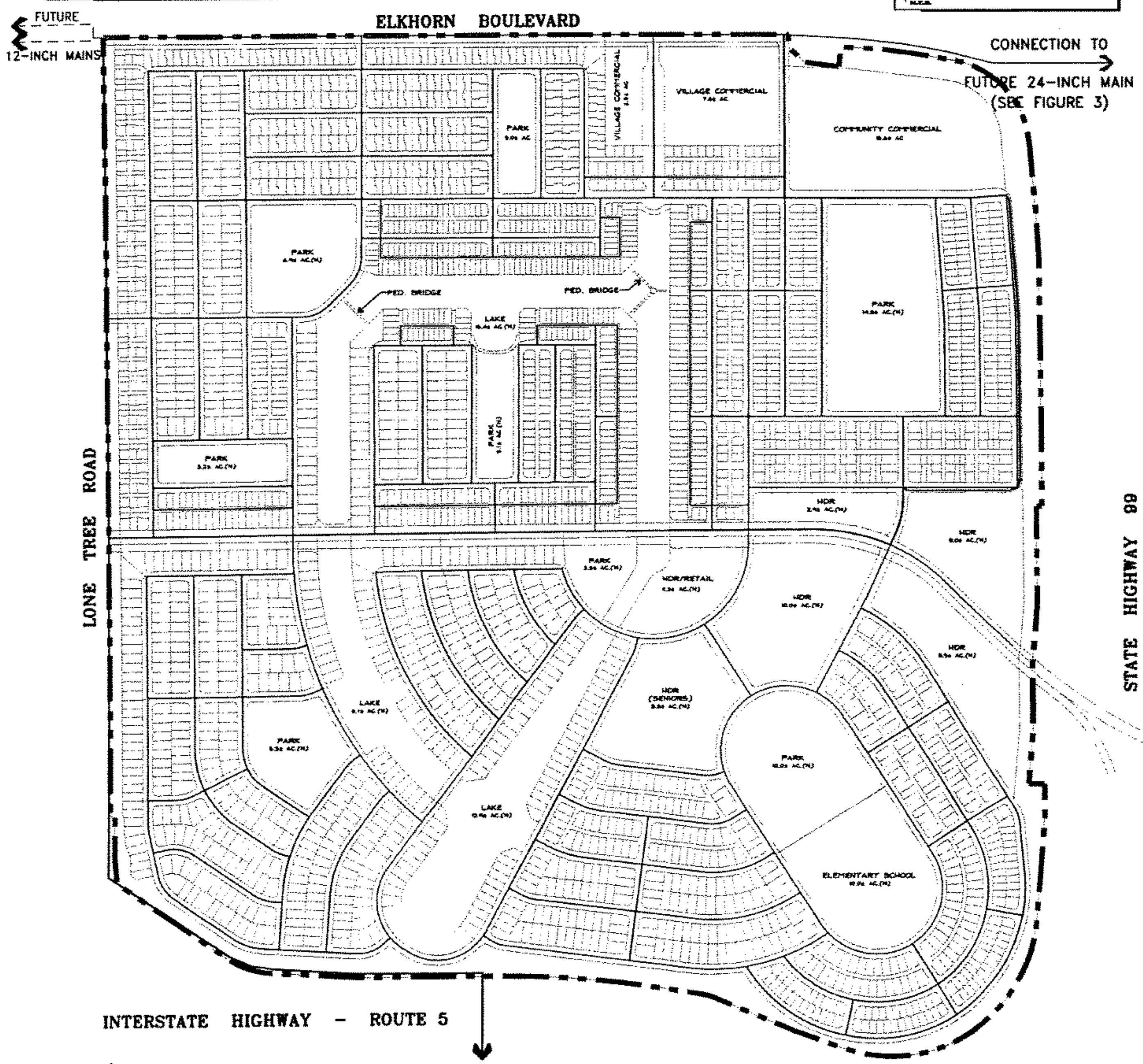
CITY OF SACRAMENTO, CALIFORNIA

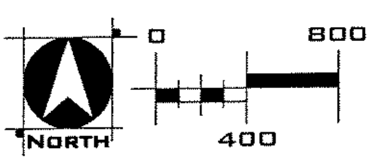
JULY 2005



LEGEND

- 8-INCH DISTRIBUTION MAIN
- 12-INCH DISTRIBUTION MAIN
- 18-INCH TRANSMISSION MAIN
- 24-INCH TRANSMISSION MAIN
- 30-INCH TRANSMISSION MAIN
- GREENBRIAR BOUNDARY





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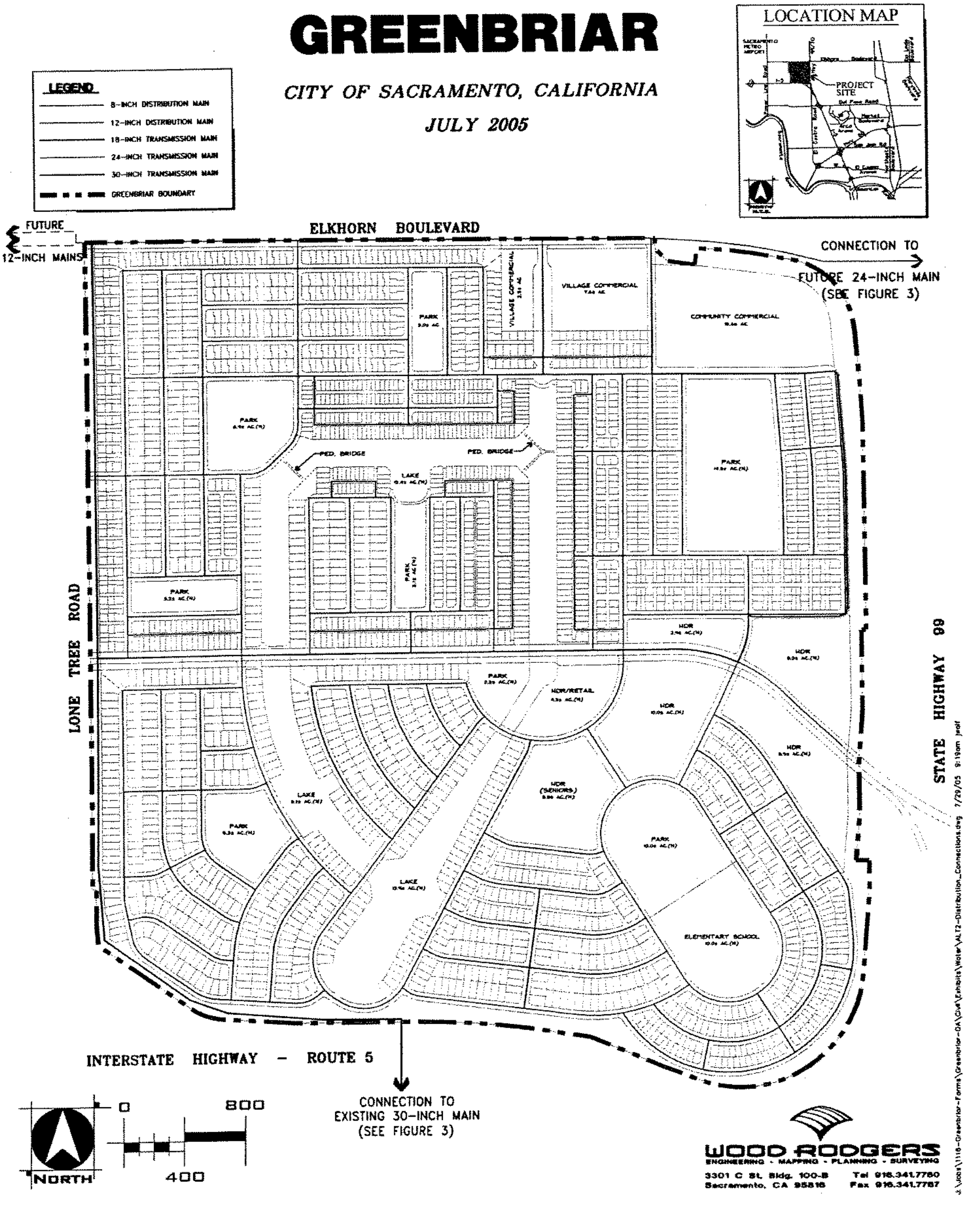
ALTERNATIVE 2 DISTRIBUTION SYSTEM CONNECTIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY 2005

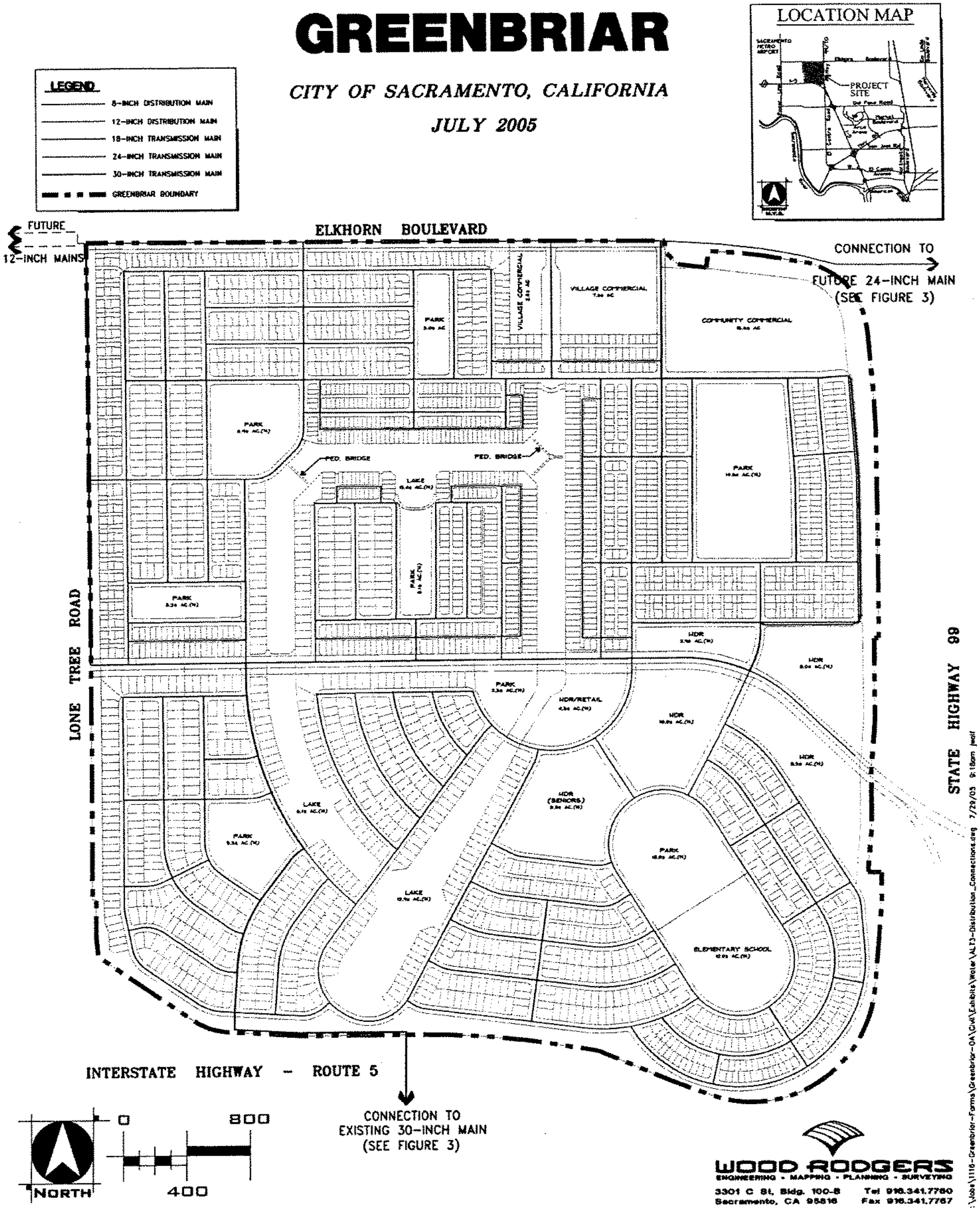


ALTERNATIVE 3 DISTRIBUTION SYSTEM CONNECTIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY 2005



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APPENDIX C

EXHIBIT - WATER DISTRIBUTION SYSTEM

APPENDIX D

H_2ONET ANALYSIS RESULTS

- AVERAGE DAY DEMANDS
- MAXIMUM DAY DEMANDS
- PEAK HOUR DEMANDS
- FIRE FLOW SUMMARY
- MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443
- MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313
- MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427

AVERAGE DAY DEMANDS

AVERAGE DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	104.30	36.53
GB-103	2.76	15.00	104.35	38.71
GB-105	2.76	19.00	104.44	37.02
GB-107	0.00	20.00	104.50	36.61
GB-108	15.62	21.00	104.75	36.29
GB-109	17.03	20.00	104.25	36.51
GB-111	9.46	20.00	104.25	36.51
GB-113	8.51	19.59	104.26	36.69
GB-115	14.19	18.97	104.32	36.98
GB-117	9.46	18.87	104.27	37.00
GB-119	10.76	18.84	104.27	37.02
GB-121	8.51	18.80	104.27	37.03
GB-122	15.86	18.80	104.44	37.11
GB-123	8.04	19.02	104.26	36.94
GB-125	13.72	18.39	104.27	37.21
GB-127	7.57	18.28	104.26	37.26
GB-128	23.20	18.50	104.41	37.23
GB-129	8.04	18.53	104.26	37.15
GB-131	13.24	17.81	104.26	37.46
GB-133	7.57	17.67	104.26	37.52
GB-135	6.62	17.23	104.27	37.71
GB-137	9.46	17.16	104.30	37.76
GB-139	9.46	17.85	104.34	37.48
GB-141	20.34	18.91	104.25	36.98
GB-143	12.30	18.52	104.25	37.15
GB-145	6.62	18.08	104.25	37.34
GB-147	12.39	17.24	104.25	37.70
GB-149	8.99	17.21	104.25	37.72
GB-151	10.41	16.99	104.26	37.81
GB-153	10.76	16.99	104.26	37.81
GB-155	3.78	16.94	104.27	37.84
GB-157	1.42	16.96	104.27	37.83
GB-159	3.20	16.62	104.28	37.98
GB-161	2.37	17.14	104.27	37.75
GB-163	5.20	17.39	104.28	37.65
GB-165	5.68	17.79	104.33	37.50
GB-167	13.18	18.26	104.31	37.28
GB-169	2.37	19.75	104.27	36.62
GB-171	4.73	20.27	104.26	36.39

AVERAGE DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	15.81	20.84	104.25	36.14
GB-175	0.95	16.69	104.26	37.94
GB-177	3.31	16.45	104.25	38.04
GB-179	5.68	16.82	104.25	37.88
GB-181	3.31	16.63	104.25	37.97
GB-183	11.35	16.54	104.25	38.01
GB-185	18.92	16.64	104.25	37.96
GB-187	10.41	16.47	104.26	38.04
GB-189	4.73	16.36	104.26	38.08
GB-191	10.30	16.28	104.25	38.12
GB-193	6.48	16.24	104.26	38.14
GB-195	6.48	16.38	104.24	38.07
GB-197	11.35	16.75	104.24	37.91
GB-199	11.35	17.29	104.24	37.68
GB-201	13.24	17.77	104.25	37.47
GB-203	16.96	18.25	104.25	37.26
GB-205	16.96	19.83	104.23	36.57
GB-207	13.24	20.34	104.23	36.35
GB-209	6.62	20.85	104.23	36.13
GB-210	10.34	15.00	104.28	38.69
GB-211	25.54	18.60	104.27	37.12
GB-213	12.30	17.80	104.25	37.46
GB-215	16.65	17.16	104.25	37.73
GB-217	6.62	16.45	104.25	38.04
GB-219	7.09	16.33	104.18	38.07
GB-221	9.63	16.30	104.18	38.08
GB-223	10.24	16.58	104.18	37.96
GB-225	5.68	16.63	104.18	37.93
GB-227	6.15	16.52	104.18	37.98
GB-229	10.48	16.65	104.18	37.92
GB-231	10.41	16.65	104.18	37.92
GB-233	6.62	16.59	104.18	37.95
GB-235	10.41	17.04	104.18	37.76
GB-237	6.96	16.54	104.18	37.98
GB-239	6.96	16.37	104.21	38.06
GB-241	13.24	16.74	104.21	37.90
GB-243	14.19	17.28	104.21	37.67
GB-245	13.24	17.76	104.21	37.46
GB-247	8.99	18.25	104.22	37.25

AVERAGE DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	19.80	19.30	104.21	36.79
GB-251	8.99	19.87	104.21	36.55
GB-253	13.24	20.36	104.21	36.33
GB-255	17.71	20.86	104.21	36.12
GB-257	11.82	18.14	104.25	37.31
GB-259	5.68	17.78	104.24	37.46
GB-261	6.15	17.15	104.24	37.74
GB-263	7.09	16.46	104.24	38.03
GB-265	13.88	18.00	104.24	37.37
GB-267	11.04	16.46	104.22	38.03
GB-269	10.41	16.52	104.19	37.99
GB-271	9.93	17.44	104.18	37.58
GB-273	5.68	18.00	104.18	37.34
GB-275	5.28	18.00	104.18	37.34
GB-277	5.68	18.00	104.18	37.34
GB-279	10.41	17.76	104.18	37.45
GB-281	5.20	17.04	104.18	37.76
GB-283	11.82	17.28	104.19	37.66
GB-285	14.19	19.52	104.19	36.69
GB-286	9.46	20.86	104.21	36.11
GB-287	9.46	18.00	104.25	37.37
GB-288	5.20	16.45	104.21	38.03
GB-289	3.78	16.52	104.19	37.99
GB-290	6.15	18.00	104.19	37.35
GB-291	8.99	17.04	104.18	37.76
GB-292	4.26	16.37	104.19	38.05
GB-293	7.57	16.74	104.18	37.89
GB-294	5.87	17.28	104.18	37.66
GB-295	0.00	15.00	104.27	38.68
GB-297	0.00	18.00	104.25	37.37
GB-299	0.00	16.45	104.21	38.02
GB-301	0.00	16.53	104.20	37.99
GB-303	0.00	18.00	104.19	37.35
GB-305	0.00	17.05	104.18	37.76
GB-307	0.00	16.86	104.18	37.84
GB-309	0.00	17.28	104.18	37.65
GB-311	18.00	19.13	104.18	36.85
GB-313	23.40	20.80	104.18	36.13
GB-315	8.51	18.00	104.10	37.31

AVERAGE DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	8.04	17.77	104.11	37.41
GB-319	5.20	17.24	104.12	37.65
GB-321	5.20	16.45	104.17	38.01
GB-323	12.30	16.54	104.08	37.93
GB-325	9.93	17.42	104.08	37.55
GB-327	8.04	18.00	104.08	37.30
GB-329	5.68	18.00	104.08	37.30
GB-331	2.37	17.39	104.09	37.56
GB-333	6.62	17.35	104.12	37.60
GB-335	5.68	16.42	104.13	38.00
GB-337	10.41	18.00	104.10	37.31
GB-339	8.99	18.00	104.10	37.31
GB-341	7.47	17.49	104.10	37.53
GB-343	6.05	16.16	104.11	38.11
GB-345	8.04	18.00	104.09	37.30
GB-347	9.46	18.00	104.09	37.30
GB-349	3.78	17.75	104.09	37.41
GB-351	11.82	18.00	104.08	37.30
GB-352	16.75	17.35	104.08	37.58
GB-353	8.99	17.91	104.08	37.34
GB-355	7.57	17.82	104.09	37.38
GB-357	8.42	17.40	104.09	37.56
GB-359	6.53	16.14	104.09	38.11
GB-361	8.99	17.26	104.08	37.62
GB-362	11.35	16.38	104.09	38.00
GB-363	6.15	16.29	104.08	38.04
GB-365	7.88	16.32	104.08	38.03
GB-367	10.69	16.59	104.08	37.91
GB-369	9.46	17.03	104.08	37.72
GB-371	7.57	16.87	104.08	37.79
GB-373	5.68	16.73	104.08	37.85
GB-375	8.18	16.59	104.09	37.92
GB-377	10.18	16.34	104.10	38.02
GB-379	25.22	17.08	104.11	37.71
GB-381	14.44	16.42	104.08	37.98
GB-383	9.71	18.29	104.08	37.17
GB-385	5.92	18.09	104.10	37.27
GB-387	8.54	18.82	104.10	36.95
GB-389	5.20	18.79	104.11	36.97

AVERAGE DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	21.23	18.77	104.13	36.99
GB-393	8.35	16.43	104.07	37.98
GB-395	8.51	17.71	104.07	37.42
GB-397	20.84	18.80	104.08	36.95
GB-399	19.43	19.79	104.09	36.53
GB-401	10.88	20.09	104.09	36.40
GB-403	6.15	20.39	104.09	36.27
GB-405	6.43	16.13	104.07	38.11
GB-407	12.30	17.95	104.07	37.32
GB-409	7.57	19.40	104.08	36.69
GB-411	9.46	16.46	104.07	37.96
GB-413	14.66	18.20	104.07	37.21
GB-415	7.57	19.96	104.07	36.45
GB-417	19.59	16.45	104.07	37.97
GB-419	6.15	18.63	104.07	37.02
GB-421	18.55	19.83	104.07	36.50
GB-423	6.15	20.20	104.07	36.34
GB-425	12.27	20.56	104.07	36.19
GB-427	6.15	21.58	104.08	35.75
GB-429	15.10	21.13	104.08	35.94
GB-431	12.30	21.45	104.08	35.80
GB-433	19.03	22.00	104.08	35.56
GB-435	9.46	21.27	104.07	35.88
GB-437	9.93	22.00	104.07	35.56
GB-439	9.93	22.00	104.07	35.56
GB-441	6.15	21.27	104.07	35.88
GB-443	6.62	22.00	104.07	35.56
GB-445	6.15	21.00	104.07	36.00
GB-446	0.00	22.00	104.27	35.65
GB-447	0.00	26.00	105.48	34.44

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	32.23	0.21	0.00
P102	117.50	8.00	130.00	-60.42	0.39	0.01
P103	739.21	8.00	130.00	40.96	0.26	0.04
P104	117.50	8.00	130.00	39.01	0.25	0.01
P105	117.50	8.00	130.00	47.12	0.30	0.01
P106	436.40	12.00	130.00	21.90	0.06	0.000
P107	650.57	8.00	130.00	17.22	0.11	0.01
P108	535.27	8.00	130.00	14.47	0.09	0.00
P109	357.35	18.00	130.00	-723.26	0.91	0.07
P110	243.09	12.00	130.00	-65.63	0.19	0.00
P111	253.19	8.00	130.00	-17.22	0.11	0.00
P112	380.98	8.00	130.00	35.81	0.23	0.01
P113	904.24	8.00	130.00	5.40	0.03	0.00
P114	693.26	8.00	130.00	-30.28	0.19	0.02
P115	105.50	8.00	130.00	-5.22	0.03	0.000
P116	147.51	12.00	130.00	44.63	0.13	0.00
P117	132.50	12.00	130.00	-49.10	0.14	0.00
P118	226.54	8.00	130.00	30.42	0.19	0.01
P119	193.01	8.00	130.00	8.31	0.05	0.000
P120	193.01	8.00	130.00	-8.73	0.06	0.000
P121	713.00	8.00	130.00	6.72	0.04	0.00
P122	615.89	8.00	130.00	-6.48	0.04	0.000
P123	713.00	8.00	130.00	-50.80	0.32	0.05
P124	677.66	8.00	130.00	-38.32	0.24	0.03
P125	476.65	8.00	130.00	-35.69	0.23	0.02
P126	117.50	8.00	130.00	-31.43	0.20	0.00
P127	677.66	8.00	130.00	40.74	0.26	0.03
P128	193.00	8.00	130.00	-8.76	0.06	0.000
P129	117.50	8.00	130.00	-33.43	0.21	0.00
P130	633.34	8.00	130.00	16.67	0.11	0.01
P131	232.72	8.00	130.00	24.89	0.16	0.00
P132	233.02	8.00	130.00	26.45	0.17	0.01
P133	618.66	8.00	130.00	20.17	0.13	0.01
P134	713.00	8.00	130.00	-14.89	0.10	0.01
P135	195.00	8.00	130.00	18.12	0.12	0.00
P136	193.00	8.00	130.00	33.89	0.22	0.01
P137	112.20	18.00	130.00	666.03	0.84	0.02
P138	701.50	8.00	130.00	-47.77	0.30	0.05
P139	378.03	8.00	130.00	-53.11	0.34	0.03

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	-13.30	0.08	0.00
P141	253.00	8.00	130.00	18.97	0.12	0.00
P142	233.00	8.00	130.00	-22.37	0.14	0.00
P143	233.00	8.00	130.00	-29.69	0.19	0.01
P144	232.70	8.00	130.00	-17.56	0.11	0.00
P145	574.54	8.00	130.00	11.80	0.08	0.00
P146	105.50	8.00	130.00	46.31	0.30	0.01
P147	126.23	8.00	130.00	25.67	0.16	0.00
P148	126.78	8.00	130.00	-8.06	0.05	0.000
P149	388.16	8.00	130.00	8.80	0.06	0.00
P150	117.50	8.00	130.00	3.96	0.03	0.0000
P151	611.16	8.00	130.00	-7.22	0.05	0.00
P152	418.00	8.00	130.00	-0.05	0.000	0.0000
P153	97.50	8.00	130.00	-0.23	0.00	0.00
P154	261.76	8.00	130.00	-4.68	0.03	0.000
P155	839.51	8.00	130.00	-7.06	0.05	0.00
P156	170.40	8.00	130.00	2.31	0.01	0.0000
P157	116.20	8.00	130.00	0.00	0.000	0.00
P158	248.92	8.00	130.00	-5.49	0.04	0.000
P159	247.10	8.00	130.00	8.50	0.05	0.000
P160	247.67	8.00	130.00	18.41	0.12	0.00
P161	247.82	8.00	130.00	28.53	0.18	0.01
P162	247.00	8.00	130.00	-17.68	0.11	0.00
P163	249.87	8.00	130.00	-11.98	0.08	0.00
P164	1,149.31	8.00	130.00	5.72	0.04	0.00
P165	710.72	12.00	130.00	-35.85	0.10	0.00
P166	369.00	8.00	130.00	13.48	0.09	0.00
P167	253.00	8.00	130.00	9.69	0.06	0.000
P168	918.21	8.00	130.00	9.22	0.06	0.00
P169	282.81	8.00	130.00	24.29	0.16	0.01
P170	333.36	12.00	130.00	-57.99	0.16	0.00
P171	253.00	8.00	130.00	41.19	0.26	0.01
P172	234.54	8.00	130.00	27.59	0.18	0.01
P173	253.00	8.00	130.00	19.68	0.13	0.00
P174	657.99	8.00	130.00	16.52	0.11	0.01
P175	633.34	8.00	130.00	6.36	0.04	0.000
P176	253.02	8.00	130.00	5.50	0.04	0.000
P177	633.34	8.00	130.00	27.27	0.17	0.01
P178	242.02	12.00	130.00	132.25	0.38	0.01

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	49.48	0.32	0.02
P180	273.00	8.00	130.00	-23.28	0.15	0.00
P181	628.13	12.00	130.00	6.61	0.02	0.000
P182	797.55	12.00	130.00	14.96	0.04	0.000
P183	578.83	12.00	130.00	43.19	0.12	0.00
P184	193.00	8.00	130.00	-4.39	0.03	0.000
P185	653.19	8.00	130.00	6.10	0.04	0.000
P186	193.00	8.00	130.00	-0.65	0.00	0.00000
P187	193.00	8.00	130.00	0.16	0.000	0.00
P188	437.56	8.00	130.00	4.25	0.03	0.000
P189	203.57	12.00	130.00	-14.06	0.04	0.000
P190	596.95	8.00	130.00	24.63	0.16	0.01
P191	292.91	8.00	130.00	-3.17	0.02	0.000
P192	695.05	8.00	130.00	-2.35	0.01	0.000
P193	253.00	8.00	130.00	4.72	0.03	0.000
P194	656.00	8.00	130.00	-18.21	0.12	0.01
P195	504.88	8.00	130.00	-20.86	0.13	0.01
P196	313.32	8.00	130.00	-12.75	0.08	0.00
P197	549.00	8.00	130.00	19.58	0.13	0.01
P198	253.00	8.00	130.00	15.28	0.10	0.00
P199	253.00	8.00	130.00	26.91	0.17	0.01
P200	253.00	8.00	130.00	43.03	0.27	0.01
P201	403.00	8.00	130.00	20.51	0.13	0.01
P202	276.11	8.00	130.00	75.19	0.48	0.04
P203	253.02	8.00	130.00	-46.85	0.30	0.02
P204	253.02	8.00	130.00	-24.39	0.16	0.00
P205	236.90	8.00	130.00	-10.35	0.07	0.000
P206	636.18	8.00	130.00	16.97	0.11	0.01
P207	211.30	8.00	130.00	10.28	0.07	0.000
P208	232.70	8.00	130.00	27.39	0.17	0.01
P209	233.00	8.00	130.00	42.55	0.27	0.01
P210	233.00	8.00	130.00	91.33	0.58	0.05
P211	621.42	8.00	130.00	-57.44	0.37	0.06
P212	253.02	8.00	130.00	-34.60	0.22	0.01
P213	699.07	8.00	130.00	-9.54	0.06	0.00
P214	253.02	8.00	130.00	3.61	0.02	0.000
P215	613.13	8.00	130.00	2.01	0.01	0.000
P216	253.00	8.00	130.00	25.96	0.17	0.01
P217	233.00	8.00	130.00	23.72	0.15	0.00

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	42.05	0.27	0.01
P219	313.50	8.00	130.00	-34.56	0.22	0.01
P220	391.14	12.00	130.00	172.59	0.49	0.04
P221	590.71	8.00	130.00	12.57	0.08	0.00
P222	253.00	8.00	130.00	13.92	0.09	0.00
P223	390.32	8.00	130.00	30.54	0.19	0.01
P224	430.55	8.00	130.00	21.89	0.14	0.01
P225	248.33	12.00	130.00	137.77	0.39	0.02
P226	430.73	8.00	130.00	13.54	0.09	0.00
P227	412.22	12.00	130.00	109.83	0.31	0.02
P228	262.25	12.00	130.00	14.35	0.04	0.000
P229	253.00	12.00	130.00	27.32	0.08	0.000
P230	273.31	12.00	130.00	42.62	0.12	0.00
P231	234.73	12.00	130.00	75.93	0.22	0.01
P232	422.16	12.00	130.00	-76.56	0.22	0.01
P233	596.34	12.00	130.00	-66.14	0.19	0.01
P234	591.74	12.00	130.00	-41.77	0.12	0.00
P235	587.67	12.00	130.00	-197.91	0.56	0.07
P236	457.95	12.00	130.00	-76.88	0.22	0.01
P237	359.68	12.00	130.00	24.76	0.07	0.000
P238	193.00	8.00	130.00	-2.02	0.01	0.0000
P239	487.33	8.00	130.00	42.82	0.27	0.03
P240	486.84	8.00	130.00	-35.68	0.23	0.02
P241	708.39	8.00	130.00	-30.37	0.19	0.02
P242	617.10	8.00	130.00	-28.35	0.18	0.02
P243	319.69	18.00	130.00	-276.07	0.35	0.01
P244	861.88	12.00	130.00	-23.40	0.07	0.00
P245	534.05	18.00	130.00	-120.42	0.15	0.00
P246	627.02	18.00	130.00	-75.79	0.10	0.00
P247	195.01	18.00	130.00	-124.89	0.16	0.00
P248	751.91	18.00	130.00	21.66	0.03	0.000
P249	370.87	12.00	130.00	-213.01	0.60	0.05
P250	602.79	8.00	130.00	-26.06	0.17	0.01
P251	656.30	8.00	130.00	-12.90	0.08	0.00
P252	501.81	8.00	130.00	-50.07	0.32	0.04
P253	464.05	12.00	130.00	95.72	0.27	0.02
P254	250.56	12.00	130.00	89.76	0.25	0.01
P255	423.72	8.00	130.00	-12.84	0.08	0.00
P256	235.04	8.00	130.00	-17.96	0.11	0.00

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	29.15	0.19	0.01
P258	656.00	8.00	130.00	14.71	0.09	0.00
P259	497.14	8.00	130.00	15.72	0.10	0.00
P260	494.52	8.00	130.00	-6.44	0.04	0.000
P261	466.36	8.00	130.00	-5.37	0.03	0.000
P262	616.00	8.00	130.00	-3.87	0.02	0.000
P263	651.25	8.00	130.00	2.12	0.01	0.000
P264	246.49	8.00	130.00	22.96	0.15	0.00
P265	375.42	12.00	130.00	-95.80	0.27	0.01
P266	665.79	8.00	130.00	27.63	0.18	0.02
P267	285.98	8.00	130.00	-8.64	0.06	0.000
P268	272.69	8.00	130.00	10.48	0.07	0.00
P269	744.21	8.00	130.00	8.01	0.05	0.00
P270	105.50	8.00	130.00	2.37	0.02	0.0000
P271	892.22	8.00	130.00	14.09	0.09	0.01
P272	193.00	8.00	130.00	6.55	0.04	0.000
P273	105.50	8.00	130.00	10.00	0.06	0.000
P274	698.75	8.00	130.00	-1.43	0.01	0.0000
P275	181.50	12.00	130.00	-213.76	0.61	0.03
P276	112.20	8.00	130.00	-33.19	0.21	0.00
P277	698.70	8.00	130.00	-12.99	0.08	0.00
P278	713.00	8.00	130.00	-4.56	0.03	0.000
P279	422.00	8.00	130.00	-25.20	0.16	0.01
P280	117.50	8.00	130.00	4.32	0.03	0.0000
P281	589.97	8.00	130.00	-94.61	0.60	0.14
P282	130.50	8.00	130.00	-73.84	0.47	0.02
P283	410.65	18.00	130.00	-746.46	0.94	0.08
P284	500.49	8.00	130.00	-66.46	0.42	0.06
P285	807.99	8.00	130.00	12.16	0.08	0.00
P286	193.00	8.00	130.00	1.31	0.01	0.0000
P287	263.00	8.00	130.00	-2.19	0.01	0.0000
P288	738.30	8.00	130.00	10.37	0.07	0.00
P289	233.02	8.00	130.00	-14.32	0.09	0.00
P290	739.64	8.00	130.00	-30.27	0.19	0.02
P291	252.00	8.00	130.00	-8.84	0.06	0.000
P292	262.03	8.00	130.00	-22.63	0.14	0.00
P293	924.17	8.00	130.00	-4.53	0.03	0.000
P294	770.75	8.00	130.00	-3.25	0.02	0.000
P295	956.68	8.00	130.00	12.78	0.08	0.01

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-42.91	0.27	0.04
P297	678.13	8.00	130.00	31.09	0.20	0.02
P298	837.42	8.00	130.00	10.76	0.07	0.00
P299	557.94	8.00	130.00	-33.81	0.22	0.02
P300	696.14	8.00	130.00	-2.34	0.01	0.000
P301	468.04	8.00	130.00	-4.45	0.03	0.000
P302	255.36	8.00	130.00	-18.91	0.12	0.00
P303	247.32	8.00	130.00	21.27	0.14	0.00
P304	208.11	12.00	130.00	-252.98	0.72	0.04
P305	88.53	8.00	130.00	5.68	0.04	0.000
P306	193.00	8.00	130.00	-97.85	0.62	0.05
P307	582.27	8.00	130.00	18.13	0.12	0.01
P308	677.66	8.00	130.00	-41.12	0.26	0.03
P309	195.00	8.00	130.00	-41.64	0.27	0.01
P310	132.50	12.00	130.00	-51.36	0.15	0.00
P311	380.98	8.00	130.00	-42.70	0.27	0.02
P312	475.68	8.00	130.00	-39.42	0.25	0.02
P313	655.89	8.00	130.00	-14.06	0.09	0.00
P314	653.93	8.00	130.00	-20.70	0.13	0.01
P315	215.00	8.00	130.00	0.19	0.00	0.00000
P316	195.01	8.00	130.00	9.24	0.06	0.000
P317	214.88	8.00	130.00	-11.54	0.07	0.00
P318	252.22	8.00	130.00	3.23	0.02	0.000
P319	245.38	8.00	130.00	3.87	0.02	0.000
P320	607.50	8.00	130.00	-7.69	0.05	0.00
P321	574.53	8.00	130.00	-11.94	0.08	0.00
P322	105.50	8.00	130.00	-28.97	0.18	0.00
P323	212.18	8.00	130.00	11.66	0.07	0.00
P324	105.50	8.00	130.00	6.62	0.04	0.000
P325	211.00	8.00	130.00	-6.95	0.04	0.000
P326	211.30	8.00	130.00	-19.88	0.13	0.00
P327	209.82	8.00	130.00	-16.39	0.10	0.00
P328	728.60	8.00	130.00	-7.73	0.05	0.00
P329	594.64	8.00	130.00	0.89	0.01	0.00
P330	258.06	8.00	130.00	-8.40	0.05	0.000
P331	499.01	8.00	130.00	4.45	0.03	0.000
P332	545.88	8.00	130.00	-12.47	0.08	0.00
P333	783.02	8.00	130.00	-10.08	0.06	0.00
P334	260.55	12.00	130.00	-24.46	0.07	0.000

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	13.25	0.08	0.00
P336	255.00	8.00	130.00	9.26	0.06	0.000
P337	255.07	8.00	130.00	5.87	0.04	0.000
P338	255.00	12.00	130.00	148.88	0.42	0.02
P339	255.00	12.00	130.00	-109.86	0.31	0.01
P340	255.00	8.00	130.00	-9.00	0.06	0.000
P341	255.00	8.00	130.00	-10.70	0.07	0.00
P342	246.98	8.00	130.00	-6.58	0.04	0.000
P343	253.00	8.00	130.00	-23.23	0.15	0.00
P344	147.50	12.00	130.00	42.41	0.12	0.00
P345	147.37	12.00	130.00	68.13	0.19	0.00
P346	147.50	12.00	130.00	82.65	0.23	0.00
P347	147.59	12.00	130.00	-96.18	0.27	0.00
P348	381.04	8.00	130.00	-21.39	0.14	0.01
P349	190.72	18.00	130.00	-306.17	0.39	0.01
P350	253.02	8.00	130.00	15.60	0.10	0.00
P351	233.00	8.00	130.00	-4.78	0.03	0.000
P352	1,365.42	24.00	130.00	613.00	0.43	0.05
P353	1,505.76	30.00	130.00	-613.00	0.28	0.02
P354	369.99	8.00	130.00	-30.12	0.19	0.01
P355	369.99	8.00	130.00	-34.73	0.22	0.01
P356	117.50	8.00	130.00	-14.68	0.09	0.000
P357	195.00	8.00	130.00	-30.17	0.19	0.01
P358	193.00	8.00	130.00	-31.63	0.20	0.01
P359	500.49	8.00	130.00	-51.01	0.33	0.04
P360	500.78	8.00	130.00	-76.70	0.49	0.08
P361	677.66	8.00	130.00	-40.58	0.26	0.03
P362	482.45	12.00	130.00	-22.37	0.06	0.00
P363	677.66	8.00	130.00	-38.86	0.25	0.03
P364	1,180.18	30.00	130.00	-470.41	0.21	0.01
P365	1,577.01	24.00	130.00	-829.52	0.59	0.10
P366	701.50	24.00	130.00	-942.75	0.67	0.05
P367	242.00	18.00	130.00	470.41	0.59	0.02
P368	738.68	18.00	130.00	387.76	0.49	0.04
P369	253.00	8.00	130.00	-11.92	0.08	0.00
P370	660.09	8.00	130.00	-32.58	0.21	0.02
P371	193.00	18.00	130.00	485.80	0.61	0.02
P372	595.91	18.00	130.00	406.16	0.51	0.04
P373	191.34	18.00	130.00	353.72	0.45	0.01

AVERAGE DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	2.70	0.02	0.0000
P375	607.50	8.00	130.00	-13.23	0.08	0.00
P376	438.00	18.00	130.00	230.96	0.29	0.01
P377	650.57	18.00	130.00	162.83	0.21	0.01
P378	112.20	8.00	130.00	-79.81	0.51	0.02
P379	117.50	8.00	130.00	31.99	0.20	0.00
P380	348.36	8.00	130.00	15.25	0.10	0.00
P381	178.10	12.00	130.00	-110.47	0.31	0.01
P382	1,122.42	24.00	130.00	-1,689.21	1.20	0.26
P383	93.09	8.00	130.00	-43.04	0.27	0.01
P384	195.01	8.00	130.00	14.19	0.09	0.00
P385	4,416.05	30.00	130.00	0.00	0.00	0.00
P386	3,100.00	24.00	130.00	-1,704.83	1.21	0.72
P388	1,581.75	18.00	130.00	254.68	0.32	0.04
P389	621.96	18.00	130.00	238.26	0.30	0.02
P990	235.86	99.00	130.00	0.00	0.00	0.00
P991	377.34	99.00	130.00	0.00	0.00	0.00
P992	233.99	99.00	130.00	1,704.83	0.07	0.0000
P993	232.72	99.00	130.00	1,704.83	0.07	0.0000

AVERAGE DAY DEMANDS - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	35.65	0.00	0.00
PUMP107	26.00	34.44	1,704.83	105.48

Maximum Day Demands

MAXIMUM DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	93.16	31.70
GB-103	4.98	15.00	93.30	33.93
GB-105	4.98	19.00	93.59	32.32
GB-107	0.00	20.00	93.75	31.96
GB-108	28.11	21.00	94.51	31.85
GB-109	30.65	20.00	93.02	31.64
GB-111	17.03	20.00	93.03	31.64
GB-113	15.33	19.59	93.06	31.83
GB-115	25.54	18.97	93.23	32.17
GB-117	17.03	18.87	93.07	32.15
GB-119	19.36	18.84	93.06	32.16
GB-121	15.33	18.80	93.06	32.18
GB-122	28.53	18.80	93.57	32.40
GB-123	14.47	19.02	93.05	32.08
GB-125	24.69	18.39	93.08	32.36
GB-127	13.62	18.28	93.06	32.40
GB-128	41.75	18.50	93.50	32.50
GB-129	14.47	18.53	93.04	32.29
GB-131	23.84	17.81	93.04	32.60
GB-133	13.62	17.67	93.04	32.66
GB-135	11.92	17.23	93.07	32.86
GB-137	17.03	17.16	93.16	32.93
GB-139	17.03	17.85	93.30	32.69
GB-141	36.61	18.91	93.02	32.11
GB-143	22.13	18.52	93.02	32.28
GB-145	11.92	18.08	93.02	32.47
GB-147	22.32	17.24	93.02	32.84
GB-149	16.18	17.21	93.02	32.85
GB-151	18.73	16.99	93.03	32.95
GB-153	19.36	16.99	93.05	32.96
GB-155	6.82	16.94	93.06	32.98
GB-157	2.56	16.96	93.06	32.97
GB-159	5.76	16.62	93.11	33.14
GB-161	4.26	17.14	93.07	32.90
GB-163	9.36	17.39	93.10	32.81
GB-165	10.21	17.79	93.24	32.69
GB-167	23.73	18.26	93.19	32.47
GB-169	4.26	19.75	93.07	31.77
GB-171	8.51	20.27	93.04	31.53

MAXIMUM DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	28.46	20.84	93.02	31.28
GB-175	1.70	16.69	93.04	33.08
GB-177	5.96	16.45	93.00	33.17
GB-179	10.21	16.82	93.02	33.02
GB-181	5.96	16.63	93.02	33.10
GB-183	20.44	16.54	93.02	33.14
GB-185	34.06	16.64	93.03	33.10
GB-187	18.73	16.47	93.03	33.17
GB-189	8.51	16.36	93.04	33.22
GB-191	18.53	16.28	93.02	33.26
GB-193	11.67	16.24	93.03	33.27
GB-195	11.67	16.38	92.97	33.19
GB-197	20.44	16.75	92.98	33.03
GB-199	20.44	17.29	92.99	32.80
GB-201	23.84	17.77	93.01	32.60
GB-203	30.53	18.25	93.01	32.39
GB-205	30.53	19.83	92.97	31.69
GB-207	23.84	20.34	92.97	31.47
GB-209	11.92	20.85	92.97	31.25
GB-210	18.62	15.00	93.11	33.84
GB-211	45.98	18.60	93.07	32.27
GB-213	22.13	17.80	93.02	32.59
GB-215	29.98	17.16	93.00	32.86
GB-217	11.92	16.45	93.00	33.17
GB-219	12.77	16.33	92.81	33.14
GB-221	17.33	16.30	92.80	33.15
GB-223	18.44	16.58	92.81	33.03
GB-225	10.21	16.63	92.81	33.01
GB-227	11.07	16.52	92.81	33.06
GB-229	18.87	16.65	92.80	32.99
GB-231	18.73	16.65	92.80	32.99
GB-233	11.92	16.59	92.80	33.02
GB-235	18.73	17.04	92.80	32.83
GB-237	12.52	16.54	92.80	33.05
GB-239	12.52	16.37	92.89	33.15
GB-241	23.84	16.74	92.89	32.99
GB-243	25.54	17.28	92.89	32.76
GB-245	23.84	17.76	92.91	32.56
GB-247	16.18	18.25	92.91	32.35

MAXIMUM DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	35.65	19.30	92.89	31.89
GB-251	16.18	19.87	92.91	31.65
GB-253	23.84	20.36	92.91	31.44
GB-255	31.86	20.86	92.91	31.22
GB-257	21.28	18.14	93.00	32.44
GB-259	10.21	17.78	93.00	32.59
GB-261	11.07	17.15	92.99	32.86
GB-263	12.77	16.46	92.97	33.16
GB-265	24.97	18.00	93.00	32.50
GB-267	19.87	16.46	92.94	33.14
GB-269	18.73	16.52	92.83	33.06
GB-271	17.88	17.44	92.81	32.66
GB-273	10.21	18.00	92.81	32.42
GB-275	9.50	18.00	92.82	32.42
GB-277	10.21	18.00	92.81	32.41
GB-279	18.73	17.76	92.81	32.52
GB-281	9.36	17.04	92.81	32.83
GB-283	21.28	17.28	92.83	32.74
GB-285	25.54	19.52	92.84	31.77
GB-286	17.03	20.86	92.89	31.21
GB-287	17.03	18.00	93.01	32.50
GB-288	9.36	16.45	92.90	33.13
GB-289	6.82	16.52	92.85	33.07
GB-290	11.07	18.00	92.83	32.42
GB-291	16.18	17.04	92.82	32.84
GB-292	7.66	16.37	92.83	33.13
GB-293	13.62	16.74	92.82	32.97
GB-294	10.56	17.28	92.82	32.73
GB-295	0.00	15.00	93.08	33.83
GB-297	0.00	18.00	93.02	32.51
GB-299	0.00	16.45	92.89	33.12
GB-301	0.00	16.53	92.86	33.07
GB-303	0.00	18.00	92.83	32.43
GB-305	0.00	17.05	92.82	32.83
GB-307	0.00	16.86	92.82	32.91
GB-309	0.00	17.28	92.81	32.73
GB-311	32.39	19.13	92.81	31.93
GB-313	42.13	20.80	92.81	31.20
GB-315	15.33	18.00	92.58	32.31

MAXIMUM DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	14.47	17.77	92.59	32.42
GB-319	9.36	17.24	92.64	32.67
GB-321	9.36	16.45	92.77	33.07
GB-323	22.13	16.54	92.51	32.92
GB-325	17.88	17.42	92.51	32.54
GB-327	14.47	18.00	92.52	32.29
GB-329	10.21	18.00	92.52	32.29
GB-331	4.26	17.39	92.53	32.56
GB-333	11.92	17.35	92.62	32.62
GB-335	10.21	16.42	92.65	33.03
GB-337	18.73	18.00	92.56	32.31
GB-339	16.18	18.00	92.57	32.31
GB-341	13.45	17.49	92.58	32.54
GB-343	10.90	16.16	92.60	33.12
GB-345	14.47	18.00	92.54	32.30
GB-347	17.03	18.00	92.55	32.30
GB-349	6.82	17.75	92.55	32.41
GB-351	21.28	18.00	92.52	32.29
GB-352	30.14	17.35	92.52	32.57
GB-353	16.18	17.91	92.52	32.33
GB-355	13.62	17.82	92.54	32.38
GB-357	15.16	17.40	92.54	32.56
GB-359	11.75	16.14	92.55	33.11
GB-361	16.18	17.26	92.51	32.61
GB-362	20.44	16.38	92.53	33.00
GB-363	11.07	16.29	92.51	33.03
GB-365	14.18	16.32	92.52	33.02
GB-367	19.23	16.59	92.52	32.90
GB-369	17.03	17.03	92.51	32.71
GB-371	13.62	16.87	92.52	32.78
GB-373	10.21	16.73	92.52	32.84
GB-375	14.73	16.59	92.54	32.91
GB-377	18.32	16.34	92.56	33.02
GB-379	45.40	17.08	92.59	32.72
GB-381	25.98	16.42	92.51	32.97
GB-383	17.47	18.29	92.52	32.16
GB-385	10.65	18.09	92.56	32.27
GB-387	15.35	18.82	92.57	31.95
GB-389	9.36	18.79	92.60	31.98

MAXIMUM DAY DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	38.21	18.77	92.65	32.01
GB-393	15.03	16.43	92.50	32.96
GB-395	15.33	17.71	92.49	32.40
GB-397	37.53	18.80	92.50	31.94
GB-399	34.97	19.79	92.54	31.52
GB-401	19.59	20.09	92.54	31.39
GB-403	11.07	20.39	92.54	31.26
GB-405	11.57	16.13	92.49	33.09
GB-407	22.13	17.95	92.49	32.30
GB-409	13.62	19.40	92.50	31.67
GB-411	17.03	16.46	92.49	32.95
GB-413	26.39	18.20	92.49	32.19
GB-415	13.62	19.96	92.49	31.43
GB-417	35.25	16.45	92.49	32.95
GB-419	11.07	18.63	92.49	32.00
GB-421	33.40	19.83	92.49	31.48
GB-423	11.07	20.20	92.49	31.32
GB-425	22.08	20.56	92.49	31.17
GB-427	11.07	21.58	92.50	30.73
GB-429	27.19	21.13	92.51	30.93
GB-431	22.13	21.45	92.51	30.79
GB-433	34.25	22.00	92.51	30.55
GB-435	17.03	21.27	92.49	30.86
GB-437	17.88	22.00	92.49	30.54
GB-439	17.88	22.00	92.49	30.55
GB-441	11.07	21.27	92.49	30.86
GB-443	11.92	22.00	92.49	30.54
GB-445	11.07	21.00	92.49	30.98
GB-446	0.00	22.00	93.08	30.80
GB-447	0.00	26.00	96.66	30.62

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	58.01	0.37	0.01
P102	117.50	8.00	130.00	-108.76	0.69	0.04
P103	739.21	8.00	130.00	73.73	0.47	0.11
P104	117.50	8.00	130.00	70.21	0.45	0.02
P105	117.50	8.00	130.00	84.81	0.54	0.02
P106	436.40	12.00	130.00	39.40	0.11	0.00
P107	650.57	8.00	130.00	31.00	0.20	0.02
P108	535.27	8.00	130.00	26.05	0.17	0.01
P109	357.35	18.00	130.00	-1,301.83	1.64	0.20
P110	243.09	12.00	130.00	-118.11	0.34	0.01
P111	253.19	8.00	130.00	-31.00	0.20	0.01
P112	380.98	8.00	130.00	64.45	0.41	0.04
P113	904.24	8.00	130.00	9.75	0.06	0.00
P114	693.26	8.00	130.00	-54.51	0.35	0.06
P115	105.50	8.00	130.00	-9.39	0.06	0.000
P116	147.51	12.00	130.00	80.32	0.23	0.00
P117	132.50	12.00	130.00	-88.37	0.25	0.00
P118	226.54	8.00	130.00	54.75	0.35	0.02
P119	193.01	8.00	130.00	14.96	0.10	0.00
P120	193.01	8.00	130.00	-15.70	0.10	0.00
P121	713.00	8.00	130.00	12.10	0.08	0.00
P122	615.89	8.00	130.00	-11.66	0.07	0.00
P123	713.00	8.00	130.00	-91.44	0.58	0.16
P124	677.66	8.00	130.00	-68.98	0.44	0.09
P125	476.65	8.00	130.00	-64.24	0.41	0.05
P126	117.50	8.00	130.00	-56.57	0.36	0.01
P127	677.66	8.00	130.00	73.32	0.47	0.10
P128	193.00	8.00	130.00	-15.78	0.10	0.00
P129	117.50	8.00	130.00	-60.18	0.38	0.01
P130	633.34	8.00	130.00	30.01	0.19	0.02
P131	232.72	8.00	130.00	44.80	0.29	0.01
P132	233.02	8.00	130.00	47.61	0.30	0.02
P133	618.66	8.00	130.00	36.31	0.23	0.02
P134	713.00	8.00	130.00	-26.80	0.17	0.02
P135	195.00	8.00	130.00	32.62	0.21	0.01
P136	193.00	8.00	130.00	61.01	0.39	0.02
P137	112.20	18.00	130.00	1,198.83	1.51	0.06
P138	701.50	8.00	130.00	-85.98	0.55	0.14
P139	378.03	8.00	130.00	-95.59	0.61	0.09

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	-23.94	0.15	0.01
P141	253.00	8.00	130.00	34.14	0.22	0.01
P142	233.00	8.00	130.00	-40.26	0.26	0.01
P143	233.00	8.00	130.00	-53.44	0.34	0.02
P144	232.70	8.00	130.00	-31.60	0.20	0.01
P145	574.54	8.00	130.00	21.24	0.14	0.01
P146	105.50	8.00	130.00	83.35	0.53	0.02
P147	126.23	8.00	130.00	46.20	0.29	0.01
P148	126.78	8.00	130.00	-14.50	0.09	0.000
P149	388.16	8.00	130.00	15.87	0.10	0.00
P150	117.50	8.00	130.00	7.15	0.05	0.000
P151	611.16	8.00	130.00	-12.95	0.08	0.00
P152	418.00	8.00	130.00	-1.21	0.01	0.0000
P153	97.50	8.00	130.00	0.71	0.00	0.00000
P154	261.76	8.00	130.00	-8.43	0.05	0.000
P155	839.51	8.00	130.00	-12.71	0.08	0.00
P156	170.40	8.00	130.00	4.16	0.03	0.000
P157	116.20	8.00	130.00	-0.05	0.000	0.00
P158	248.92	8.00	130.00	-9.87	0.06	0.000
P159	247.10	8.00	130.00	15.31	0.10	0.00
P160	247.67	8.00	130.00	33.14	0.21	0.01
P161	247.82	8.00	130.00	51.35	0.33	0.02
P162	247.00	8.00	130.00	-31.82	0.20	0.01
P163	249.87	8.00	130.00	-21.56	0.14	0.00
P164	1,149.31	8.00	130.00	10.30	0.07	0.00
P165	710.72	12.00	130.00	-64.53	0.18	0.01
P166	369.00	8.00	130.00	24.27	0.15	0.01
P167	253.00	8.00	130.00	17.44	0.11	0.00
P168	918.21	8.00	130.00	16.59	0.11	0.01
P169	282.81	8.00	130.00	43.72	0.28	0.02
P170	333.36	12.00	130.00	-104.37	0.30	0.01
P171	253.00	8.00	130.00	74.14	0.47	0.04
P172	234.54	8.00	130.00	49.65	0.32	0.02
P173	253.00	8.00	130.00	35.42	0.23	0.01
P174	657.99	8.00	130.00	29.72	0.19	0.02
P175	633.34	8.00	130.00	11.45	0.07	0.00
P176	253.02	8.00	130.00	9.91	0.06	0.000
P177	633.34	8.00	130.00	49.09	0.31	0.04
P178	242.02	12.00	130.00	238.04	0.68	0.04

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	89.06	0.57	0.05
P180	273.00	8.00	130.00	-41.89	0.27	0.01
P181	628.13	12.00	130.00	11.89	0.03	0.000
P182	797.55	12.00	130.00	27.08	0.08	0.00
P183	578.83	12.00	130.00	77.73	0.22	0.01
P184	193.00	8.00	130.00	-7.89	0.05	0.000
P185	653.19	8.00	130.00	10.99	0.07	0.00
P186	193.00	8.00	130.00	-1.17	0.01	0.00000
P187	193.00	8.00	130.00	0.30	0.00	0.00000
P188	437.56	8.00	130.00	7.66	0.05	0.000
P189	203.57	12.00	130.00	-25.32	0.07	0.000
P190	596.95	8.00	130.00	44.33	0.28	0.03
P191	292.91	8.00	130.00	-5.55	0.04	0.000
P192	695.05	8.00	130.00	-3.92	0.03	0.000
P193	253.00	8.00	130.00	8.61	0.05	0.000
P194	656.00	8.00	130.00	-32.78	0.21	0.02
P195	504.88	8.00	130.00	-37.54	0.24	0.02
P196	313.32	8.00	130.00	-22.94	0.15	0.01
P197	549.00	8.00	130.00	35.25	0.22	0.02
P198	253.00	8.00	130.00	27.50	0.18	0.01
P199	253.00	8.00	130.00	48.43	0.31	0.02
P200	253.00	8.00	130.00	77.45	0.49	0.04
P201	403.00	8.00	130.00	36.91	0.24	0.02
P202	276.11	8.00	130.00	135.34	0.86	0.12
P203	253.02	8.00	130.00	-84.32	0.54	0.05
P204	253.02	8.00	130.00	-43.91	0.28	0.01
P205	236.90	8.00	130.00	-18.64	0.12	0.00
P206	636.18	8.00	130.00	30.54	0.19	0.02
P207	211.30	8.00	130.00	18.50	0.12	0.00
P208	232.70	8.00	130.00	49.30	0.31	0.02
P209	233.00	8.00	130.00	76.59	0.49	0.04
P210	233.00	8.00	130.00	164.40	1.05	0.15
P211	621.42	8.00	130.00	-103.38	0.66	0.17
P212	253.02	8.00	130.00	-62.29	0.40	0.03
P213	699.07	8.00	130.00	-17.18	0.11	0.01
P214	253.02	8.00	130.00	6.49	0.04	0.000
P215	613.13	8.00	130.00	3.62	0.02	0.000
P216	253.00	8.00	130.00	46.73	0.30	0.02
P217	233.00	8.00	130.00	42.70	0.27	0.01

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	75.68	0.48	0.04
P219	313.50	8.00	130.00	-62.21	0.40	0.03
P220	391.14	12.00	130.00	310.66	0.88	0.11
P221	590.71	8.00	130.00	22.62	0.14	0.01
P222	253.00	8.00	130.00	25.05	0.16	0.01
P223	390.32	8.00	130.00	54.97	0.35	0.03
P224	430.55	8.00	130.00	39.39	0.25	0.02
P225	248.33	12.00	130.00	247.98	0.70	0.05
P226	430.73	8.00	130.00	24.38	0.16	0.01
P227	412.22	12.00	130.00	197.68	0.56	0.05
P228	262.25	12.00	130.00	25.85	0.07	0.000
P229	253.00	12.00	130.00	49.22	0.14	0.00
P230	273.31	12.00	130.00	76.75	0.22	0.01
P231	234.73	12.00	130.00	136.70	0.39	0.01
P232	422.16	12.00	130.00	-137.83	0.39	0.03
P233	596.34	12.00	130.00	-119.06	0.34	0.03
P234	591.74	12.00	130.00	-75.20	0.21	0.01
P235	587.67	12.00	130.00	-356.22	1.01	0.22
P236	457.95	12.00	130.00	-138.39	0.39	0.03
P237	359.68	12.00	130.00	44.56	0.13	0.00
P238	193.00	8.00	130.00	-3.63	0.02	0.000
P239	487.33	8.00	130.00	77.07	0.49	0.08
P240	486.84	8.00	130.00	-64.22	0.41	0.06
P241	708.39	8.00	130.00	-54.66	0.35	0.06
P242	617.10	8.00	130.00	-51.03	0.33	0.05
P243	319.69	18.00	130.00	-496.90	0.63	0.03
P244	861.88	12.00	130.00	-42.13	0.12	0.01
P245	534.05	18.00	130.00	-216.76	0.27	0.01
P246	627.02	18.00	130.00	-136.43	0.17	0.01
P247	195.01	18.00	130.00	-224.80	0.28	0.00
P248	751.91	18.00	130.00	38.97	0.05	0.000
P249	370.87	12.00	130.00	-383.41	1.09	0.16
P250	602.79	8.00	130.00	-46.91	0.30	0.04
P251	656.30	8.00	130.00	-23.23	0.15	0.01
P252	501.81	8.00	130.00	-90.13	0.58	0.11
P253	464.05	12.00	130.00	172.30	0.49	0.05
P254	250.56	12.00	130.00	161.55	0.46	0.02
P255	423.72	8.00	130.00	-23.11	0.15	0.01
P256	235.04	8.00	130.00	-32.33	0.21	0.01

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	52.46	0.33	0.03
P258	656.00	8.00	130.00	26.48	0.17	0.01
P259	497.14	8.00	130.00	28.30	0.18	0.01
P260	494.52	8.00	130.00	-11.59	0.07	0.00
P261	466.36	8.00	130.00	-9.67	0.06	0.00
P262	616.00	8.00	130.00	-6.96	0.04	0.00
P263	651.25	8.00	130.00	3.81	0.02	0.000
P264	246.49	8.00	130.00	41.32	0.26	0.01
P265	375.42	12.00	130.00	-172.42	0.49	0.04
P266	665.79	8.00	130.00	49.74	0.32	0.05
P267	285.98	8.00	130.00	-15.40	0.10	0.00
P268	272.69	8.00	130.00	18.77	0.12	0.00
P269	744.21	8.00	130.00	14.42	0.09	0.01
P270	105.50	8.00	130.00	3.17	0.02	0.0000
P271	892.22	8.00	130.00	25.35	0.16	0.02
P272	193.00	8.00	130.00	11.80	0.08	0.000
P273	105.50	8.00	130.00	18.00	0.11	0.00
P274	698.75	8.00	130.00	-2.57	0.02	0.000
P275	181.50	12.00	130.00	-384.76	1.09	0.08
P276	112.20	8.00	130.00	-59.74	0.38	0.01
P277	698.70	8.00	130.00	-23.39	0.15	0.01
P278	713.00	8.00	130.00	-8.22	0.05	0.00
P279	422.00	8.00	130.00	-45.35	0.29	0.03
P280	117.50	8.00	130.00	7.78	0.05	0.000
P281	589.97	8.00	130.00	-170.30	1.09	0.41
P282	130.50	8.00	130.00	-132.90	0.85	0.06
P283	410.65	18.00	130.00	-1,343.58	1.69	0.25
P284	500.49	8.00	130.00	-119.63	0.76	0.18
P285	807.99	8.00	130.00	21.89	0.14	0.01
P286	193.00	8.00	130.00	2.35	0.02	0.0000
P287	263.00	8.00	130.00	-4.11	0.03	0.000
P288	738.30	8.00	130.00	18.66	0.12	0.01
P289	233.02	8.00	130.00	-25.77	0.16	0.00
P290	739.64	8.00	130.00	-54.49	0.35	0.06
P291	252.00	8.00	130.00	-15.91	0.10	0.00
P292	262.03	8.00	130.00	-40.73	0.26	0.01
P293	924.17	8.00	130.00	-8.15	0.05	0.00
P294	770.75	8.00	130.00	-5.85	0.04	0.00
P295	956.68	8.00	130.00	23.01	0.15	0.02

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-77.23	0.49	0.11
P297	678.13	8.00	130.00	55.97	0.36	0.06
P298	837.42	8.00	130.00	19.36	0.12	0.01
P299	557.94	8.00	130.00	-60.86	0.39	0.06
P300	696.14	8.00	130.00	-4.21	0.03	0.000
P301	468.04	8.00	130.00	-8.00	0.05	0.00
P302	255.36	8.00	130.00	-34.03	0.22	0.01
P303	247.32	8.00	130.00	38.29	0.24	0.01
P304	208.11	12.00	130.00	-455.36	1.29	0.12
P305	88.53	8.00	130.00	10.22	0.07	0.000
P306	193.00	8.00	130.00	-176.13	1.12	0.14
P307	582.27	8.00	130.00	32.62	0.21	0.02
P308	677.66	8.00	130.00	-74.01	0.47	0.10
P309	195.00	8.00	130.00	-74.95	0.48	0.03
P310	132.50	12.00	130.00	-92.44	0.26	0.00
P311	380.98	8.00	130.00	-76.86	0.49	0.06
P312	475.68	8.00	130.00	-70.95	0.45	0.06
P313	655.89	8.00	130.00	-25.30	0.16	0.01
P314	653.93	8.00	130.00	-37.26	0.24	0.03
P315	215.00	8.00	130.00	-0.78	0.00	0.0000
P316	195.01	8.00	130.00	16.63	0.11	0.00
P317	214.88	8.00	130.00	-20.76	0.13	0.00
P318	252.22	8.00	130.00	5.80	0.04	0.000
P319	245.38	8.00	130.00	6.97	0.04	0.000
P320	607.50	8.00	130.00	-13.84	0.09	0.00
P321	574.53	8.00	130.00	-21.50	0.14	0.01
P322	105.50	8.00	130.00	-52.15	0.33	0.01
P323	212.18	8.00	130.00	20.99	0.13	0.00
P324	105.50	8.00	130.00	11.93	0.08	0.000
P325	211.00	8.00	130.00	-12.50	0.08	0.00
P326	211.30	8.00	130.00	-35.79	0.23	0.01
P327	209.82	8.00	130.00	-29.50	0.19	0.01
P328	728.60	8.00	130.00	-13.91	0.09	0.00
P329	594.64	8.00	130.00	1.65	0.01	0.0000
P330	258.06	8.00	130.00	-15.18	0.10	0.00
P331	499.01	8.00	130.00	8.09	0.05	0.00
P332	545.88	8.00	130.00	-22.42	0.14	0.01
P333	783.02	8.00	130.00	-18.13	0.12	0.01
P334	260.55	12.00	130.00	-44.05	0.12	0.00

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	23.85	0.15	0.00
P336	255.00	8.00	130.00	16.68	0.11	0.00
P337	255.07	8.00	130.00	10.57	0.07	0.00
P338	255.00	12.00	130.00	267.97	0.76	0.06
P339	255.00	12.00	130.00	-197.74	0.56	0.03
P340	255.00	8.00	130.00	-16.20	0.10	0.00
P341	255.00	8.00	130.00	-19.25	0.12	0.00
P342	246.98	8.00	130.00	-11.84	0.08	0.00
P343	253.00	8.00	130.00	-41.81	0.27	0.01
P344	147.50	12.00	130.00	76.33	0.22	0.00
P345	147.37	12.00	130.00	122.62	0.35	0.01
P346	147.50	12.00	130.00	148.76	0.42	0.01
P347	147.59	12.00	130.00	-173.12	0.49	0.01
P348	381.04	8.00	130.00	-38.50	0.25	0.02
P349	190.72	18.00	130.00	-551.09	0.69	0.02
P350	253.02	8.00	130.00	28.08	0.18	0.01
P351	233.00	8.00	130.00	-8.61	0.05	0.000
P352	1,365.42	24.00	130.00	1,103.36	0.78	0.14
P353	1,505.76	30.00	130.00	-1,103.36	0.50	0.05
P354	369.99	8.00	130.00	-54.22	0.35	0.03
P355	369.99	8.00	130.00	-62.51	0.40	0.04
P356	117.50	8.00	130.00	-26.43	0.17	0.00
P357	195.00	8.00	130.00	-54.31	0.35	0.02
P358	193.00	8.00	130.00	-56.94	0.36	0.02
P359	500.49	8.00	130.00	-91.82	0.59	0.11
P360	500.78	8.00	130.00	-138.05	0.88	0.23
P361	677.66	8.00	130.00	-73.05	0.47	0.10
P362	482.45	12.00	130.00	-40.28	0.11	0.00
P363	677.66	8.00	130.00	-69.95	0.45	0.09
P364	1,180.18	30.00	130.00	-846.70	0.38	0.03
P365	1,577.01	24.00	130.00	-1,493.09	1.06	0.29
P366	701.50	24.00	130.00	-1,696.90	1.20	0.16
P367	242.00	18.00	130.00	846.70	1.07	0.06
P368	738.68	18.00	130.00	697.94	0.88	0.13
P369	253.00	8.00	130.00	-21.45	0.14	0.00
P370	660.09	8.00	130.00	-58.65	0.37	0.06
P371	193.00	18.00	130.00	874.42	1.10	0.05
P372	595.91	18.00	130.00	731.07	0.92	0.12
P373	191.34	18.00	130.00	636.68	0.80	0.03

MAXIMUM DAY DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	4.87	0.03	0.0000
P375	607.50	8.00	130.00	-23.81	0.15	0.01
P376	438.00	18.00	130.00	415.71	0.52	0.03
P377	650.57	18.00	130.00	293.09	0.37	0.02
P378	112.20	8.00	130.00	-143.66	0.92	0.06
P379	117.50	8.00	130.00	57.57	0.37	0.01
P380	348.36	8.00	130.00	27.44	0.18	0.01
P381	178.10	12.00	130.00	-198.83	0.56	0.02
P382	1,122.42	24.00	130.00	-3,040.48	2.16	0.76
P383	93.09	8.00	130.00	-77.47	0.49	0.01
P384	195.01	8.00	130.00	25.53	0.16	0.00
P385	4,416.05	30.00	130.00	0.00	0.00	0.00
P386	3,100.00	24.00	130.00	-3,068.59	2.18	2.14
P388	1,581.75	18.00	130.00	458.41	0.58	0.13
P389	621.96	18.00	130.00	428.85	0.54	0.05
P990	235.86	99.00	130.00	0.00	0.00	0.00
P991	377.34	99.00	130.00	0.00	0.00	0.00
P992	233.99	99.00	130.00	3,068.59	0.13	0.000
P993	232.72	99.00	130.00	3,068.59	0.13	0.000

MAXIMUM DAY DEMANDS - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	30.80	0.00	0.00
PUMP107	26.00	30.62	3,068.59	96.66

PEAK HOUR DEMANDS

PEAK HOUR DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	91.31	30.90
GB-103	6.47	15.00	91.47	33.13
GB-105	6.47	19.00	91.82	31.55
GB-107	0.00	20.00	92.02	31.21
GB-108	36.54	21.00	93.03	31.21
GB-109	39.85	20.00	91.06	30.79
GB-111	22.13	20.00	91.06	30.79
GB-113	19.92	19.59	91.10	30.98
GB-115	33.21	18.97	91.35	31.36
GB-117	22.13	18.87	91.11	31.30
GB-119	25.18	18.84	91.09	31.31
GB-121	19.92	18.80	91.09	31.32
GB-122	37.09	18.80	91.79	31.62
GB-123	18.81	19.02	91.09	31.23
GB-125	32.10	18.39	91.12	31.51
GB-127	17.71	18.28	91.09	31.55
GB-128	54.28	18.50	91.66	31.70
GB-129	18.81	18.53	91.07	31.43
GB-131	30.99	17.81	91.07	31.74
GB-133	17.71	17.67	91.07	31.80
GB-135	15.49	17.23	91.10	32.01
GB-137	22.13	17.16	91.21	32.08
GB-139	22.13	17.85	91.37	31.86
GB-141	47.59	18.91	91.06	31.26
GB-143	28.78	18.52	91.06	31.43
GB-145	15.49	18.08	91.05	31.62
GB-147	29.00	17.24	91.05	31.98
GB-149	21.03	17.21	91.04	31.99
GB-151	24.35	16.99	91.05	32.09
GB-153	25.18	16.99	91.07	32.10
GB-155	8.86	16.94	91.08	32.13
GB-157	3.32	16.96	91.08	32.12
GB-159	7.49	16.62	91.13	32.28
GB-161	5.54	17.14	91.06	32.03
GB-163	12.18	17.39	91.10	31.94
GB-165	13.29	17.79	91.29	31.85
GB-167	30.84	18.26	91.22	31.61
GB-169	5.54	19.75	91.05	30.89
GB-171	11.07	20.27	91.00	30.65

PEAK HOUR DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	36.99	20.84	90.97	30.39
GB-175	2.21	16.69	91.06	32.22
GB-177	7.75	16.45	90.95	32.28
GB-179	13.29	16.82	90.97	32.13
GB-181	7.75	16.63	91.04	32.24
GB-183	26.56	16.54	91.04	32.28
GB-185	44.27	16.64	91.04	32.24
GB-187	24.35	16.47	91.05	32.31
GB-189	11.07	16.36	91.05	32.36
GB-191	24.09	16.28	91.04	32.40
GB-193	15.17	16.24	91.05	32.41
GB-195	15.17	16.38	90.91	32.29
GB-197	26.56	16.75	90.91	32.14
GB-199	26.56	17.29	90.93	31.91
GB-201	30.99	17.77	90.95	31.71
GB-203	39.70	18.25	90.96	31.50
GB-205	39.70	19.83	90.89	30.79
GB-207	30.99	20.34	90.89	30.57
GB-209	15.49	20.85	90.89	30.35
GB-210	24.20	15.00	91.25	33.04
GB-211	59.77	18.60	91.16	31.44
GB-213	28.78	17.80	91.06	31.74
GB-215	38.97	17.16	91.03	32.01
GB-217	15.49	16.45	91.03	32.31
GB-219	16.60	16.33	90.70	32.23
GB-221	22.53	16.30	90.67	32.22
GB-223	23.97	16.58	90.70	32.12
GB-225	13.29	16.63	90.70	32.09
GB-227	14.38	16.52	90.70	32.14
GB-229	24.53	16.65	90.67	32.07
GB-231	24.35	16.65	90.67	32.07
GB-233	15.49	16.59	90.67	32.10
GB-235	24.35	17.04	90.68	31.91
GB-237	16.28	16.54	90.68	32.13
GB-239	16.28	16.37	90.78	32.24
GB-241	30.99	16.74	90.78	32.08
GB-243	33.21	17.28	90.79	31.85
GB-245	30.99	17.76	90.82	31.65
GB-247	21.03	18.25	90.82	31.44

PEAK HOUR DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	46.33	19.30	90.78	30.97
GB-251	21.03	19.87	90.81	30.74
GB-253	30.99	20.36	90.81	30.53
GB-255	41.42	20.86	90.81	30.31
GB-257	27.67	18.14	91.05	31.59
GB-259	13.29	17.78	91.04	31.74
GB-261	14.38	17.15	91.02	32.01
GB-263	16.60	16.46	90.99	32.30
GB-265	32.47	18.00	91.05	31.65
GB-267	25.83	16.46	90.94	32.27
GB-269	24.35	16.52	90.73	32.16
GB-271	23.24	17.44	90.71	31.74
GB-273	13.29	18.00	90.71	31.50
GB-275	12.35	18.00	90.71	31.50
GB-277	13.29	18.00	90.69	31.50
GB-279	24.35	17.76	90.69	31.60
GB-281	12.18	17.04	90.69	31.91
GB-283	27.67	17.28	90.71	31.82
GB-285	33.21	19.52	90.72	30.85
GB-286	22.13	20.86	90.79	30.30
GB-287	22.13	18.00	91.08	31.67
GB-288	12.18	16.45	90.88	32.25
GB-289	8.86	16.52	90.77	32.17
GB-290	14.38	18.00	90.73	31.51
GB-291	21.03	17.04	90.71	31.92
GB-292	9.97	16.37	90.71	32.21
GB-293	17.71	16.74	90.70	32.05
GB-294	13.73	17.28	90.69	31.81
GB-295	0.00	15.00	91.23	33.03
GB-297	0.00	18.00	91.10	31.68
GB-299	0.00	16.45	90.85	32.24
GB-301	0.00	16.53	90.79	32.18
GB-303	0.00	18.00	90.74	31.52
GB-305	0.00	17.05	90.71	31.92
GB-307	0.00	16.86	90.69	31.99
GB-309	0.00	17.28	90.68	31.81
GB-311	42.11	19.13	90.68	31.00
GB-313	54.77	20.80	90.67	30.28
GB-315	19.92	18.00	90.32	31.34

PEAK HOUR DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	18.81	17.77	90.35	31.45
GB-319	12.18	17.24	90.43	31.71
GB-321	12.18	16.45	90.64	32.15
GB-323	28.78	16.54	90.21	31.92
GB-325	23.24	17.42	90.21	31.54
GB-327	18.81	18.00	90.22	31.29
GB-329	13.29	18.00	90.23	31.30
GB-331	5.54	17.39	90.24	31.56
GB-333	15.49	17.35	90.41	31.65
GB-335	13.29	16.42	90.45	32.08
GB-337	24.35	18.00	90.30	31.33
GB-339	21.03	18.00	90.31	31.33
GB-341	17.49	17.49	90.34	31.56
GB-343	14.17	16.16	90.37	32.15
GB-345	18.81	18.00	90.26	31.31
GB-347	22.13	18.00	90.27	31.32
GB-349	8.86	17.75	90.28	31.43
GB-351	27.67	18.00	90.24	31.30
GB-352	39.18	17.35	90.22	31.58
GB-353	21.03	17.91	90.23	31.34
GB-355	17.71	17.82	90.26	31.39
GB-357	19.70	17.40	90.27	31.57
GB-359	15.28	16.14	90.28	32.13
GB-361	21.03	17.26	90.22	31.61
GB-362	26.56	16.38	90.24	32.00
GB-363	14.38	16.29	90.20	32.03
GB-365	18.43	16.32	90.22	32.02
GB-367	25.00	16.59	90.22	31.90
GB-369	22.13	17.03	90.21	31.71
GB-371	17.71	16.87	90.22	31.78
GB-373	13.29	16.73	90.23	31.85
GB-375	19.15	16.59	90.26	31.92
GB-377	23.81	16.34	90.28	32.04
GB-379	59.02	17.08	90.33	31.74
GB-381	33.78	16.42	90.20	31.97
GB-383	22.70	18.29	90.21	31.16
GB-385	13.85	18.09	90.29	31.28
GB-387	19.96	18.82	90.29	30.97
GB-389	12.18	18.79	90.34	31.00

PEAK HOUR DEMANDS - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	49.67	18.77	90.43	31.05
GB-393	19.53	16.43	90.18	31.95
GB-395	19.92	17.71	90.18	31.40
GB-397	48.78	18.80	90.19	30.93
GB-399	45.46	19.79	90.25	30.53
GB-401	25.46	20.09	90.25	30.40
GB-403	14.38	20.39	90.25	30.27
GB-405	15.04	16.13	90.17	32.08
GB-407	28.78	17.95	90.17	31.29
GB-409	17.71	19.40	90.18	30.67
GB-411	22.13	16.46	90.17	31.94
GB-413	34.31	18.20	90.17	31.19
GB-415	17.71	19.96	90.18	30.42
GB-417	45.83	16.45	90.18	31.95
GB-419	14.38	18.63	90.17	31.00
GB-421	43.42	19.83	90.17	30.48
GB-423	14.38	20.20	90.17	30.32
GB-425	28.70	20.56	90.18	30.16
GB-427	14.38	21.58	90.18	29.72
GB-429	35.35	21.13	90.20	29.93
GB-431	28.78	21.45	90.20	29.79
GB-433	44.53	22.00	90.19	29.55
GB-435	22.13	21.27	90.17	29.85
GB-437	23.24	22.00	90.17	29.54
GB-439	23.24	22.00	90.18	29.54
GB-441	14.38	21.27	90.17	29.85
GB-443	15.49	22.00	90.17	29.54
GB-445	14.38	21.00	90.18	29.97
GB-446	0.00	22.00	91.25	30.01
GB-447	0.00	26.00	95.89	30.28

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	97.95	0.63	0.03
P102	117.50	8.00	130.00	-143.32	0.91	0.06
P103	739.21	8.00	130.00	104.14	0.66	0.20
P104	117.50	8.00	130.00	90.76	0.58	0.03
P105	117.50	8.00	130.00	117.36	0.75	0.04
P106	436.40	12.00	130.00	55.91	0.16	0.01
P107	650.57	8.00	130.00	47.22	0.30	0.04
P108	535.27	8.00	130.00	40.47	0.26	0.03
P109	357.35	18.00	130.00	-1,577.09	1.99	0.29
P110	243.09	12.00	130.00	-161.72	0.46	0.02
P111	253.19	8.00	130.00	-42.63	0.27	0.01
P112	380.98	8.00	130.00	73.75	0.47	0.06
P113	904.24	8.00	130.00	11.72	0.07	0.00
P114	693.26	8.00	130.00	-65.85	0.42	0.08
P115	105.50	8.00	130.00	-10.86	0.07	0.000
P116	147.51	12.00	130.00	91.26	0.26	0.00
P117	132.50	12.00	130.00	-92.68	0.26	0.00
P118	226.54	8.00	130.00	64.64	0.41	0.03
P119	193.01	8.00	130.00	18.08	0.12	0.00
P120	193.01	8.00	130.00	-16.79	0.11	0.00
P121	713.00	8.00	130.00	5.43	0.03	0.000
P122	615.89	8.00	130.00	-5.34	0.03	0.000
P123	713.00	8.00	130.00	-116.56	0.74	0.24
P124	677.66	8.00	130.00	-83.78	0.53	0.13
P125	476.65	8.00	130.00	-74.93	0.48	0.07
P126	117.50	8.00	130.00	-64.97	0.41	0.01
P127	677.66	8.00	130.00	89.01	0.57	0.14
P128	193.00	8.00	130.00	-17.14	0.11	0.00
P129	117.50	8.00	130.00	-75.87	0.48	0.02
P130	633.34	8.00	130.00	32.71	0.21	0.02
P131	232.72	8.00	130.00	45.99	0.29	0.01
P132	233.02	8.00	130.00	59.47	0.38	0.02
P133	618.66	8.00	130.00	41.93	0.27	0.03
P134	713.00	8.00	130.00	-36.88	0.24	0.03
P135	195.00	8.00	130.00	36.01	0.23	0.01
P136	193.00	8.00	130.00	70.28	0.45	0.03
P137	112.20	18.00	130.00	1,459.29	1.84	0.08
P138	701.50	8.00	130.00	-95.67	0.61	0.17
P139	378.03	8.00	130.00	-106.66	0.68	0.11

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	-22.29	0.14	0.01
P141	253.00	8.00	130.00	51.12	0.33	0.02
P142	233.00	8.00	130.00	-43.31	0.28	0.01
P143	233.00	8.00	130.00	-62.49	0.40	0.03
P144	232.70	8.00	130.00	-44.86	0.29	0.01
P145	574.54	8.00	130.00	18.66	0.12	0.01
P146	105.50	8.00	130.00	90.33	0.58	0.02
P147	126.23	8.00	130.00	66.65	0.43	0.02
P148	126.78	8.00	130.00	-11.76	0.08	0.000
P149	388.16	8.00	130.00	19.46	0.12	0.00
P150	117.50	8.00	130.00	8.51	0.05	0.000
P151	611.16	8.00	130.00	-15.91	0.10	0.01
P152	418.00	8.00	130.00	-1.64	0.01	0.0000
P153	97.50	8.00	130.00	-0.56	0.00	0.0000
P154	261.76	8.00	130.00	-16.33	0.10	0.00
P155	839.51	8.00	130.00	-14.81	0.09	0.01
P156	170.40	8.00	130.00	6.72	0.04	0.000
P157	116.20	8.00	130.00	1.60	0.01	0.0000
P158	248.92	8.00	130.00	-16.52	0.11	0.00
P159	247.10	8.00	130.00	16.81	0.11	0.00
P160	247.67	8.00	130.00	40.55	0.26	0.01
P161	247.82	8.00	130.00	64.00	0.41	0.03
P162	247.00	8.00	130.00	-39.21	0.25	0.01
P163	249.87	8.00	130.00	-26.44	0.17	0.01
P164	1,149.31	8.00	130.00	14.39	0.09	0.01
P165	710.72	12.00	130.00	-87.39	0.25	0.02
P166	369.00	8.00	130.00	35.58	0.23	0.01
P167	253.00	8.00	130.00	26.35	0.17	0.01
P168	918.21	8.00	130.00	22.90	0.15	0.02
P169	282.81	8.00	130.00	58.88	0.38	0.03
P170	333.36	12.00	130.00	-131.02	0.37	0.02
P171	253.00	8.00	130.00	92.24	0.59	0.06
P172	234.54	8.00	130.00	66.34	0.42	0.03
P173	253.00	8.00	130.00	55.78	0.36	0.02
P174	657.99	8.00	130.00	29.09	0.19	0.02
P175	633.34	8.00	130.00	-9.93	0.06	0.00
P176	253.02	8.00	130.00	20.83	0.13	0.00
P177	633.34	8.00	130.00	78.20	0.50	0.10
P178	242.02	12.00	130.00	346.27	0.98	0.09

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	117.92	0.75	0.09
P180	273.00	8.00	130.00	-53.51	0.34	0.02
P181	628.13	12.00	130.00	19.49	0.06	0.00
P182	797.55	12.00	130.00	40.00	0.11	0.01
P183	578.83	12.00	130.00	108.58	0.31	0.02
P184	193.00	8.00	130.00	-10.07	0.06	0.000
P185	653.19	8.00	130.00	13.61	0.09	0.00
P186	193.00	8.00	130.00	-1.49	0.01	0.0000
P187	193.00	8.00	130.00	0.05	0.000	0.00
P188	437.56	8.00	130.00	10.52	0.07	0.00
P189	203.57	12.00	130.00	-30.07	0.09	0.000
P190	596.95	8.00	130.00	56.81	0.36	0.05
P191	292.91	8.00	130.00	-5.39	0.03	0.000
P192	695.05	8.00	130.00	-6.01	0.04	0.000
P193	253.00	8.00	130.00	10.45	0.07	0.000
P194	656.00	8.00	130.00	-43.77	0.28	0.04
P195	504.88	8.00	130.00	-50.27	0.32	0.04
P196	313.32	8.00	130.00	-30.39	0.19	0.01
P197	549.00	8.00	130.00	47.30	0.30	0.04
P198	253.00	8.00	130.00	36.22	0.23	0.01
P199	253.00	8.00	130.00	63.75	0.41	0.03
P200	253.00	8.00	130.00	102.92	0.66	0.07
P201	403.00	8.00	130.00	49.26	0.31	0.03
P202	276.11	8.00	130.00	179.36	1.14	0.21
P203	253.02	8.00	130.00	-129.21	0.82	0.10
P204	253.02	8.00	130.00	-61.41	0.39	0.03
P205	236.90	8.00	130.00	-30.21	0.19	0.01
P206	636.18	8.00	130.00	27.77	0.18	0.02
P207	211.30	8.00	130.00	27.35	0.17	0.00
P208	232.70	8.00	130.00	58.14	0.37	0.02
P209	233.00	8.00	130.00	94.54	0.60	0.05
P210	233.00	8.00	130.00	205.45	1.31	0.23
P211	621.42	8.00	130.00	-127.32	0.81	0.25
P212	253.02	8.00	130.00	-71.05	0.45	0.03
P213	699.07	8.00	130.00	-18.85	0.12	0.01
P214	253.02	8.00	130.00	-20.83	0.13	0.00
P215	613.13	8.00	130.00	-18.63	0.12	0.01
P216	253.00	8.00	130.00	45.67	0.29	0.02
P217	233.00	8.00	130.00	42.54	0.27	0.01

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	76.16	0.49	0.04
P219	313.50	8.00	130.00	-89.73	0.57	0.07
P220	391.14	12.00	130.00	412.63	1.17	0.19
P221	590.71	8.00	130.00	30.58	0.20	0.02
P222	253.00	8.00	130.00	32.84	0.21	0.01
P223	390.32	8.00	130.00	73.19	0.47	0.06
P224	430.55	8.00	130.00	51.51	0.33	0.03
P225	248.33	12.00	130.00	330.19	0.94	0.08
P226	430.73	8.00	130.00	30.69	0.20	0.01
P227	412.22	12.00	130.00	264.51	0.75	0.09
P228	262.25	12.00	130.00	33.51	0.10	0.00
P229	253.00	12.00	130.00	62.94	0.18	0.00
P230	273.31	12.00	130.00	97.91	0.28	0.01
P231	234.73	12.00	130.00	175.03	0.50	0.02
P232	422.16	12.00	130.00	-177.45	0.50	0.04
P233	596.34	12.00	130.00	-152.46	0.43	0.05
P234	591.74	12.00	130.00	-95.25	0.27	0.02
P235	587.67	12.00	130.00	-457.04	1.30	0.35
P236	457.95	12.00	130.00	-178.87	0.51	0.05
P237	359.68	12.00	130.00	55.68	0.16	0.00
P238	193.00	8.00	130.00	-3.47	0.02	0.0000
P239	487.33	8.00	130.00	95.04	0.61	0.11
P240	486.84	8.00	130.00	-79.68	0.51	0.08
P241	708.39	8.00	130.00	-65.86	0.42	0.08
P242	617.10	8.00	130.00	-60.72	0.39	0.06
P243	319.69	18.00	130.00	-585.83	0.74	0.04
P244	861.88	12.00	130.00	-54.77	0.16	0.01
P245	534.05	18.00	130.00	-346.68	0.44	0.03
P246	627.02	18.00	130.00	-255.42	0.32	0.02
P247	195.01	18.00	130.00	-348.10	0.44	0.01
P248	751.91	18.00	130.00	-3.24	0.00	0.00000
P249	370.87	12.00	130.00	-492.19	1.40	0.25
P250	602.79	8.00	130.00	-60.13	0.38	0.06
P251	656.30	8.00	130.00	-29.48	0.19	0.02
P252	501.81	8.00	130.00	-110.76	0.71	0.16
P253	464.05	12.00	130.00	220.70	0.63	0.07
P254	250.56	12.00	130.00	218.55	0.62	0.04
P255	423.72	8.00	130.00	-31.49	0.20	0.01
P256	235.04	8.00	130.00	-42.48	0.27	0.01

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	69.15	0.44	0.04
P258	656.00	8.00	130.00	35.42	0.23	0.02
P259	497.14	8.00	130.00	36.01	0.23	0.02
P260	494.52	8.00	130.00	-14.26	0.09	0.00
P261	466.36	8.00	130.00	-11.66	0.07	0.00
P262	616.00	8.00	130.00	-8.18	0.05	0.00
P263	651.25	8.00	130.00	6.14	0.04	0.000
P264	246.49	8.00	130.00	55.35	0.35	0.02
P265	375.42	12.00	130.00	-219.15	0.62	0.06
P266	665.79	8.00	130.00	64.32	0.41	0.08
P267	285.98	8.00	130.00	-22.76	0.15	0.00
P268	272.69	8.00	130.00	23.52	0.15	0.00
P269	744.21	8.00	130.00	18.41	0.12	0.01
P270	105.50	8.00	130.00	4.99	0.03	0.0000
P271	892.22	8.00	130.00	35.03	0.22	0.03
P272	193.00	8.00	130.00	12.55	0.08	0.00
P273	105.50	8.00	130.00	8.17	0.05	0.000
P274	698.75	8.00	130.00	-9.78	0.06	0.00
P275	181.50	12.00	130.00	-482.55	1.37	0.12
P276	112.20	8.00	130.00	-68.88	0.44	0.01
P277	698.70	8.00	130.00	-28.31	0.18	0.02
P278	713.00	8.00	130.00	0.08	0.000	0.00000
P279	422.00	8.00	130.00	-55.44	0.35	0.04
P280	117.50	8.00	130.00	7.43	0.05	0.000
P281	589.97	8.00	130.00	-206.51	1.32	0.58
P282	130.50	8.00	130.00	-168.13	1.07	0.09
P283	410.65	18.00	130.00	-1,631.37	2.06	0.36
P284	500.49	8.00	130.00	-145.85	0.93	0.26
P285	807.99	8.00	130.00	25.67	0.16	0.02
P286	193.00	8.00	130.00	1.66	0.01	0.0000
P287	263.00	8.00	130.00	-6.12	0.04	0.000
P288	738.30	8.00	130.00	24.81	0.16	0.01
P289	233.02	8.00	130.00	-36.35	0.23	0.01
P290	739.64	8.00	130.00	-76.92	0.49	0.12
P291	252.00	8.00	130.00	-39.98	0.26	0.01
P292	262.03	8.00	130.00	-57.99	0.37	0.02
P293	924.17	8.00	130.00	-11.20	0.07	0.00
P294	770.75	8.00	130.00	-8.31	0.05	0.00
P295	956.68	8.00	130.00	30.26	0.19	0.03

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-99.09	0.63	0.18
P297	678.13	8.00	130.00	67.59	0.43	0.08
P298	837.42	8.00	130.00	26.73	0.17	0.02
P299	557.94	8.00	130.00	-78.16	0.50	0.09
P300	696.14	8.00	130.00	-6.04	0.04	0.000
P301	468.04	8.00	130.00	-10.16	0.06	0.00
P302	255.36	8.00	130.00	-42.34	0.27	0.01
P303	247.32	8.00	130.00	47.88	0.31	0.02
P304	208.11	12.00	130.00	-604.17	1.71	0.21
P305	88.53	8.00	130.00	17.49	0.11	0.000
P306	193.00	8.00	130.00	-210.11	1.34	0.20
P307	582.27	8.00	130.00	40.69	0.26	0.03
P308	677.66	8.00	130.00	-89.77	0.57	0.14
P309	195.00	8.00	130.00	-83.94	0.54	0.04
P310	132.50	12.00	130.00	-112.18	0.32	0.01
P311	380.98	8.00	130.00	-90.83	0.58	0.08
P312	475.68	8.00	130.00	-82.50	0.53	0.09
P313	655.89	8.00	130.00	-24.94	0.16	0.01
P314	653.93	8.00	130.00	-42.49	0.27	0.03
P315	215.00	8.00	130.00	1.02	0.01	0.0000
P316	195.01	8.00	130.00	26.63	0.17	0.00
P317	214.88	8.00	130.00	-22.53	0.14	0.00
P318	252.22	8.00	130.00	7.15	0.05	0.000
P319	245.38	8.00	130.00	9.45	0.06	0.000
P320	607.50	8.00	130.00	-7.51	0.05	0.00
P321	574.53	8.00	130.00	-18.87	0.12	0.01
P322	105.50	8.00	130.00	-55.77	0.36	0.01
P323	212.18	8.00	130.00	21.28	0.14	0.00
P324	105.50	8.00	130.00	12.55	0.08	0.000
P325	211.00	8.00	130.00	-21.80	0.14	0.00
P326	211.30	8.00	130.00	-43.77	0.28	0.01
P327	209.82	8.00	130.00	-32.35	0.21	0.01
P328	728.60	8.00	130.00	-17.26	0.11	0.01
P329	594.64	8.00	130.00	3.09	0.02	0.000
P330	258.06	8.00	130.00	-18.88	0.12	0.00
P331	499.01	8.00	130.00	10.46	0.07	0.00
P332	545.88	8.00	130.00	-28.34	0.18	0.01
P333	783.02	8.00	130.00	-22.96	0.15	0.01
P334	260.55	12.00	130.00	-54.97	0.16	0.00

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	30.71	0.20	0.01
P336	255.00	8.00	130.00	21.86	0.14	0.00
P337	255.07	8.00	130.00	13.88	0.09	0.00
P338	255.00	12.00	130.00	343.43	0.97	0.09
P339	255.00	12.00	130.00	-253.09	0.72	0.05
P340	255.00	8.00	130.00	-20.47	0.13	0.00
P341	255.00	8.00	130.00	-24.58	0.16	0.00
P342	246.98	8.00	130.00	-14.39	0.09	0.00
P343	253.00	8.00	130.00	-55.34	0.35	0.02
P344	147.50	12.00	130.00	98.39	0.28	0.01
P345	147.37	12.00	130.00	173.44	0.49	0.01
P346	147.50	12.00	130.00	224.22	0.64	0.02
P347	147.59	12.00	130.00	-235.28	0.67	0.03
P348	381.04	8.00	130.00	-41.22	0.26	0.02
P349	190.72	18.00	130.00	-668.54	0.84	0.03
P350	253.02	8.00	130.00	30.07	0.19	0.01
P351	233.00	8.00	130.00	-2.37	0.02	0.0000
P352	1,365.42	24.00	130.00	1,175.44	0.83	0.16
P353	1,505.76	30.00	130.00	-1,175.44	0.53	0.06
P354	369.99	8.00	130.00	-68.12	0.43	0.05
P355	369.99	8.00	130.00	-78.97	0.50	0.06
P356	117.50	8.00	130.00	-30.82	0.20	0.00
P357	195.00	8.00	130.00	-63.33	0.40	0.02
P358	193.00	8.00	130.00	-65.67	0.42	0.02
P359	500.49	8.00	130.00	-113.99	0.73	0.16
P360	500.78	8.00	130.00	-168.25	1.07	0.34
P361	677.66	8.00	130.00	-88.73	0.57	0.14
P362	482.45	12.00	130.00	-50.16	0.14	0.00
P363	677.66	8.00	130.00	-84.91	0.54	0.13
P364	1,180.18	30.00	130.00	-804.97	0.37	0.02
P365	1,577.01	24.00	130.00	-1,664.46	1.18	0.35
P366	701.50	24.00	130.00	-1,914.52	1.36	0.20
P367	242.00	18.00	130.00	1,211.61	1.53	0.12
P368	738.68	18.00	130.00	987.40	1.24	0.25
P369	253.00	8.00	130.00	-11.44	0.07	0.00
P370	660.09	8.00	130.00	-79.09	0.50	0.11
P371	193.00	18.00	130.00	1,067.64	1.35	0.08
P372	595.91	18.00	130.00	890.95	1.12	0.17
P373	191.34	18.00	130.00	774.65	0.98	0.04

PEAK HOUR DEMANDS - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	20.41	0.13	0.00
P375	607.50	8.00	130.00	-22.41	0.14	0.01
P376	438.00	18.00	130.00	618.51	0.78	0.06
P377	650.57	18.00	130.00	445.07	0.56	0.05
P378	112.20	8.00	130.00	-173.38	1.11	0.08
P379	117.50	8.00	130.00	70.01	0.45	0.02
P380	348.36	8.00	130.00	35.30	0.23	0.01
P381	178.10	12.00	130.00	-243.60	0.69	0.03
P382	1,122.42	24.00	130.00	-3,545.90	2.51	1.01
P383	93.09	8.00	130.00	-88.83	0.57	0.02
P384	195.01	8.00	130.00	37.08	0.24	0.01
P385	4,416.05	30.00	130.00	406.65	0.18	0.02
P386	3,100.00	24.00	130.00	-3,582.44	2.54	2.85
P388	1,581.75	18.00	130.00	551.87	0.70	0.19
P389	621.96	18.00	130.00	510.24	0.64	0.06
P990	235.86	99.00	130.00	406.65	0.02	0.00000
P991	377.34	99.00	130.00	406.65	0.02	0.00000
P992	233.99	99.00	130.00	3,582.44	0.15	0.000
P993	232.72	99.00	130.00	3,582.44	0.15	0.000

PEAK HOUR DEMANDS - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	30.01	406.65	91.25
PUMP107	26.00	30.28	3,582.44	95.89

FIRE FLOW SUMMARY

FIRE FLOW SUMMARY - GREENBRIAR

ID	Static Demand (gpm)	Static Pressure (psi)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow @Hydrant (gpm)	Available Flow Pressure (psi)	Available Flow Head (ft)
GB-103	4.98	33.93	1,500.00	30.83	6,159.42	20.38	62.03
GB-105	4.98	32.32	3,000.00	26.14	5,607.58	20.31	65.88
GB-107	0.00	31.96	3,000.00	25.81	5,517.28	20.30	66.86
GB-108	28.11	31.85	3,000.00	25.73	5,561.93	20.31	67.86
GB-109	30.65	31.64	1,500.00	25.47	2,345.20	20.05	66.28
GB-111	17.03	31.64	1,500.00	26.71	2,841.32	20.08	66.34
GB-113	15.33	31.83	1,500.00	27.42	3,191.37	20.10	65.98
GB-115	25.54	32.17	1,500.00	28.83	4,775.91	20.23	65.65
GB-117	17.03	32.15	1,500.00	27.66	3,203.48	20.10	65.26
GB-119	19.36	32.16	1,500.00	27.27	2,953.26	20.09	65.19
GB-121	15.33	32.18	1,500.00	26.33	2,511.07	20.06	65.10
GB-122	28.53	32.40	3,000.00	25.08	4,639.70	20.21	65.45
GB-123	14.47	32.08	1,500.00	27.73	3,288.68	20.11	65.42
GB-125	24.69	32.36	1,500.00	28.48	3,862.46	20.15	64.89
GB-127	13.62	32.40	1,500.00	27.96	3,282.36	20.11	64.68
GB-128	41.75	32.50	3,000.00	25.95	5,416.21	20.29	65.32
GB-129	14.47	32.29	1,500.00	27.98	3,379.10	20.11	64.94
GB-131	23.84	32.60	1,500.00	28.59	3,780.26	20.14	64.29
GB-133	13.62	32.66	1,500.00	28.25	3,371.23	20.11	64.09
GB-135	11.92	32.86	1,500.00	28.55	3,493.10	20.12	63.67
GB-137	17.03	32.93	3,000.00	24.20	4,056.59	20.16	63.69
GB-139	17.03	32.69	3,000.00	26.00	5,318.00	20.28	64.66
GB-141	36.61	32.11	1,500.00	27.36	3,047.64	20.09	65.28
GB-143	22.13	32.28	1,500.00	28.13	3,544.15	20.12	64.96
GB-145	11.92	32.47	1,500.00	28.48	3,746.30	20.14	64.56
GB-147	22.32	32.84	1,500.00	28.84	3,857.34	20.15	63.73
GB-149	16.18	32.85	1,500.00	28.59	3,567.37	20.13	63.66
GB-151	18.73	32.95	1,500.00	28.87	3,787.15	20.14	63.47
GB-153	19.36	32.96	1,500.00	28.49	3,393.38	20.11	63.41
GB-155	6.82	32.98	1,500.00	28.89	3,751.25	20.14	63.42
GB-157	2.56	32.97	1,500.00	28.89	3,751.56	20.14	63.44
GB-159	5.76	33.14	1,500.00	29.22	3,946.16	20.16	63.14
GB-161	4.26	32.90	1,500.00	28.91	3,832.71	20.15	63.64
GB-163	9.36	32.81	1,500.00	28.86	3,874.29	20.15	63.89
GB-165	10.21	32.69	3,000.00	25.96	5,267.08	20.28	64.59
GB-167	23.73	32.47	3,000.00	25.62	5,107.67	20.26	65.01
GB-169	4.26	31.77	3,000.00	24.67	4,622.24	20.21	66.40
GB-171	8.51	31.53	3,000.00	24.37	4,498.42	20.20	66.89

FIRE FLOW SUMMARY - GREENBRIAR

ID	Static Demand (gpm)	Static Pressure (psi)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow @Hydrant (gpm)	Available Flow Pressure (psi)	Available Flow Head (ft)
GB-173	28.46	31.28	3,000.00	24.06	4,403.34	20.19	67.44
GB-175	1.70	33.08	1,500.00	28.54	3,338.28	20.11	63.10
GB-177	5.96	33.17	1,500.00	28.27	3,095.23	20.10	62.83
GB-179	10.21	33.02	1,500.00	28.73	3,562.26	20.13	63.27
GB-181	5.96	33.10	1,500.00	28.86	3,622.67	20.13	63.09
GB-183	20.44	33.14	1,500.00	28.96	3,718.53	20.14	63.01
GB-185	34.06	33.10	1,500.00	28.80	3,619.14	20.13	63.10
GB-187	18.73	33.17	1,500.00	28.46	3,241.56	20.10	62.87
GB-189	8.51	33.22	1,500.00	27.73	2,805.68	20.08	62.70
GB-191	18.53	33.26	1,500.00	28.61	3,307.49	20.11	62.68
GB-193	11.67	33.27	1,500.00	28.38	3,133.40	20.10	62.62
GB-195	11.67	33.19	1,500.00	28.79	3,497.85	20.12	62.82
GB-197	20.44	33.03	1,500.00	29.00	3,862.83	20.15	63.24
GB-199	20.44	32.80	1,500.00	28.91	3,985.22	20.16	63.81
GB-201	23.84	32.60	1,500.00	28.71	3,935.49	20.15	64.28
GB-203	30.53	32.39	1,500.00	28.07	3,420.76	20.11	64.67
GB-205	30.53	31.69	1,500.00	27.19	3,164.05	20.10	66.21
GB-207	23.84	31.47	1,500.00	27.33	3,442.70	20.12	66.77
GB-209	11.92	31.25	1,500.00	26.75	3,060.29	20.09	67.22
GB-210	18.62	33.84	1,500.00	30.77	6,181.89	20.38	62.03
GB-211	45.98	32.27	1,500.00	28.92	4,738.69	20.22	65.27
GB-213	22.13	32.59	1,500.00	28.75	3,945.91	20.15	64.31
GB-215	29.98	32.86	1,500.00	28.87	3,836.14	20.14	63.65
GB-217	11.92	33.17	1,500.00	28.67	3,369.67	20.11	62.87
GB-219	12.77	33.14	1,500.00	25.76	2,214.02	20.05	62.60
GB-221	17.33	33.15	1,500.00	27.63	2,828.01	20.08	62.64
GB-223	18.44	33.03	1,500.00	26.56	2,440.04	20.06	62.87
GB-225	10.21	33.01	1,500.00	26.65	2,465.51	20.06	62.93
GB-227	11.07	33.06	1,500.00	26.51	2,413.77	20.06	62.81
GB-229	18.87	32.99	1,500.00	27.51	2,822.52	20.08	62.99
GB-231	18.73	32.99	1,500.00	27.60	2,864.81	20.08	63.00
GB-233	11.92	33.02	1,500.00	27.65	2,872.07	20.08	62.94
GB-235	18.73	32.83	1,500.00	27.81	3,033.46	20.09	63.41
GB-237	12.52	33.05	1,500.00	27.95	3,014.38	20.09	62.90
GB-239	12.52	33.15	1,500.00	28.89	3,637.50	20.13	62.84
GB-241	23.84	32.99	1,500.00	29.08	4,021.44	20.16	63.27
GB-243	25.54	32.76	1,500.00	28.87	4,000.00	20.16	63.80
GB-245	23.84	32.56	1,500.00	28.31	3,533.45	20.12	64.21

FIRE FLOW SUMMARY - GREENBRIAR

ID	Static Demand (gpm)	Static Pressure (psi)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow @Hydrant (gpm)	Available Flow Pressure (psi)	Available Flow Head (ft)
GB-247	16.18	32.35	1,500.00	27.92	3,301.79	20.11	64.65
GB-249	35.65	31.89	1,500.00	27.55	3,335.70	20.11	65.71
GB-251	16.18	31.65	1,500.00	27.20	3,173.60	20.10	66.26
GB-253	23.84	31.44	1,500.00	26.94	3,108.70	20.10	66.74
GB-255	31.86	31.22	1,500.00	26.71	3,065.55	20.09	67.23
GB-257	21.28	32.44	1,500.00	28.30	3,549.74	20.12	64.59
GB-259	10.21	32.59	1,500.00	28.32	3,438.90	20.12	64.21
GB-261	11.07	32.86	1,500.00	28.54	3,459.40	20.12	63.58
GB-263	12.77	33.16	1,500.00	28.92	3,605.26	20.13	62.91
GB-265	24.97	32.50	1,500.00	28.68	3,945.26	20.15	64.51
GB-267	19.87	33.14	1,500.00	29.29	4,054.85	20.16	62.99
GB-269	18.73	33.06	1,500.00	28.60	3,453.27	20.12	62.95
GB-271	17.88	32.66	1,500.00	27.62	2,983.15	20.09	63.81
GB-273	10.21	32.42	1,500.00	27.75	3,168.16	20.10	64.39
GB-275	9.50	32.42	1,500.00	28.39	3,777.39	20.14	64.49
GB-277	10.21	32.41	1,500.00	27.94	3,315.85	20.11	64.41
GB-279	18.73	32.52	1,500.00	27.81	3,171.40	20.10	64.15
GB-281	9.36	32.83	1,500.00	28.56	3,604.35	20.13	63.50
GB-283	21.28	32.74	2,000.00	27.11	3,883.79	20.15	63.78
GB-285	25.54	31.77	2,000.00	27.04	4,555.76	20.21	66.15
GB-286	17.03	31.21	2,000.00	26.46	4,328.61	20.19	67.45
GB-287	17.03	32.50	1,500.00	29.17	4,874.71	20.24	64.70
GB-288	9.36	33.13	1,500.00	29.73	4,955.80	20.24	63.17
GB-289	6.82	33.07	1,500.00	29.50	4,597.56	20.21	63.16
GB-290	11.07	32.42	1,500.00	28.88	4,508.35	20.20	64.62
GB-291	16.18	32.84	1,500.00	29.21	4,493.08	20.20	63.66
GB-292	7.66	33.13	1,500.00	28.65	3,412.75	20.12	62.79
GB-293	13.62	32.97	1,500.00	29.43	4,719.17	20.22	63.41
GB-294	10.56	32.73	1,500.00	29.17	4,603.72	20.21	63.92
GB-295	0.00	33.83	1,500.00	30.77	6,188.37	20.38	62.04
GB-297	0.00	32.51	1,500.00	29.36	5,481.34	20.30	64.85
GB-299	0.00	33.12	1,500.00	29.84	5,391.14	20.29	63.28
GB-301	0.00	33.07	1,500.00	29.72	5,177.82	20.27	63.31
GB-303	0.00	32.43	1,500.00	29.02	4,848.96	20.24	64.70
GB-305	0.00	32.83	1,500.00	29.41	4,974.29	20.25	63.78
GB-307	0.00	32.91	3,000.00	25.77	5,019.08	20.25	63.60
GB-309	0.00	32.73	3,000.00	25.57	4,952.25	20.25	64.00
GB-311	32.39	31.93	2,000.00	27.19	4,616.43	20.21	65.77

FIRE FLOW SUMMARY - GREENBRIAR

ID	Static Demand (gpm)	Static Pressure (psi)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow @Hydrant (gpm)	Available Flow Pressure (psi)	Available Flow Head (ft)
GB-313	42.13	31.20	2,000.00	22.91	2,513.26	20.06	67.10
GB-315	15.33	32.31	1,500.00	25.48	2,258.49	20.05	64.27
GB-317	14.47	32.42	1,500.00	26.87	2,720.56	20.07	64.10
GB-319	9.36	32.67	1,500.00	27.90	3,172.76	20.10	63.63
GB-321	9.36	33.07	1,500.00	29.36	4,483.37	20.20	63.07
GB-323	22.13	32.92	1,500.00	25.35	2,172.41	20.05	62.80
GB-325	17.88	32.54	1,500.00	26.26	2,467.43	20.06	63.72
GB-327	14.47	32.29	1,500.00	26.48	2,603.25	20.07	64.31
GB-329	10.21	32.29	1,500.00	26.67	2,676.70	20.07	64.32
GB-331	4.26	32.56	1,500.00	26.63	2,573.60	20.07	63.70
GB-333	11.92	32.62	1,500.00	27.82	3,158.86	20.10	63.74
GB-335	10.21	33.03	1,500.00	29.03	4,037.36	20.16	62.95
GB-337	18.73	32.31	1,500.00	26.60	2,639.88	20.07	64.32
GB-339	16.18	32.31	1,500.00	27.29	2,987.14	20.09	64.36
GB-341	13.45	32.54	1,500.00	27.91	3,281.56	20.11	63.89
GB-343	10.90	33.12	1,500.00	29.01	3,933.79	20.15	62.67
GB-345	14.47	32.30	1,500.00	26.69	2,685.95	20.07	64.32
GB-347	17.03	32.30	1,500.00	27.21	2,951.87	20.09	64.36
GB-349	6.82	32.41	1,500.00	27.16	2,861.15	20.08	64.10
GB-351	21.28	32.29	1,500.00	26.16	2,478.62	20.06	64.30
GB-352	30.14	32.57	1,500.00	26.95	2,741.14	20.07	63.68
GB-353	16.18	32.33	1,500.00	26.67	2,667.15	20.07	64.23
GB-355	13.62	32.38	1,500.00	26.96	2,788.57	20.08	64.15
GB-357	15.16	32.56	1,500.00	27.34	2,912.95	20.08	63.76
GB-359	11.75	33.11	1,500.00	28.90	3,841.42	20.15	62.64
GB-361	16.18	32.61	1,500.00	27.34	2,899.48	20.08	63.61
GB-362	20.44	33.00	1,500.00	28.75	3,791.25	20.14	62.87
GB-363	11.07	33.03	1,500.00	28.65	3,667.14	20.13	62.75
GB-365	14.18	33.02	1,500.00	28.74	3,769.26	20.14	62.80
GB-367	19.23	32.90	1,500.00	28.19	3,323.12	20.11	63.00
GB-369	17.03	32.71	1,500.00	27.24	2,825.30	20.08	63.37
GB-371	13.62	32.78	1,500.00	27.18	2,773.44	20.08	63.20
GB-373	10.21	32.84	1,500.00	27.49	2,894.56	20.08	63.08
GB-375	14.73	32.91	1,500.00	28.28	3,388.22	20.11	63.01
GB-377	18.32	33.02	3,000.00	23.28	3,770.82	20.14	62.82
GB-379	45.40	32.72	3,000.00	24.15	4,164.60	20.17	63.63
GB-381	25.98	32.97	2,000.00	25.20	2,943.97	20.09	62.77
GB-383	17.47	32.16	2,000.00	26.18	3,611.27	20.13	64.75

FIRE FLOW SUMMARY - GREENBRIAR

ID	Static Demand (gpm)	Static Pressure (psi)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow @Hydrant (gpm)	Available Flow Pressure (psi)	Available Flow Head (ft)
GB-385	10.65	32.27	2,000.00	26.68	3,905.49	20.15	64.60
GB-387	15.35	31.95	2,000.00	26.35	3,817.00	20.14	65.31
GB-389	9.36	31.98	2,000.00	26.40	3,822.78	20.15	65.28
GB-391	38.21	32.01	2,000.00	26.62	3,996.05	20.16	65.29
GB-393	15.03	32.96	1,500.00	27.73	2,991.29	20.09	62.79
GB-395	15.33	32.40	1,500.00	27.14	2,883.41	20.08	64.05
GB-397	37.53	31.94	1,500.00	27.61	3,517.00	20.12	65.24
GB-399	34.97	31.52	1,500.00	27.26	3,461.10	20.12	66.22
GB-401	19.59	31.39	1,500.00	26.79	3,102.97	20.10	66.47
GB-403	11.07	31.26	2,000.00	23.78	2,726.93	20.07	66.72
GB-405	11.57	33.09	1,500.00	27.82	2,984.60	20.09	62.49
GB-407	22.13	32.30	1,500.00	27.43	3,110.22	20.10	64.33
GB-409	13.62	31.67	3,000.00	21.70	3,387.61	20.11	65.82
GB-411	17.03	32.95	1,500.00	27.78	3,024.39	20.09	62.82
GB-413	26.39	32.19	1,500.00	27.39	3,140.88	20.10	64.58
GB-415	13.62	31.43	3,000.00	21.44	3,323.05	20.11	66.37
GB-417	35.25	32.95	1,500.00	28.50	3,616.19	20.13	62.90
GB-419	11.07	32.00	1,500.00	27.50	3,324.01	20.11	65.04
GB-421	33.40	31.48	1,500.00	26.97	3,238.24	20.10	66.23
GB-423	11.07	31.32	1,500.00	26.87	3,228.65	20.10	66.60
GB-425	22.08	31.17	3,000.00	21.29	3,300.42	20.11	66.97
GB-427	11.07	30.73	3,000.00	20.49	3,099.96	20.10	67.96
GB-429	27.19	30.93	3,000.00	20.75	3,173.73	20.10	67.52
GB-431	22.13	30.79	1,500.00	25.95	2,846.20	20.08	67.79
GB-433	34.25	30.55	1,500.00	25.09	2,479.40	20.06	68.30
GB-435	17.03	30.86	1,500.00	25.50	2,570.60	20.07	67.58
GB-437	17.88	30.54	1,500.00	25.58	2,726.65	20.07	68.33
GB-439	17.88	30.55	1,500.00	25.05	2,449.12	20.06	68.29
GB-441	11.07	30.86	1,500.00	25.33	2,487.09	20.06	67.57
GB-443	11.92	30.54	1,500.00	25.00	2,423.28	20.06	68.29
GB-445	11.07	30.98	1,500.00	25.33	2,452.15	20.06	67.29

Maximum Day Demands With Fire Flow at GB-443

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	86.23	28.70
GB-103	4.98	15.00	86.41	30.94
GB-105	4.98	19.00	86.78	29.37
GB-107	0.00	20.00	87.00	29.03
GB-108	28.11	21.00	88.16	29.10
GB-109	30.65	20.00	86.00	28.60
GB-111	17.03	20.00	86.00	28.60
GB-113	15.33	19.59	86.04	28.79
GB-115	25.54	18.97	86.29	29.17
GB-117	17.03	18.87	86.04	29.11
GB-119	19.36	18.84	86.02	29.11
GB-121	15.33	18.80	86.02	29.12
GB-122	28.53	18.80	86.75	29.44
GB-123	14.47	19.02	86.03	29.04
GB-125	24.69	18.39	86.07	29.32
GB-127	13.62	18.28	86.03	29.36
GB-128	41.75	18.50	86.55	29.48
GB-129	14.47	18.53	86.01	29.24
GB-131	23.84	17.81	86.01	29.55
GB-133	13.62	17.67	86.01	29.61
GB-135	11.92	17.23	86.02	29.80
GB-137	17.03	17.16	86.09	29.87
GB-139	17.03	17.85	86.17	29.60
GB-141	36.61	18.91	86.00	29.07
GB-143	22.13	18.52	85.99	29.23
GB-145	11.92	18.08	85.99	29.42
GB-147	22.32	17.24	85.98	29.79
GB-149	16.18	17.21	85.98	29.80
GB-151	18.73	16.99	85.99	29.90
GB-153	19.36	16.99	86.00	29.90
GB-155	6.82	16.94	86.00	29.92
GB-157	2.56	16.96	86.00	29.91
GB-159	5.76	16.62	86.00	30.06
GB-161	4.26	17.14	85.82	29.76
GB-163	9.36	17.39	85.85	29.66
GB-165	10.21	17.79	86.06	29.58
GB-167	23.73	18.26	85.95	29.33
GB-169	4.26	19.75	85.70	28.58
GB-171	8.51	20.27	85.64	28.32

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	28.46	20.84	85.58	28.05
GB-175	1.70	16.69	85.98	30.03
GB-177	5.96	16.45	85.65	29.98
GB-179	10.21	16.82	85.68	29.84
GB-181	5.96	16.63	85.97	30.05
GB-183	20.44	16.54	85.98	30.09
GB-185	34.06	16.64	85.98	30.04
GB-187	18.73	16.47	85.98	30.12
GB-189	8.51	16.36	85.98	30.17
GB-191	18.53	16.28	85.98	30.20
GB-193	11.67	16.24	85.98	30.22
GB-195	11.67	16.38	85.56	29.98
GB-197	20.44	16.75	85.57	29.82
GB-199	20.44	17.29	85.60	29.60
GB-201	23.84	17.77	85.62	29.40
GB-203	30.53	18.25	85.63	29.19
GB-205	30.53	19.83	85.49	28.45
GB-207	23.84	20.34	85.49	28.23
GB-209	11.92	20.85	85.49	28.01
GB-210	18.62	15.00	86.16	30.83
GB-211	45.98	18.60	86.08	29.24
GB-213	22.13	17.80	85.98	29.54
GB-215	29.98	17.16	85.94	29.80
GB-217	11.92	16.45	85.93	30.11
GB-219	12.77	16.33	85.23	29.85
GB-221	17.33	16.30	85.16	29.84
GB-223	18.44	16.58	85.23	29.74
GB-225	10.21	16.63	85.23	29.72
GB-227	11.07	16.52	85.23	29.77
GB-229	18.87	16.65	85.16	29.69
GB-231	18.73	16.65	85.16	29.69
GB-233	11.92	16.59	85.16	29.71
GB-235	18.73	17.04	85.16	29.52
GB-237	12.52	16.54	85.16	29.74
GB-239	12.52	16.37	85.32	29.87
GB-241	23.84	16.74	85.32	29.72
GB-243	25.54	17.28	85.34	29.49
GB-245	23.84	17.76	85.39	29.30
GB-247	16.18	18.25	85.39	29.10

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	35.65	19.30	85.31	28.60
GB-251	16.18	19.87	85.36	28.38
GB-253	23.84	20.36	85.36	28.17
GB-255	31.86	20.86	85.35	27.94
GB-257	21.28	18.14	85.92	29.37
GB-259	10.21	17.78	85.92	29.52
GB-261	11.07	17.15	85.89	29.79
GB-263	12.77	16.46	85.84	30.06
GB-265	24.97	18.00	85.89	29.42
GB-267	19.87	16.46	85.68	29.99
GB-269	18.73	16.52	85.27	29.79
GB-271	17.88	17.44	85.23	29.37
GB-273	10.21	18.00	85.22	29.13
GB-275	9.50	18.00	85.22	29.13
GB-277	10.21	18.00	85.19	29.11
GB-279	18.73	17.76	85.17	29.21
GB-281	9.36	17.04	85.17	29.52
GB-283	21.28	17.28	85.12	29.40
GB-285	25.54	19.52	85.14	28.43
GB-286	17.03	20.86	85.26	27.91
GB-287	17.03	18.00	85.91	29.42
GB-288	9.36	16.45	85.52	29.93
GB-289	6.82	16.52	85.32	29.81
GB-290	11.07	18.00	85.24	29.13
GB-291	16.18	17.04	85.17	29.52
GB-292	7.66	16.37	85.14	29.80
GB-293	13.62	16.74	85.10	29.62
GB-294	10.56	17.28	85.07	29.37
GB-295	0.00	15.00	86.13	30.82
GB-297	0.00	18.00	85.93	29.43
GB-299	0.00	16.45	85.46	29.90
GB-301	0.00	16.53	85.34	29.82
GB-303	0.00	18.00	85.24	29.13
GB-305	0.00	17.05	85.17	29.52
GB-307	0.00	16.86	85.09	29.56
GB-309	0.00	17.28	85.05	29.36
GB-311	32.39	19.13	85.04	28.56
GB-313	42.13	20.80	85.04	27.83
GB-315	15.33	18.00	84.42	28.78

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	14.47	17.77	84.46	28.90
GB-319	9.36	17.24	84.63	29.20
GB-321	9.36	16.45	85.04	29.72
GB-323	22.13	16.54	83.89	29.18
GB-325	17.88	17.42	83.89	28.80
GB-327	14.47	18.00	83.89	28.55
GB-329	10.21	18.00	83.89	28.55
GB-331	4.26	17.39	83.89	28.81
GB-333	11.92	17.35	84.56	29.12
GB-335	10.21	16.42	84.63	29.55
GB-337	18.73	18.00	84.35	28.75
GB-339	16.18	18.00	84.37	28.76
GB-341	13.45	17.49	84.41	28.99
GB-343	10.90	16.16	84.44	29.58
GB-345	14.47	18.00	84.24	28.70
GB-347	17.03	18.00	84.26	28.71
GB-349	6.82	17.75	84.27	28.82
GB-351	21.28	18.00	84.16	28.67
GB-352	30.14	17.35	84.06	28.91
GB-353	16.18	17.91	84.13	28.70
GB-355	13.62	17.82	84.19	28.76
GB-357	15.16	17.40	84.20	28.94
GB-359	11.75	16.14	84.19	29.48
GB-361	16.18	17.26	83.95	28.90
GB-362	20.44	16.38	84.02	29.31
GB-363	11.07	16.29	83.70	29.21
GB-365	14.18	16.32	83.91	29.29
GB-367	19.23	16.59	83.90	29.16
GB-369	17.03	17.03	83.89	28.97
GB-371	13.62	16.87	83.89	29.04
GB-373	10.21	16.73	83.89	29.10
GB-375	14.73	16.59	83.90	29.17
GB-377	18.32	16.34	83.90	29.28
GB-379	45.40	17.08	83.99	28.99
GB-381	25.98	16.42	83.38	29.01
GB-383	17.47	18.29	83.37	28.20
GB-385	10.65	18.09	83.64	28.40
GB-387	15.35	18.82	83.64	28.09
GB-389	9.36	18.79	83.81	28.17

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	38.21	18.77	84.15	28.33
GB-393	15.03	16.43	83.26	28.96
GB-395	15.33	17.71	83.21	28.38
GB-397	37.53	18.80	83.23	27.92
GB-399	34.97	19.79	83.30	27.52
GB-401	19.59	20.09	83.30	27.39
GB-403	11.07	20.39	83.30	27.26
GB-405	11.57	16.13	83.23	29.08
GB-407	22.13	17.95	83.16	28.25
GB-409	13.62	19.40	83.12	27.61
GB-411	17.03	16.46	83.23	28.93
GB-413	26.39	18.20	83.11	28.13
GB-415	13.62	19.96	83.00	27.31
GB-417	35.25	16.45	83.33	28.98
GB-419	11.07	18.63	83.07	27.92
GB-421	33.40	19.83	82.80	27.28
GB-423	11.07	20.20	82.79	27.12
GB-425	22.08	20.56	82.84	26.99
GB-427	11.07	21.58	82.77	26.52
GB-429	27.19	21.13	82.91	26.77
GB-431	22.13	21.45	82.72	26.55
GB-433	34.25	22.00	82.68	26.29
GB-435	17.03	21.27	81.87	26.26
GB-437	17.88	22.00	81.63	25.84
GB-439	17.88	22.00	81.82	25.92
GB-441	11.07	21.27	81.77	26.22
GB-443	1,511.92	22.00	79.69	25.00
GB-445	11.07	21.00	81.73	26.31
GB-446	0.00	22.00	86.20	27.82
GB-447	0.00	26.00	91.43	28.35

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	66.26	0.42	0.01
P102	117.50	8.00	130.00	-244.58	1.56	0.16
P103	739.21	8.00	130.00	145.59	0.93	0.38
P104	117.50	8.00	130.00	72.47	0.46	0.02
P105	117.50	8.00	130.00	133.10	0.85	0.05
P106	436.40	12.00	130.00	75.22	0.21	0.01
P107	650.57	8.00	130.00	70.40	0.45	0.09
P108	535.27	8.00	130.00	66.24	0.42	0.06
P109	357.35	18.00	130.00	-1,805.71	2.28	0.38
P110	243.09	12.00	130.00	-405.12	1.15	0.12
P111	253.19	8.00	130.00	-104.49	0.67	0.07
P112	380.98	8.00	130.00	137.52	0.88	0.18
P113	904.24	8.00	130.00	-67.73	0.43	0.11
P114	693.26	8.00	130.00	-83.97	0.54	0.13
P115	105.50	8.00	130.00	-12.86	0.08	0.000
P116	147.51	12.00	130.00	-10.42	0.03	0.0000
P117	132.50	12.00	130.00	-161.29	0.46	0.01
P118	226.54	8.00	130.00	88.18	0.56	0.05
P119	193.01	8.00	130.00	18.26	0.12	0.00
P120	193.01	8.00	130.00	-41.87	0.27	0.01
P121	713.00	8.00	130.00	5.99	0.04	0.000
P122	615.89	8.00	130.00	-7.63	0.05	0.00
P123	713.00	8.00	130.00	-117.30	0.75	0.25
P124	677.66	8.00	130.00	-120.30	0.77	0.25
P125	476.65	8.00	130.00	-122.71	0.78	0.18
P126	117.50	8.00	130.00	-115.05	0.73	0.04
P127	677.66	8.00	130.00	116.50	0.74	0.23
P128	193.00	8.00	130.00	-18.60	0.12	0.00
P129	117.50	8.00	130.00	-100.05	0.64	0.03
P130	633.34	8.00	130.00	48.41	0.31	0.04
P131	232.72	8.00	130.00	57.33	0.37	0.02
P132	233.02	8.00	130.00	64.17	0.41	0.03
P133	618.66	8.00	130.00	42.56	0.27	0.03
P134	713.00	8.00	130.00	-38.91	0.25	0.03
P135	195.00	8.00	130.00	54.38	0.35	0.02
P136	193.00	8.00	130.00	107.80	0.69	0.06
P137	112.20	18.00	130.00	1,723.58	2.17	0.11
P138	701.50	8.00	130.00	-65.10	0.42	0.08
P139	378.03	8.00	130.00	-85.87	0.55	0.07

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	-3.09	0.02	0.000
P141	253.00	8.00	130.00	61.87	0.39	0.03
P142	233.00	8.00	130.00	-38.40	0.25	0.01
P143	233.00	8.00	130.00	-63.69	0.41	0.03
P144	232.70	8.00	130.00	-52.60	0.34	0.02
P145	574.54	8.00	130.00	11.66	0.07	0.00
P146	105.50	8.00	130.00	63.25	0.40	0.01
P147	126.23	8.00	130.00	96.76	0.62	0.03
P148	126.78	8.00	130.00	33.79	0.22	0.00
P149	388.16	8.00	130.00	8.35	0.05	0.000
P150	117.50	8.00	130.00	1.71	0.01	0.0000
P151	611.16	8.00	130.00	-6.85	0.04	0.00
P152	418.00	8.00	130.00	-6.53	0.04	0.000
P153	97.50	8.00	130.00	-6.40	0.04	0.000
P154	261.76	8.00	130.00	-37.21	0.24	0.01
P155	839.51	8.00	130.00	6.79	0.04	0.00
P156	170.40	8.00	130.00	16.12	0.10	0.00
P157	116.20	8.00	130.00	8.55	0.05	0.000
P158	248.92	8.00	130.00	-36.88	0.24	0.01
P159	247.10	8.00	130.00	-9.44	0.06	0.000
P160	247.67	8.00	130.00	12.57	0.08	0.00
P161	247.82	8.00	130.00	29.91	0.19	0.01
P162	247.00	8.00	130.00	-16.57	0.11	0.00
P163	249.87	8.00	130.00	-10.49	0.07	0.000
P164	1,149.31	8.00	130.00	19.11	0.12	0.01
P165	710.72	12.00	130.00	-315.72	0.90	0.21
P166	369.00	8.00	130.00	170.57	1.09	0.25
P167	253.00	8.00	130.00	134.53	0.86	0.11
P168	918.21	8.00	130.00	60.18	0.38	0.09
P169	282.81	8.00	130.00	111.63	0.71	0.09
P170	333.36	12.00	130.00	-68.55	0.19	0.01
P171	253.00	8.00	130.00	159.30	1.02	0.15
P172	234.54	8.00	130.00	97.98	0.63	0.06
P173	253.00	8.00	130.00	57.97	0.37	0.02
P174	657.99	8.00	130.00	56.70	0.36	0.06
P175	633.34	8.00	130.00	22.57	0.14	0.01
P176	253.02	8.00	130.00	33.27	0.21	0.01
P177	633.34	8.00	130.00	69.25	0.44	0.08
P178	242.02	12.00	130.00	338.84	0.96	0.08

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	165.98	1.06	0.17
P180	273.00	8.00	130.00	-136.40	0.87	0.12
P181	628.13	12.00	130.00	386.81	1.10	0.27
P182	797.55	12.00	130.00	325.51	0.92	0.25
P183	578.83	12.00	130.00	475.22	1.35	0.37
P184	193.00	8.00	130.00	-724.30	4.62	1.94
P185	653.19	8.00	130.00	385.35	2.46	2.04
P186	193.00	8.00	130.00	142.07	0.91	0.09
P187	193.00	8.00	130.00	146.99	0.94	0.10
P188	437.56	8.00	130.00	311.15	1.99	0.92
P189	203.57	12.00	130.00	87.05	0.25	0.01
P190	596.95	8.00	130.00	205.52	1.31	0.58
P191	292.91	8.00	130.00	16.20	0.10	0.00
P192	695.05	8.00	130.00	-81.23	0.52	0.12
P193	253.00	8.00	130.00	85.26	0.54	0.05
P194	656.00	8.00	130.00	-74.03	0.47	0.10
P195	504.88	8.00	130.00	-90.50	0.58	0.11
P196	313.32	8.00	130.00	-39.37	0.25	0.01
P197	549.00	8.00	130.00	86.73	0.55	0.11
P198	253.00	8.00	130.00	43.30	0.28	0.01
P199	253.00	8.00	130.00	75.95	0.48	0.04
P200	253.00	8.00	130.00	158.03	1.01	0.15
P201	403.00	8.00	130.00	82.16	0.52	0.07
P202	276.11	8.00	130.00	257.51	1.64	0.41
P203	253.02	8.00	130.00	-126.99	0.81	0.10
P204	253.02	8.00	130.00	-70.73	0.45	0.03
P205	236.90	8.00	130.00	-38.07	0.24	0.01
P206	636.18	8.00	130.00	47.94	0.31	0.04
P207	211.30	8.00	130.00	33.85	0.22	0.01
P208	232.70	8.00	130.00	63.98	0.41	0.03
P209	233.00	8.00	130.00	97.98	0.63	0.06
P210	233.00	8.00	130.00	204.14	1.30	0.22
P211	621.42	8.00	130.00	-126.86	0.81	0.25
P212	253.02	8.00	130.00	-75.45	0.48	0.04
P213	699.07	8.00	130.00	-27.14	0.17	0.02
P214	253.02	8.00	130.00	-15.71	0.10	0.00
P215	613.13	8.00	130.00	-12.71	0.08	0.00
P216	253.00	8.00	130.00	32.21	0.21	0.01
P217	233.00	8.00	130.00	21.30	0.14	0.00

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	23.06	0.15	0.00
P219	313.50	8.00	130.00	-154.18	0.98	0.18
P220	391.14	12.00	130.00	621.80	1.76	0.41
P221	590.71	8.00	130.00	67.00	0.43	0.07
P222	253.00	8.00	130.00	32.90	0.21	0.01
P223	390.32	8.00	130.00	119.08	0.76	0.14
P224	430.55	8.00	130.00	50.45	0.32	0.03
P225	248.33	12.00	130.00	523.79	1.49	0.19
P226	430.73	8.00	130.00	-27.09	0.17	0.01
P227	412.22	12.00	130.00	462.44	1.31	0.25
P228	262.25	12.00	130.00	461.53	1.31	0.16
P229	253.00	12.00	130.00	407.42	1.16	0.12
P230	273.31	12.00	130.00	377.76	1.07	0.11
P231	234.73	12.00	130.00	455.29	1.29	0.14
P232	422.16	12.00	130.00	-534.14	1.52	0.33
P233	596.34	12.00	130.00	-482.14	1.37	0.39
P234	591.74	12.00	130.00	-275.65	0.78	0.14
P235	587.67	12.00	130.00	-833.40	2.36	1.06
P236	457.95	12.00	130.00	-518.64	1.47	0.34
P237	359.68	12.00	130.00	-55.34	0.16	0.00
P238	193.00	8.00	130.00	-12.43	0.08	0.00
P239	487.33	8.00	130.00	107.66	0.69	0.14
P240	486.84	8.00	130.00	-85.67	0.55	0.09
P241	708.39	8.00	130.00	-86.03	0.55	0.14
P242	617.10	8.00	130.00	-87.61	0.56	0.12
P243	319.69	18.00	130.00	-912.17	1.15	0.09
P244	861.88	12.00	130.00	-42.13	0.12	0.01
P245	534.05	18.00	130.00	-575.97	0.73	0.07
P246	627.02	18.00	130.00	-586.39	0.74	0.08
P247	195.01	18.00	130.00	-747.68	0.94	0.04
P248	751.91	18.00	130.00	-135.27	0.17	0.01
P249	370.87	12.00	130.00	-972.92	2.76	0.89
P250	602.79	8.00	130.00	-212.04	1.35	0.62
P251	656.30	8.00	130.00	-254.35	1.62	0.95
P252	501.81	8.00	130.00	-129.05	0.82	0.21
P253	464.05	12.00	130.00	452.65	1.28	0.27
P254	250.56	12.00	130.00	477.78	1.36	0.16
P255	423.72	8.00	130.00	-79.36	0.51	0.07
P256	235.04	8.00	130.00	-37.12	0.24	0.01

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	87.79	0.56	0.07
P258	656.00	8.00	130.00	62.15	0.40	0.07
P259	497.14	8.00	130.00	286.13	1.83	0.89
P260	494.52	8.00	130.00	-126.19	0.81	0.20
P261	466.36	8.00	130.00	147.14	0.94	0.24
P262	616.00	8.00	130.00	402.28	2.57	2.08
P263	651.25	8.00	130.00	266.36	1.70	1.03
P264	246.49	8.00	130.00	90.50	0.58	0.05
P265	375.42	12.00	130.00	-269.36	0.76	0.08
P266	665.79	8.00	130.00	182.49	1.16	0.52
P267	285.98	8.00	130.00	-114.46	0.73	0.09
P268	272.69	8.00	130.00	61.25	0.39	0.03
P269	744.21	8.00	130.00	17.79	0.11	0.01
P270	105.50	8.00	130.00	3.95	0.03	0.0000
P271	892.22	8.00	130.00	41.50	0.26	0.04
P272	193.00	8.00	130.00	15.33	0.10	0.00
P273	105.50	8.00	130.00	20.04	0.13	0.00
P274	698.75	8.00	130.00	0.64	0.00	0.0000
P275	181.50	12.00	130.00	-473.85	1.34	0.12
P276	112.20	8.00	130.00	-70.86	0.45	0.02
P277	698.70	8.00	130.00	-30.27	0.19	0.02
P278	713.00	8.00	130.00	2.53	0.02	0.000
P279	422.00	8.00	130.00	-84.99	0.54	0.08
P280	117.50	8.00	130.00	14.93	0.10	0.000
P281	589.97	8.00	130.00	-220.81	1.41	0.66
P282	130.50	8.00	130.00	-218.54	1.39	0.14
P283	410.65	18.00	130.00	-1,847.47	2.33	0.45
P284	500.49	8.00	130.00	-165.63	1.06	0.33
P285	807.99	8.00	130.00	23.65	0.15	0.01
P286	193.00	8.00	130.00	12.28	0.08	0.00
P287	263.00	8.00	130.00	72.37	0.46	0.04
P288	738.30	8.00	130.00	19.85	0.13	0.01
P289	233.02	8.00	130.00	-36.08	0.23	0.01
P290	739.64	8.00	130.00	-105.14	0.67	0.21
P291	252.00	8.00	130.00	-11.48	0.07	0.00
P292	262.03	8.00	130.00	-72.88	0.47	0.04
P293	924.17	8.00	130.00	-10.41	0.07	0.00
P294	770.75	8.00	130.00	-30.17	0.19	0.02
P295	956.68	8.00	130.00	52.22	0.33	0.07

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-232.17	1.48	0.85
P297	678.13	8.00	130.00	86.09	0.55	0.13
P298	837.42	8.00	130.00	31.79	0.20	0.03
P299	557.94	8.00	130.00	-199.02	1.27	0.51
P300	696.14	8.00	130.00	-8.39	0.05	0.00
P301	468.04	8.00	130.00	-7.13	0.05	0.000
P302	255.36	8.00	130.00	-19.65	0.13	0.00
P303	247.32	8.00	130.00	23.91	0.15	0.00
P304	208.11	12.00	130.00	-888.67	2.52	0.42
P305	88.53	8.00	130.00	42.75	0.27	0.00
P306	193.00	8.00	130.00	-221.43	1.41	0.22
P307	582.27	8.00	130.00	21.09	0.13	0.01
P308	677.66	8.00	130.00	-124.16	0.79	0.26
P309	195.00	8.00	130.00	-68.62	0.44	0.02
P310	132.50	12.00	130.00	-220.98	0.63	0.02
P311	380.98	8.00	130.00	-152.04	0.97	0.21
P312	475.68	8.00	130.00	-137.00	0.87	0.22
P313	655.89	8.00	130.00	-51.08	0.33	0.05
P314	653.93	8.00	130.00	-74.09	0.47	0.10
P315	215.00	8.00	130.00	7.52	0.05	0.000
P316	195.01	8.00	130.00	54.76	0.35	0.02
P317	214.88	8.00	130.00	16.18	0.10	0.00
P318	252.22	8.00	130.00	-1.75	0.01	0.0000
P319	245.38	8.00	130.00	14.52	0.09	0.00
P320	607.50	8.00	130.00	-8.48	0.05	0.00
P321	574.53	8.00	130.00	-10.98	0.07	0.00
P322	105.50	8.00	130.00	-38.72	0.25	0.00
P323	212.18	8.00	130.00	14.32	0.09	0.00
P324	105.50	8.00	130.00	9.01	0.06	0.000
P325	211.00	8.00	130.00	-26.02	0.17	0.00
P326	211.30	8.00	130.00	-44.41	0.28	0.01
P327	209.82	8.00	130.00	-22.84	0.15	0.00
P328	728.60	8.00	130.00	43.27	0.28	0.04
P329	594.64	8.00	130.00	65.89	0.42	0.07
P330	258.06	8.00	130.00	-84.79	0.54	0.05
P331	499.01	8.00	130.00	60.12	0.38	0.05
P332	545.88	8.00	130.00	-39.99	0.26	0.03
P333	783.02	8.00	130.00	20.10	0.13	0.01
P334	260.55	12.00	130.00	-235.18	0.67	0.05

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	468.85	2.99	1.15
P336	255.00	8.00	130.00	179.31	1.14	0.19
P337	255.07	8.00	130.00	76.56	0.49	0.04
P338	255.00	12.00	130.00	702.54	1.99	0.34
P339	255.00	12.00	130.00	-494.15	1.40	0.18
P340	255.00	8.00	130.00	17.03	0.11	0.00
P341	255.00	8.00	130.00	-9.06	0.06	0.000
P342	246.98	8.00	130.00	-3.02	0.02	0.0000
P343	253.00	8.00	130.00	-77.48	0.49	0.04
P344	147.50	12.00	130.00	79.38	0.23	0.00
P345	147.37	12.00	130.00	210.32	0.60	0.02
P346	147.50	12.00	130.00	228.89	0.65	0.02
P347	147.59	12.00	130.00	-380.81	1.08	0.06
P348	381.04	8.00	130.00	-96.03	0.61	0.09
P349	190.72	18.00	130.00	-858.97	1.08	0.05
P350	253.02	8.00	130.00	31.29	0.20	0.01
P351	233.00	8.00	130.00	12.24	0.08	0.00
P352	1,365.42	24.00	130.00	1,247.74	0.88	0.18
P353	1,505.76	30.00	130.00	-1,247.74	0.57	0.07
P354	369.99	8.00	130.00	-94.10	0.60	0.08
P355	369.99	8.00	130.00	-108.28	0.69	0.11
P356	117.50	8.00	130.00	-37.88	0.24	0.01
P357	195.00	8.00	130.00	-71.43	0.46	0.03
P358	193.00	8.00	130.00	-72.58	0.46	0.03
P359	500.49	8.00	130.00	-143.45	0.92	0.25
P360	500.78	8.00	130.00	-194.14	1.24	0.44
P361	677.66	8.00	130.00	-116.32	0.74	0.23
P362	482.45	12.00	130.00	204.27	0.58	0.06
P363	677.66	8.00	130.00	-121.39	0.77	0.25
P364	1,180.18	30.00	130.00	-890.27	0.40	0.03
P365	1,577.01	24.00	130.00	-1,726.57	1.22	0.38
P366	701.50	24.00	130.00	-1,980.88	1.40	0.22
P367	242.00	18.00	130.00	1,602.41	2.02	0.20
P368	738.68	18.00	130.00	1,373.52	1.73	0.47
P369	253.00	8.00	130.00	-63.85	0.41	0.03
P370	660.09	8.00	130.00	-96.62	0.62	0.16
P371	193.00	18.00	130.00	1,297.80	1.64	0.11
P372	595.91	18.00	130.00	1,108.45	1.40	0.25
P373	191.34	18.00	130.00	975.14	1.23	0.06

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	20.52	0.13	0.00
P375	607.50	8.00	130.00	-21.67	0.14	0.01
P376	438.00	18.00	130.00	865.67	1.09	0.12
P377	650.57	18.00	130.00	655.35	0.83	0.10
P378	112.20	8.00	130.00	-183.01	1.17	0.09
P379	117.50	8.00	130.00	18.55	0.12	0.00
P380	348.36	8.00	130.00	25.37	0.16	0.01
P381	178.10	12.00	130.00	-249.34	0.71	0.03
P382	1,122.42	24.00	130.00	-3,828.35	2.72	1.17
P383	93.09	8.00	130.00	-154.40	0.99	0.05
P384	195.01	8.00	130.00	77.13	0.49	0.03
P385	4,416.05	30.00	130.00	712.14	0.32	0.07
P386	3,100.00	24.00	130.00	-3,856.46	2.73	3.27
P388	1,581.75	18.00	130.00	744.84	0.94	0.32
P389	621.96	18.00	130.00	736.23	0.93	0.12
P990	235.86	99.00	130.00	712.14	0.03	0.0000
P991	377.34	99.00	130.00	712.14	0.03	0.0000
P992	233.99	99.00	130.00	3,856.46	0.16	0.000
P993	232.72	99.00	130.00	3,856.46	0.16	0.000

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-443 - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	27.82	712.14	86.20
PUMP107	26.00	28.35	3,856.46	91.44

Maximum Day Demands With Fire Flow at GB-313

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	83.84	27.66
GB-103	4.98	15.00	84.00	29.90
GB-105	4.98	19.00	84.35	28.32
GB-107	0.00	20.00	84.56	27.98
GB-108	28.11	21.00	85.85	28.10
GB-109	30.65	20.00	83.55	27.53
GB-111	17.03	20.00	83.55	27.54
GB-113	15.33	19.59	83.59	27.73
GB-115	25.54	18.97	83.86	28.12
GB-117	17.03	18.87	83.56	28.03
GB-119	19.36	18.84	83.51	28.03
GB-121	15.33	18.80	83.51	28.04
GB-122	28.53	18.80	84.31	28.39
GB-123	14.47	19.02	83.57	27.97
GB-125	24.69	18.39	83.60	28.26
GB-127	13.62	18.28	83.55	28.28
GB-128	41.75	18.50	84.01	28.39
GB-129	14.47	18.53	83.54	28.17
GB-131	23.84	17.81	83.53	28.48
GB-133	13.62	17.67	83.52	28.53
GB-135	11.92	17.23	83.50	28.72
GB-137	17.03	17.16	83.54	28.76
GB-139	17.03	17.85	83.54	28.47
GB-141	36.61	18.91	83.55	28.01
GB-143	22.13	18.52	83.53	28.17
GB-145	11.92	18.08	83.52	28.35
GB-147	22.32	17.24	83.50	28.71
GB-149	16.18	17.21	83.49	28.72
GB-151	18.73	16.99	83.49	28.82
GB-153	19.36	16.99	83.49	28.82
GB-155	6.82	16.94	83.49	28.84
GB-157	2.56	16.96	83.48	28.82
GB-159	5.76	16.62	83.46	28.96
GB-161	4.26	17.14	83.15	28.60
GB-163	9.36	17.39	83.17	28.50
GB-165	10.21	17.79	83.40	28.43
GB-167	23.73	18.26	83.25	28.16
GB-169	4.26	19.75	82.89	27.36
GB-171	8.51	20.27	82.80	27.09

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	28.46	20.84	82.72	26.81
GB-175	1.70	16.69	83.48	28.94
GB-177	5.96	16.45	82.91	28.80
GB-179	10.21	16.82	82.96	28.66
GB-181	5.96	16.63	83.48	28.97
GB-183	20.44	16.54	83.48	29.01
GB-185	34.06	16.64	83.48	28.96
GB-187	18.73	16.47	83.48	29.03
GB-189	8.51	16.36	83.48	29.08
GB-191	18.53	16.28	83.48	29.12
GB-193	11.67	16.24	83.48	29.13
GB-195	11.67	16.38	82.80	28.78
GB-197	20.44	16.75	82.80	28.62
GB-199	20.44	17.29	82.83	28.40
GB-201	23.84	17.77	82.86	28.20
GB-203	30.53	18.25	82.86	27.99
GB-205	30.53	19.83	82.61	27.20
GB-207	23.84	20.34	82.61	26.98
GB-209	11.92	20.85	82.61	26.76
GB-210	18.62	15.00	83.78	29.80
GB-211	45.98	18.60	83.67	28.20
GB-213	22.13	17.80	83.53	28.48
GB-215	29.98	17.16	83.48	28.74
GB-217	11.92	16.45	83.47	29.04
GB-219	12.77	16.33	82.54	28.69
GB-221	17.33	16.30	82.40	28.64
GB-223	18.44	16.58	82.55	28.58
GB-225	10.21	16.63	82.54	28.56
GB-227	11.07	16.52	82.54	28.61
GB-229	18.87	16.65	82.40	28.49
GB-231	18.73	16.65	82.40	28.49
GB-233	11.92	16.59	82.40	28.51
GB-235	18.73	17.04	82.40	28.32
GB-237	12.52	16.54	82.40	28.54
GB-239	12.52	16.37	82.47	28.64
GB-241	23.84	16.74	82.47	28.48
GB-243	25.54	17.28	82.48	28.25
GB-245	23.84	17.76	82.54	28.07
GB-247	16.18	18.25	82.54	27.86

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	35.65	19.30	82.37	27.33
GB-251	16.18	19.87	82.43	27.11
GB-253	23.84	20.36	82.43	26.90
GB-255	31.86	20.86	82.41	26.67
GB-257	21.28	18.14	83.48	28.31
GB-259	10.21	17.78	83.48	28.47
GB-261	11.07	17.15	83.44	28.72
GB-263	12.77	16.46	83.38	29.00
GB-265	24.97	18.00	83.46	28.36
GB-267	19.87	16.46	83.21	28.92
GB-269	18.73	16.52	82.62	28.64
GB-271	17.88	17.44	82.55	28.21
GB-273	10.21	18.00	82.53	27.96
GB-275	9.50	18.00	82.51	27.95
GB-277	10.21	18.00	82.45	27.93
GB-279	18.73	17.76	82.41	28.01
GB-281	9.36	17.04	82.40	28.32
GB-283	21.28	17.28	82.16	28.11
GB-285	25.54	19.52	82.05	27.10
GB-286	17.03	20.86	82.24	26.60
GB-287	17.03	18.00	83.48	28.37
GB-288	9.36	16.45	83.03	28.85
GB-289	6.82	16.52	82.70	28.68
GB-290	11.07	18.00	82.53	27.96
GB-291	16.18	17.04	82.40	28.32
GB-292	7.66	16.37	82.25	28.55
GB-293	13.62	16.74	82.21	28.37
GB-294	10.56	17.28	82.14	28.10
GB-295	0.00	15.00	83.76	29.79
GB-297	0.00	18.00	83.51	28.39
GB-299	0.00	16.45	82.96	28.82
GB-301	0.00	16.53	82.74	28.69
GB-303	0.00	18.00	82.53	27.96
GB-305	0.00	17.05	82.39	28.31
GB-307	0.00	16.86	82.20	28.31
GB-309	0.00	17.28	82.12	28.09
GB-311	32.39	19.13	81.88	27.19
GB-313	2,042.13	20.80	73.68	22.91
GB-315	15.33	18.00	82.28	27.85

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	14.47	17.77	82.31	27.96
GB-319	9.36	17.24	82.42	28.24
GB-321	9.36	16.45	82.68	28.70
GB-323	22.13	16.54	81.92	28.33
GB-325	17.88	17.42	81.91	27.94
GB-327	14.47	18.00	81.91	27.69
GB-329	10.21	18.00	81.91	27.69
GB-331	4.26	17.39	81.91	27.95
GB-333	11.92	17.35	82.37	28.17
GB-335	10.21	16.42	82.42	28.60
GB-337	18.73	18.00	82.24	27.84
GB-339	16.18	18.00	82.25	27.84
GB-341	13.45	17.49	82.28	28.07
GB-343	10.90	16.16	82.30	28.66
GB-345	14.47	18.00	82.18	27.81
GB-347	17.03	18.00	82.19	27.81
GB-349	6.82	17.75	82.19	27.92
GB-351	21.28	18.00	82.13	27.79
GB-352	30.14	17.35	82.08	28.05
GB-353	16.18	17.91	82.12	27.82
GB-355	13.62	17.82	82.15	27.87
GB-357	15.16	17.40	82.16	28.06
GB-359	11.75	16.14	82.16	28.60
GB-361	16.18	17.26	82.04	28.07
GB-362	20.44	16.38	82.07	28.46
GB-363	11.07	16.29	81.96	28.45
GB-365	14.18	16.32	82.00	28.46
GB-367	19.23	16.59	81.97	28.33
GB-369	17.03	17.03	81.93	28.12
GB-371	13.62	16.87	81.91	28.18
GB-373	10.21	16.73	81.91	28.24
GB-375	14.73	16.59	81.91	28.30
GB-377	18.32	16.34	81.91	28.41
GB-379	45.40	17.08	81.92	28.09
GB-381	25.98	16.42	81.83	28.34
GB-383	17.47	18.29	81.83	27.53
GB-385	10.65	18.09	81.85	27.63
GB-387	15.35	18.82	81.84	27.31
GB-389	9.36	18.79	81.84	27.32

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	38.21	18.77	81.85	27.33
GB-393	15.03	16.43	81.83	28.33
GB-395	15.33	17.71	81.82	27.78
GB-397	37.53	18.80	81.82	27.31
GB-399	34.97	19.79	81.82	26.88
GB-401	19.59	20.09	81.82	26.75
GB-403	11.07	20.39	81.82	26.62
GB-405	11.57	16.13	81.83	28.47
GB-407	22.13	17.95	81.82	27.67
GB-409	13.62	19.40	81.82	27.05
GB-411	17.03	16.46	81.83	28.33
GB-413	26.39	18.20	81.82	27.57
GB-415	13.62	19.96	81.82	26.80
GB-417	35.25	16.45	81.87	28.35
GB-419	11.07	18.63	81.83	27.38
GB-421	33.40	19.83	81.81	26.86
GB-423	11.07	20.20	81.81	26.70
GB-425	22.08	20.56	81.81	26.54
GB-427	11.07	21.58	81.81	26.10
GB-429	27.19	21.13	81.81	26.29
GB-431	22.13	21.45	81.81	26.15
GB-433	34.25	22.00	81.81	25.91
GB-435	17.03	21.27	81.81	26.23
GB-437	17.88	22.00	81.81	25.91
GB-439	17.88	22.00	81.81	25.91
GB-441	11.07	21.27	81.81	26.23
GB-443	11.92	22.00	81.81	25.91
GB-445	11.07	21.00	81.81	26.35
GB-446	0.00	22.00	83.89	26.82
GB-447	0.00	26.00	89.44	27.49

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	84.55	0.54	0.02
P102	117.50	8.00	130.00	-261.64	1.67	0.18
P103	739.21	8.00	130.00	159.79	1.02	0.45
P104	117.50	8.00	130.00	78.86	0.50	0.02
P105	117.50	8.00	130.00	171.50	1.09	0.08
P106	436.40	12.00	130.00	143.26	0.41	0.03
P107	650.57	8.00	130.00	101.55	0.65	0.17
P108	535.27	8.00	130.00	97.68	0.62	0.13
P109	357.35	18.00	130.00	-2,028.25	2.56	0.47
P110	243.09	12.00	130.00	-295.09	0.84	0.06
P111	253.19	8.00	130.00	-70.41	0.45	0.03
P112	380.98	8.00	130.00	189.90	1.21	0.32
P113	904.24	8.00	130.00	-13.92	0.09	0.01
P114	693.26	8.00	130.00	-99.79	0.64	0.18
P115	105.50	8.00	130.00	-13.97	0.09	0.000
P116	147.51	12.00	130.00	-86.65	0.25	0.00
P117	132.50	12.00	130.00	-145.18	0.41	0.01
P118	226.54	8.00	130.00	99.84	0.64	0.06
P119	193.01	8.00	130.00	13.96	0.09	0.00
P120	193.01	8.00	130.00	-61.98	0.40	0.02
P121	713.00	8.00	130.00	-12.62	0.08	0.00
P122	615.89	8.00	130.00	11.33	0.07	0.00
P123	713.00	8.00	130.00	-131.03	0.84	0.30
P124	677.66	8.00	130.00	-140.49	0.90	0.33
P125	476.65	8.00	130.00	-135.59	0.87	0.22
P126	117.50	8.00	130.00	-127.93	0.82	0.05
P127	677.66	8.00	130.00	138.27	0.88	0.32
P128	193.00	8.00	130.00	-13.88	0.09	0.00
P129	117.50	8.00	130.00	-118.36	0.76	0.04
P130	633.34	8.00	130.00	44.29	0.28	0.04
P131	232.72	8.00	130.00	48.93	0.31	0.02
P132	233.02	8.00	130.00	74.73	0.48	0.03
P133	618.66	8.00	130.00	41.03	0.26	0.03
P134	713.00	8.00	130.00	-48.54	0.31	0.05
P135	195.00	8.00	130.00	41.06	0.26	0.01
P136	193.00	8.00	130.00	110.49	0.71	0.06
P137	112.20	18.00	130.00	2,003.62	2.53	0.14
P138	701.50	8.00	130.00	-7.60	0.05	0.00
P139	378.03	8.00	130.00	-60.49	0.39	0.04

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	15.02	0.10	0.00
P141	253.00	8.00	130.00	82.22	0.52	0.05
P142	233.00	8.00	130.00	-31.78	0.20	0.01
P143	233.00	8.00	130.00	-66.70	0.43	0.03
P144	232.70	8.00	130.00	-71.60	0.46	0.03
P145	574.54	8.00	130.00	-8.06	0.05	0.00
P146	105.50	8.00	130.00	22.70	0.14	0.00
P147	126.23	8.00	130.00	141.55	0.90	0.06
P148	126.78	8.00	130.00	72.19	0.46	0.02
P149	388.16	8.00	130.00	-0.74	0.00	0.0000
P150	117.50	8.00	130.00	0.30	0.00	0.0000
P151	611.16	8.00	130.00	1.64	0.01	0.00000
P152	418.00	8.00	130.00	-14.06	0.09	0.00
P153	97.50	8.00	130.00	-12.67	0.08	0.000
P154	261.76	8.00	130.00	-60.30	0.38	0.03
P155	839.51	8.00	130.00	22.10	0.14	0.01
P156	170.40	8.00	130.00	24.83	0.16	0.00
P157	116.20	8.00	130.00	14.86	0.09	0.000
P158	248.92	8.00	130.00	-83.33	0.53	0.05
P159	247.10	8.00	130.00	-45.42	0.29	0.01
P160	247.67	8.00	130.00	-22.79	0.15	0.00
P161	247.82	8.00	130.00	-10.21	0.07	0.000
P162	247.00	8.00	130.00	16.11	0.10	0.00
P163	249.87	8.00	130.00	21.56	0.14	0.00
P164	1,149.31	8.00	130.00	40.70	0.26	0.06
P165	710.72	12.00	130.00	-137.65	0.39	0.05
P166	369.00	8.00	130.00	93.90	0.60	0.08
P167	253.00	8.00	130.00	80.52	0.51	0.04
P168	918.21	8.00	130.00	40.24	0.26	0.04
P169	282.81	8.00	130.00	81.20	0.52	0.05
P170	333.36	12.00	130.00	-0.51	0.00	0.00
P171	253.00	8.00	130.00	165.28	1.05	0.16
P172	234.54	8.00	130.00	106.70	0.68	0.07
P173	253.00	8.00	130.00	71.43	0.46	0.03
P174	657.99	8.00	130.00	53.71	0.34	0.05
P175	633.34	8.00	130.00	8.54	0.05	0.00
P176	253.02	8.00	130.00	44.27	0.28	0.01
P177	633.34	8.00	130.00	86.75	0.55	0.13
P178	242.02	12.00	130.00	390.59	1.11	0.11

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	132.62	0.85	0.11
P180	273.00	8.00	130.00	-29.25	0.19	0.01
P181	628.13	12.00	130.00	79.27	0.22	0.01
P182	797.55	12.00	130.00	118.51	0.34	0.04
P183	578.83	12.00	130.00	220.47	0.63	0.09
P184	193.00	8.00	130.00	-8.54	0.05	0.000
P185	653.19	8.00	130.00	-3.34	0.02	0.000
P186	193.00	8.00	130.00	1.12	0.01	0.0000
P187	193.00	8.00	130.00	-0.69	0.00	0.00
P188	437.56	8.00	130.00	21.78	0.14	0.01
P189	203.57	12.00	130.00	27.39	0.08	0.000
P190	596.95	8.00	130.00	25.47	0.16	0.01
P191	292.91	8.00	130.00	27.82	0.18	0.01
P192	695.05	8.00	130.00	-21.86	0.14	0.01
P193	253.00	8.00	130.00	-9.72	0.06	0.000
P194	656.00	8.00	130.00	-56.17	0.36	0.06
P195	504.88	8.00	130.00	-67.56	0.43	0.06
P196	313.32	8.00	130.00	-31.40	0.20	0.01
P197	549.00	8.00	130.00	64.27	0.41	0.06
P198	253.00	8.00	130.00	36.34	0.23	0.01
P199	253.00	8.00	130.00	63.91	0.41	0.03
P200	253.00	8.00	130.00	123.11	0.79	0.10
P201	403.00	8.00	130.00	62.73	0.40	0.04
P202	276.11	8.00	130.00	204.72	1.31	0.27
P203	253.02	8.00	130.00	-151.99	0.97	0.14
P204	253.02	8.00	130.00	-84.69	0.54	0.05
P205	236.90	8.00	130.00	-52.66	0.34	0.02
P206	636.18	8.00	130.00	30.62	0.20	0.02
P207	211.30	8.00	130.00	46.55	0.30	0.01
P208	232.70	8.00	130.00	76.31	0.49	0.04
P209	233.00	8.00	130.00	107.33	0.69	0.07
P210	233.00	8.00	130.00	221.60	1.41	0.26
P211	621.42	8.00	130.00	-134.48	0.86	0.28
P212	253.02	8.00	130.00	-70.99	0.45	0.03
P213	699.07	8.00	130.00	-29.17	0.19	0.02
P214	253.02	8.00	130.00	-42.77	0.27	0.01
P215	613.13	8.00	130.00	-35.49	0.23	0.02
P216	253.00	8.00	130.00	1.34	0.01	0.0000
P217	233.00	8.00	130.00	-11.80	0.08	0.00

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	-43.32	0.28	0.02
P219	313.50	8.00	130.00	-208.55	1.33	0.31
P220	391.14	12.00	130.00	487.88	1.38	0.26
P221	590.71	8.00	130.00	47.66	0.30	0.04
P222	253.00	8.00	130.00	28.53	0.18	0.01
P223	390.32	8.00	130.00	91.31	0.58	0.08
P224	430.55	8.00	130.00	45.56	0.29	0.03
P225	248.33	12.00	130.00	405.37	1.15	0.12
P226	430.73	8.00	130.00	-7.92	0.05	0.00
P227	412.22	12.00	130.00	348.91	0.99	0.15
P228	262.25	12.00	130.00	52.76	0.15	0.00
P229	253.00	12.00	130.00	52.47	0.15	0.00
P230	273.31	12.00	130.00	56.81	0.16	0.00
P231	234.73	12.00	130.00	100.89	0.29	0.01
P232	422.16	12.00	130.00	-110.56	0.31	0.02
P233	596.34	12.00	130.00	-63.45	0.18	0.01
P234	591.74	12.00	130.00	-13.16	0.04	0.000
P235	587.67	12.00	130.00	-339.68	0.96	0.20
P236	457.95	12.00	130.00	-211.88	0.60	0.07
P237	359.68	12.00	130.00	-91.22	0.26	0.01
P238	193.00	8.00	130.00	-18.63	0.12	0.00
P239	487.33	8.00	130.00	124.46	0.79	0.19
P240	486.84	8.00	130.00	-96.39	0.62	0.12
P241	708.39	8.00	130.00	-103.93	0.66	0.20
P242	617.10	8.00	130.00	-110.72	0.71	0.19
P243	319.69	18.00	130.00	-1,275.34	1.61	0.18
P244	861.88	12.00	130.00	-2,042.13	5.79	8.20
P245	534.05	18.00	130.00	-852.04	1.07	0.14
P246	627.02	18.00	130.00	-938.69	1.18	0.20
P247	195.01	18.00	130.00	-1,083.88	1.37	0.08
P248	751.91	18.00	130.00	-952.52	1.20	0.24
P249	370.87	12.00	130.00	-153.34	0.43	0.03
P250	602.79	8.00	130.00	-27.09	0.17	0.01
P251	656.30	8.00	130.00	-6.61	0.04	0.00
P252	501.81	8.00	130.00	-151.22	0.97	0.28
P253	464.05	12.00	130.00	110.00	0.31	0.02
P254	250.56	12.00	130.00	345.08	0.98	0.09
P255	423.72	8.00	130.00	-55.96	0.36	0.04
P256	235.04	8.00	130.00	-32.88	0.21	0.01

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	72.29	0.46	0.05
P258	656.00	8.00	130.00	46.66	0.30	0.04
P259	497.14	8.00	130.00	12.67	0.08	0.00
P260	494.52	8.00	130.00	6.33	0.04	0.000
P261	466.36	8.00	130.00	5.44	0.03	0.000
P262	616.00	8.00	130.00	6.72	0.04	0.00
P263	651.25	8.00	130.00	18.49	0.12	0.01
P264	246.49	8.00	130.00	66.92	0.43	0.03
P265	375.42	12.00	130.00	-82.41	0.23	0.01
P266	665.79	8.00	130.00	63.58	0.41	0.07
P267	285.98	8.00	130.00	-66.71	0.43	0.03
P268	272.69	8.00	130.00	-1.34	0.01	0.0000
P269	744.21	8.00	130.00	20.18	0.13	0.01
P270	105.50	8.00	130.00	4.91	0.03	0.0000
P271	892.22	8.00	130.00	54.42	0.35	0.07
P272	193.00	8.00	130.00	-3.61	0.02	0.0000
P273	105.50	8.00	130.00	-9.97	0.06	0.000
P274	698.75	8.00	130.00	-5.86	0.04	0.000
P275	181.50	12.00	130.00	-512.65	1.45	0.13
P276	112.20	8.00	130.00	-63.59	0.41	0.01
P277	698.70	8.00	130.00	-32.51	0.21	0.02
P278	713.00	8.00	130.00	18.52	0.12	0.01
P279	422.00	8.00	130.00	-125.71	0.80	0.17
P280	117.50	8.00	130.00	7.62	0.05	0.000
P281	589.97	8.00	130.00	-240.92	1.54	0.77
P282	130.50	8.00	130.00	-258.25	1.65	0.19
P283	410.65	18.00	130.00	-2,070.00	2.61	0.56
P284	500.49	8.00	130.00	-182.68	1.17	0.39
P285	807.99	8.00	130.00	-69.89	0.45	0.11
P286	193.00	8.00	130.00	19.46	0.12	0.00
P287	263.00	8.00	130.00	-28.16	0.18	0.01
P288	738.30	8.00	130.00	23.63	0.15	0.01
P289	233.02	8.00	130.00	-48.17	0.31	0.02
P290	739.64	8.00	130.00	-116.23	0.74	0.25
P291	252.00	8.00	130.00	-27.94	0.18	0.01
P292	262.03	8.00	130.00	-98.36	0.63	0.07
P293	924.17	8.00	130.00	-20.88	0.13	0.01
P294	770.75	8.00	130.00	-19.67	0.13	0.01
P295	956.68	8.00	130.00	29.56	0.19	0.03

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-35.87	0.23	0.03
P297	678.13	8.00	130.00	102.06	0.65	0.18
P298	837.42	8.00	130.00	45.60	0.29	0.05
P299	557.94	8.00	130.00	-35.20	0.22	0.02
P300	696.14	8.00	130.00	-9.01	0.06	0.00
P301	468.04	8.00	130.00	-2.37	0.02	0.000
P302	255.36	8.00	130.00	8.26	0.05	0.000
P303	247.32	8.00	130.00	-4.01	0.03	0.000
P304	208.11	12.00	130.00	-701.96	1.99	0.27
P305	88.53	8.00	130.00	68.58	0.44	0.01
P306	193.00	8.00	130.00	-231.47	1.48	0.23
P307	582.27	8.00	130.00	11.18	0.07	0.00
P308	677.66	8.00	130.00	-145.75	0.93	0.35
P309	195.00	8.00	130.00	-53.95	0.34	0.02
P310	132.50	12.00	130.00	-208.32	0.59	0.02
P311	380.98	8.00	130.00	-189.63	1.21	0.32
P312	475.68	8.00	130.00	-151.29	0.97	0.26
P313	655.89	8.00	130.00	-46.34	0.30	0.04
P314	653.93	8.00	130.00	-71.36	0.46	0.09
P315	215.00	8.00	130.00	17.57	0.11	0.00
P316	195.01	8.00	130.00	85.74	0.55	0.04
P317	214.88	8.00	130.00	43.39	0.28	0.01
P318	252.22	8.00	130.00	-8.35	0.05	0.000
P319	245.38	8.00	130.00	21.12	0.13	0.00
P320	607.50	8.00	130.00	12.24	0.08	0.00
P321	574.53	8.00	130.00	9.86	0.06	0.00
P322	105.50	8.00	130.00	-12.21	0.08	0.000
P323	212.18	8.00	130.00	0.28	0.00	0.00000
P324	105.50	8.00	130.00	3.33	0.02	0.0000
P325	211.00	8.00	130.00	-35.32	0.23	0.01
P326	211.30	8.00	130.00	-45.64	0.29	0.01
P327	209.82	8.00	130.00	-8.80	0.06	0.000
P328	728.60	8.00	130.00	9.28	0.06	0.00
P329	594.64	8.00	130.00	14.92	0.10	0.00
P330	258.06	8.00	130.00	-6.77	0.04	0.000
P331	499.01	8.00	130.00	15.55	0.10	0.00
P332	545.88	8.00	130.00	-6.55	0.04	0.000
P333	783.02	8.00	130.00	8.35	0.05	0.00
P334	260.55	12.00	130.00	-5.47	0.02	0.0000

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	27.31	0.17	0.01
P336	255.00	8.00	130.00	23.11	0.15	0.00
P337	255.07	8.00	130.00	13.77	0.09	0.00
P338	255.00	12.00	130.00	79.26	0.22	0.01
P339	255.00	12.00	130.00	-34.70	0.10	0.00
P340	255.00	8.00	130.00	12.14	0.08	0.00
P341	255.00	8.00	130.00	2.29	0.01	0.0000
P342	246.98	8.00	130.00	18.56	0.12	0.00
P343	253.00	8.00	130.00	-61.99	0.40	0.03
P344	147.50	12.00	130.00	86.06	0.24	0.00
P345	147.37	12.00	130.00	279.87	0.79	0.04
P346	147.50	12.00	130.00	261.37	0.74	0.03
P347	147.59	12.00	130.00	-412.07	1.17	0.07
P348	381.04	8.00	130.00	-134.05	0.86	0.17
P349	190.72	18.00	130.00	-1,048.92	1.32	0.07
P350	253.02	8.00	130.00	24.79	0.16	0.00
P351	233.00	8.00	130.00	30.35	0.19	0.01
P352	1,365.42	24.00	130.00	1,165.89	0.83	0.16
P353	1,505.76	30.00	130.00	-1,165.89	0.53	0.06
P354	369.99	8.00	130.00	-112.40	0.72	0.12
P355	369.99	8.00	130.00	-129.68	0.83	0.15
P356	117.50	8.00	130.00	-39.76	0.25	0.01
P357	195.00	8.00	130.00	-72.22	0.46	0.03
P358	193.00	8.00	130.00	-70.24	0.45	0.03
P359	500.49	8.00	130.00	-168.16	1.07	0.34
P360	500.78	8.00	130.00	-218.15	1.39	0.55
P361	677.66	8.00	130.00	-137.95	0.88	0.32
P362	482.45	12.00	130.00	25.22	0.07	0.00
P363	677.66	8.00	130.00	-141.70	0.90	0.33
P364	1,180.18	30.00	130.00	-756.68	0.34	0.02
P365	1,577.01	24.00	130.00	-1,683.52	1.19	0.36
P366	701.50	24.00	130.00	-1,957.95	1.39	0.21
P367	242.00	18.00	130.00	1,769.22	2.23	0.24
P368	738.68	18.00	130.00	1,507.86	1.90	0.56
P369	253.00	8.00	130.00	-56.65	0.36	0.02
P370	660.09	8.00	130.00	-105.87	0.68	0.19
P371	193.00	18.00	130.00	1,543.78	1.95	0.15
P372	595.91	18.00	130.00	1,337.37	1.69	0.36
P373	191.34	18.00	130.00	1,181.90	1.49	0.09

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	42.93	0.27	0.01
P375	607.50	8.00	130.00	-8.57	0.05	0.00
P376	438.00	18.00	130.00	1,217.97	1.54	0.22
P377	650.57	18.00	130.00	938.10	1.18	0.20
P378	112.20	8.00	130.00	-171.00	1.09	0.08
P379	117.50	8.00	130.00	-16.33	0.10	0.00
P380	348.36	8.00	130.00	17.69	0.11	0.00
P381	178.10	12.00	130.00	-269.45	0.76	0.04
P382	1,122.42	24.00	130.00	-4,027.95	2.86	1.28
P383	93.09	8.00	130.00	-98.46	0.63	0.02
P384	195.01	8.00	130.00	120.42	0.77	0.07
P385	4,416.05	30.00	130.00	1,012.54	0.46	0.13
P386	3,100.00	24.00	130.00	-4,056.06	2.88	3.59
P388	1,581.75	18.00	130.00	924.07	1.17	0.48
P389	621.96	18.00	130.00	930.38	1.17	0.19
P990	235.86	99.00	130.00	1,012.54	0.04	0.0000
P991	377.34	99.00	130.00	1,012.54	0.04	0.0000
P992	233.99	99.00	130.00	4,056.06	0.17	0.000
P993	232.72	99.00	130.00	4,056.06	0.17	0.000

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-313 - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	26.82	1,012.54	83.89
PUMP107	26.00	27.49	4,056.06	89.44

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-101	0.00	20.00	79.25	25.67
GB-103	4.98	15.00	79.43	27.92
GB-105	4.98	19.00	79.85	26.37
GB-107	0.00	20.00	80.10	26.04
GB-108	28.11	21.00	81.66	26.28
GB-109	30.65	20.00	78.87	25.51
GB-111	17.03	20.00	78.88	25.51
GB-113	15.33	19.59	78.92	25.71
GB-115	25.54	18.97	79.27	26.13
GB-117	17.03	18.87	78.89	26.01
GB-119	19.36	18.84	78.83	26.00
GB-121	15.33	18.80	78.82	26.01
GB-122	28.53	18.80	79.81	26.43
GB-123	14.47	19.02	78.90	25.95
GB-125	24.69	18.39	78.94	26.24
GB-127	13.62	18.28	78.88	26.26
GB-128	41.75	18.50	79.42	26.40
GB-129	14.47	18.53	78.86	26.14
GB-131	23.84	17.81	78.85	26.45
GB-133	13.62	17.67	78.84	26.51
GB-135	11.92	17.23	78.81	26.68
GB-137	17.03	17.16	78.84	26.73
GB-139	17.03	17.85	78.84	26.43
GB-141	36.61	18.91	78.87	25.98
GB-143	22.13	18.52	78.85	26.14
GB-145	11.92	18.08	78.83	26.32
GB-147	22.32	17.24	78.80	26.68
GB-149	16.18	17.21	78.80	26.69
GB-151	18.73	16.99	78.80	26.78
GB-153	19.36	16.99	78.80	26.78
GB-155	6.82	16.94	78.80	26.80
GB-157	2.56	16.96	78.78	26.79
GB-159	5.76	16.62	78.75	26.92
GB-161	4.26	17.14	78.33	26.51
GB-163	9.36	17.39	78.35	26.41
GB-165	10.21	17.79	78.66	26.37
GB-167	23.73	18.26	78.47	26.09
GB-169	4.26	19.75	78.02	25.25
GB-171	8.51	20.27	77.91	24.97

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-173	28.46	20.84	77.82	24.69
GB-175	1.70	16.69	78.78	26.90
GB-177	5.96	16.45	78.01	26.68
GB-179	10.21	16.82	78.07	26.54
GB-181	5.96	16.63	78.79	26.93
GB-183	20.44	16.54	78.79	26.97
GB-185	34.06	16.64	78.78	26.92
GB-187	18.73	16.47	78.78	27.00
GB-189	8.51	16.36	78.78	27.05
GB-191	18.53	16.28	78.78	27.08
GB-193	11.67	16.24	78.78	27.10
GB-195	11.67	16.38	77.85	26.64
GB-197	20.44	16.75	77.86	26.48
GB-199	20.44	17.29	77.90	26.26
GB-201	23.84	17.77	77.94	26.07
GB-203	30.53	18.25	77.95	25.87
GB-205	30.53	19.83	77.68	25.07
GB-207	23.84	20.34	77.68	24.84
GB-209	11.92	20.85	77.67	24.62
GB-210	18.62	15.00	79.18	27.81
GB-211	45.98	18.60	79.03	26.19
GB-213	22.13	17.80	78.84	26.45
GB-215	29.98	17.16	78.77	26.69
GB-217	11.92	16.45	78.74	26.99
GB-219	12.77	16.33	77.31	26.42
GB-221	17.33	16.30	77.13	26.36
GB-223	18.44	16.58	77.31	26.31
GB-225	10.21	16.63	77.31	26.29
GB-227	11.07	16.52	77.30	26.34
GB-229	18.87	16.65	77.14	26.21
GB-231	18.73	16.65	77.14	26.21
GB-233	11.92	16.59	77.13	26.23
GB-235	18.73	17.04	77.13	26.04
GB-237	12.52	16.54	77.13	26.26
GB-239	12.52	16.37	77.38	26.43
GB-241	23.84	16.74	77.38	26.27
GB-243	25.54	17.28	77.41	26.05
GB-245	23.84	17.76	77.52	25.89
GB-247	16.18	18.25	77.53	25.69

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-249	35.65	19.30	77.36	25.16
GB-251	16.18	19.87	77.45	24.95
GB-253	23.84	20.36	77.45	24.74
GB-255	31.86	20.86	77.43	24.51
GB-257	21.28	18.14	78.73	26.25
GB-259	10.21	17.78	78.73	26.41
GB-261	11.07	17.15	78.68	26.66
GB-263	12.77	16.46	78.56	26.91
GB-265	24.97	18.00	78.67	26.29
GB-267	19.87	16.46	78.25	26.77
GB-269	18.73	16.52	77.39	26.38
GB-271	17.88	17.44	77.32	25.94
GB-273	10.21	18.00	77.29	25.69
GB-275	9.50	18.00	77.27	25.68
GB-277	10.21	18.00	77.20	25.65
GB-279	18.73	17.76	77.15	25.73
GB-281	9.36	17.04	77.14	26.04
GB-283	21.28	17.28	76.95	25.86
GB-285	25.54	19.52	76.97	24.89
GB-286	17.03	20.86	77.21	24.42
GB-287	17.03	18.00	78.70	26.30
GB-288	9.36	16.45	77.91	26.63
GB-289	6.82	16.52	77.48	26.41
GB-290	11.07	18.00	77.29	25.69
GB-291	16.18	17.04	77.14	26.04
GB-292	7.66	16.37	77.01	26.27
GB-293	13.62	16.74	76.92	26.08
GB-294	10.56	17.28	76.84	25.81
GB-295	0.00	15.00	79.16	27.80
GB-297	0.00	18.00	78.74	26.32
GB-299	0.00	16.45	77.77	26.57
GB-301	0.00	16.53	77.52	26.43
GB-303	0.00	18.00	77.29	25.69
GB-305	0.00	17.05	77.13	26.03
GB-307	0.00	16.86	76.90	26.02
GB-309	0.00	17.28	76.80	25.79
GB-311	32.39	19.13	76.77	24.98
GB-313	42.13	20.80	76.76	24.25
GB-315	15.33	18.00	75.65	24.98

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-317	14.47	17.77	75.73	25.11
GB-319	9.36	17.24	76.06	25.49
GB-321	9.36	16.45	76.89	26.19
GB-323	22.13	16.54	74.22	24.99
GB-325	17.88	17.42	74.22	24.61
GB-327	14.47	18.00	74.22	24.36
GB-329	10.21	18.00	74.22	24.36
GB-331	4.26	17.39	74.22	24.62
GB-333	11.92	17.35	75.90	25.37
GB-335	10.21	16.42	76.03	25.83
GB-337	18.73	18.00	75.49	24.91
GB-339	16.18	18.00	75.52	24.92
GB-341	13.45	17.49	75.58	25.17
GB-343	10.90	16.16	75.62	25.76
GB-345	14.47	18.00	75.25	24.81
GB-347	17.03	18.00	75.27	24.82
GB-349	6.82	17.75	75.29	24.93
GB-351	21.28	18.00	75.04	24.72
GB-352	30.14	17.35	74.80	24.89
GB-353	16.18	17.91	74.98	24.73
GB-355	13.62	17.82	75.09	24.82
GB-357	15.16	17.40	75.10	25.00
GB-359	11.75	16.14	75.03	25.52
GB-361	16.18	17.26	74.46	24.79
GB-362	20.44	16.38	74.62	25.23
GB-363	11.07	16.29	73.72	24.88
GB-365	14.18	16.32	74.30	25.13
GB-367	19.23	16.59	74.27	24.99
GB-369	17.03	17.03	74.23	24.79
GB-371	13.62	16.87	74.22	24.85
GB-373	10.21	16.73	74.22	24.91
GB-375	14.73	16.59	74.22	24.97
GB-377	18.32	16.34	74.22	25.08
GB-379	45.40	17.08	74.35	24.81
GB-381	25.98	16.42	72.74	24.41
GB-383	17.47	18.29	72.66	23.56
GB-385	10.65	18.09	73.36	23.95
GB-387	15.35	18.82	73.33	23.62
GB-389	9.36	18.79	73.76	23.82

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - JUNCTION REPORT - GREENBRIAR

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
GB-391	38.21	18.77	74.60	24.19
GB-393	15.03	16.43	72.41	24.26
GB-395	15.33	17.71	72.24	23.63
GB-397	37.53	18.80	72.27	23.17
GB-399	34.97	19.79	72.37	22.78
GB-401	19.59	20.09	72.41	22.67
GB-403	11.07	20.39	72.44	22.55
GB-405	11.57	16.13	72.35	24.36
GB-407	22.13	17.95	72.10	23.46
GB-409	13.62	19.40	71.89	22.74
GB-411	17.03	16.46	72.36	24.22
GB-413	26.39	18.20	71.98	23.30
GB-415	13.62	19.96	71.45	22.31
GB-417	35.25	16.45	72.66	24.35
GB-419	11.07	18.63	71.89	23.08
GB-421	33.40	19.83	71.08	22.21
GB-423	11.07	20.20	70.93	21.98
GB-425	22.08	20.56	70.84	21.79
GB-427	3,011.07	21.58	68.88	20.49
GB-429	27.19	21.13	70.90	21.56
GB-431	22.13	21.45	71.17	21.54
GB-433	34.25	22.00	71.24	21.34
GB-435	17.03	21.27	70.72	21.42
GB-437	17.88	22.00	70.40	20.97
GB-439	17.88	22.00	70.81	21.15
GB-441	11.07	21.27	70.73	21.43
GB-443	11.92	22.00	70.58	21.05
GB-445	11.07	21.00	70.82	21.59
GB-446	0.00	22.00	79.45	24.89
GB-447	0.00	26.00	86.01	26.00

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P101	117.50	8.00	130.00	84.33	0.54	0.02
P102	117.50	8.00	130.00	-370.26	2.36	0.34
P103	739.21	8.00	130.00	216.10	1.38	0.79
P104	117.50	8.00	130.00	80.24	0.51	0.02
P105	117.50	8.00	130.00	180.23	1.15	0.09
P106	436.40	12.00	130.00	137.96	0.39	0.03
P107	650.57	8.00	130.00	108.80	0.69	0.20
P108	535.27	8.00	130.00	104.83	0.67	0.15
P109	357.35	18.00	130.00	-2,279.77	2.87	0.58
P110	243.09	12.00	130.00	-697.21	1.98	0.32
P111	253.19	8.00	130.00	-172.60	1.10	0.18
P112	380.98	8.00	130.00	212.79	1.36	0.40
P113	904.24	8.00	130.00	-155.78	0.99	0.53
P114	693.26	8.00	130.00	-113.98	0.73	0.23
P115	105.50	8.00	130.00	-17.06	0.11	0.00
P116	147.51	12.00	130.00	-103.92	0.29	0.01
P117	132.50	12.00	130.00	-234.96	0.67	0.02
P118	226.54	8.00	130.00	123.26	0.79	0.09
P119	193.01	8.00	130.00	22.44	0.14	0.00
P120	193.01	8.00	130.00	-67.69	0.43	0.02
P121	713.00	8.00	130.00	-12.47	0.08	0.00
P122	615.89	8.00	130.00	11.38	0.07	0.00
P123	713.00	8.00	130.00	-147.72	0.94	0.38
P124	677.66	8.00	130.00	-171.79	1.10	0.47
P125	476.65	8.00	130.00	-181.60	1.16	0.37
P126	117.50	8.00	130.00	-173.94	1.11	0.08
P127	677.66	8.00	130.00	160.87	1.03	0.42
P128	193.00	8.00	130.00	-21.98	0.14	0.00
P129	117.50	8.00	130.00	-139.19	0.89	0.06
P130	633.34	8.00	130.00	60.27	0.38	0.06
P131	232.72	8.00	130.00	61.32	0.39	0.02
P132	233.02	8.00	130.00	87.18	0.56	0.05
P133	618.66	8.00	130.00	46.49	0.30	0.04
P134	713.00	8.00	130.00	-55.22	0.35	0.06
P135	195.00	8.00	130.00	76.64	0.49	0.03
P136	193.00	8.00	130.00	156.42	1.00	0.11
P137	112.20	18.00	130.00	2,273.38	2.87	0.18
P138	701.50	8.00	130.00	10.64	0.07	0.00
P139	378.03	8.00	130.00	-55.92	0.36	0.03

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P140	586.50	8.00	130.00	22.66	0.14	0.01
P141	253.00	8.00	130.00	95.30	0.61	0.06
P142	233.00	8.00	130.00	-35.39	0.23	0.01
P143	233.00	8.00	130.00	-76.99	0.49	0.04
P144	232.70	8.00	130.00	-84.33	0.54	0.04
P145	574.54	8.00	130.00	-10.99	0.07	0.00
P146	105.50	8.00	130.00	16.52	0.11	0.000
P147	126.23	8.00	130.00	151.66	0.97	0.07
P148	126.78	8.00	130.00	80.92	0.52	0.02
P149	388.16	8.00	130.00	-4.19	0.03	0.000
P150	117.50	8.00	130.00	-2.01	0.01	0.00
P151	611.16	8.00	130.00	2.99	0.02	0.000
P152	418.00	8.00	130.00	-16.06	0.10	0.00
P153	97.50	8.00	130.00	-14.04	0.09	0.000
P154	261.76	8.00	130.00	-65.78	0.42	0.03
P155	839.51	8.00	130.00	25.35	0.16	0.02
P156	170.40	8.00	130.00	26.70	0.17	0.00
P157	116.20	8.00	130.00	16.39	0.10	0.00
P158	248.92	8.00	130.00	-79.69	0.51	0.04
P159	247.10	8.00	130.00	-42.64	0.27	0.01
P160	247.67	8.00	130.00	-20.30	0.13	0.00
P161	247.82	8.00	130.00	-7.39	0.05	0.000
P162	247.00	8.00	130.00	13.30	0.08	0.00
P163	249.87	8.00	130.00	19.05	0.12	0.00
P164	1,149.31	8.00	130.00	39.04	0.25	0.05
P165	710.72	12.00	130.00	-545.07	1.55	0.59
P166	369.00	8.00	130.00	304.93	1.95	0.75
P167	253.00	8.00	130.00	243.34	1.55	0.34
P168	918.21	8.00	130.00	100.89	0.64	0.24
P169	282.81	8.00	130.00	175.14	1.12	0.21
P170	333.36	12.00	130.00	-5.81	0.02	0.0000
P171	253.00	8.00	130.00	235.03	1.50	0.32
P172	234.54	8.00	130.00	144.72	0.92	0.12
P173	253.00	8.00	130.00	86.35	0.55	0.05
P174	657.99	8.00	130.00	77.94	0.50	0.11
P175	633.34	8.00	130.00	23.60	0.15	0.01
P176	253.02	8.00	130.00	58.17	0.37	0.02
P177	633.34	8.00	130.00	98.96	0.63	0.16
P178	242.02	12.00	130.00	461.38	1.31	0.15

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P179	253.00	8.00	130.00	241.02	1.54	0.33
P180	273.00	8.00	130.00	-230.87	1.47	0.33
P181	628.13	12.00	130.00	694.07	1.97	0.81
P182	797.55	12.00	130.00	591.97	1.68	0.77
P183	578.83	12.00	130.00	838.93	2.38	1.06
P184	193.00	8.00	130.00	204.04	1.30	0.19
P185	653.19	8.00	130.00	120.36	0.77	0.24
P186	193.00	8.00	130.00	-32.89	0.21	0.01
P187	193.00	8.00	130.00	-43.82	0.28	0.01
P188	437.56	8.00	130.00	143.35	0.91	0.22
P189	203.57	12.00	130.00	510.18	1.45	0.15
P190	596.95	8.00	130.00	309.06	1.97	1.24
P191	292.91	8.00	130.00	43.05	0.27	0.02
P192	695.05	8.00	130.00	-151.64	0.97	0.39
P193	253.00	8.00	130.00	143.71	0.92	0.13
P194	656.00	8.00	130.00	-114.38	0.73	0.22
P195	504.88	8.00	130.00	-140.60	0.90	0.24
P196	313.32	8.00	130.00	-54.35	0.35	0.03
P197	549.00	8.00	130.00	135.26	0.86	0.25
P198	253.00	8.00	130.00	57.15	0.36	0.02
P199	253.00	8.00	130.00	99.55	0.64	0.06
P200	253.00	8.00	130.00	237.16	1.51	0.32
P201	403.00	8.00	130.00	127.11	0.81	0.16
P202	276.11	8.00	130.00	377.49	2.41	0.83
P203	253.02	8.00	130.00	-180.79	1.15	0.19
P204	253.02	8.00	130.00	-104.32	0.67	0.07
P205	236.90	8.00	130.00	-65.17	0.42	0.03
P206	636.18	8.00	130.00	49.83	0.32	0.04
P207	211.30	8.00	130.00	56.61	0.36	0.02
P208	232.70	8.00	130.00	89.50	0.57	0.05
P209	233.00	8.00	130.00	122.92	0.78	0.09
P210	233.00	8.00	130.00	249.32	1.59	0.32
P211	621.42	8.00	130.00	-151.27	0.97	0.34
P212	253.02	8.00	130.00	-80.79	0.52	0.04
P213	699.07	8.00	130.00	-37.28	0.24	0.03
P214	253.02	8.00	130.00	-49.72	0.32	0.02
P215	613.13	8.00	130.00	-38.84	0.25	0.03
P216	253.00	8.00	130.00	-2.55	0.02	0.0000
P217	233.00	8.00	130.00	-21.15	0.13	0.00

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P218	289.50	8.00	130.00	-61.91	0.40	0.03
P219	313.50	8.00	130.00	-244.04	1.56	0.42
P220	391.14	12.00	130.00	928.27	2.63	0.86
P221	590.71	8.00	130.00	109.84	0.70	0.18
P222	253.00	8.00	130.00	40.62	0.26	0.01
P223	390.32	8.00	130.00	179.41	1.15	0.30
P224	430.55	8.00	130.00	55.25	0.35	0.04
P225	248.33	12.00	130.00	796.08	2.26	0.41
P226	430.73	8.00	130.00	-77.23	0.49	0.07
P227	412.22	12.00	130.00	729.94	2.07	0.58
P228	262.25	12.00	130.00	956.79	2.71	0.61
P229	253.00	12.00	130.00	814.64	2.31	0.44
P230	273.31	12.00	130.00	720.12	2.04	0.38
P231	234.73	12.00	130.00	799.64	2.27	0.39
P232	422.16	12.00	130.00	-942.95	2.67	0.96
P233	596.34	12.00	130.00	-985.57	2.80	1.47
P234	591.74	12.00	130.00	-1,174.57	3.33	2.02
P235	587.67	12.00	130.00	-1,307.88	3.71	2.45
P236	457.95	12.00	130.00	-918.58	2.61	0.99
P237	359.68	12.00	130.00	-153.75	0.44	0.03
P238	193.00	8.00	130.00	-21.78	0.14	0.00
P239	487.33	8.00	130.00	139.01	0.89	0.23
P240	486.84	8.00	130.00	-107.07	0.68	0.14
P241	708.39	8.00	130.00	-118.13	0.75	0.25
P242	617.10	8.00	130.00	-126.06	0.80	0.24
P243	319.69	18.00	130.00	-1,352.05	1.70	0.20
P244	861.88	12.00	130.00	-42.13	0.12	0.01
P245	534.05	18.00	130.00	-916.36	1.16	0.16
P246	627.02	18.00	130.00	-1,020.28	1.29	0.23
P247	195.01	18.00	130.00	-1,255.24	1.58	0.10
P248	751.91	18.00	130.00	-294.45	0.37	0.03
P249	370.87	12.00	130.00	-1,571.98	4.46	2.17
P250	602.79	8.00	130.00	-302.55	1.93	1.20
P251	656.30	8.00	130.00	-164.33	1.05	0.42
P252	501.81	8.00	130.00	-169.31	1.08	0.34
P253	464.05	12.00	130.00	754.17	2.14	0.70
P254	250.56	12.00	130.00	795.42	2.26	0.42
P255	423.72	8.00	130.00	-131.97	0.84	0.18
P256	235.04	8.00	130.00	-39.59	0.25	0.01

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P257	344.48	8.00	130.00	121.97	0.78	0.13
P258	656.00	8.00	130.00	96.84	0.62	0.16
P259	497.14	8.00	130.00	174.71	1.12	0.36
P260	494.52	8.00	130.00	-189.73	1.21	0.42
P261	466.36	8.00	130.00	170.14	1.09	0.32
P262	616.00	8.00	130.00	95.60	0.61	0.15
P263	651.25	8.00	130.00	150.49	0.96	0.36
P264	246.49	8.00	130.00	135.81	0.87	0.11
P265	375.42	12.00	130.00	-343.91	0.98	0.13
P266	665.79	8.00	130.00	319.78	2.04	1.47
P267	285.98	8.00	130.00	-211.72	1.35	0.29
P268	272.69	8.00	130.00	97.00	0.62	0.07
P269	744.21	8.00	130.00	20.53	0.13	0.01
P270	105.50	8.00	130.00	4.26	0.03	0.0000
P271	892.22	8.00	130.00	57.32	0.37	0.08
P272	193.00	8.00	130.00	19.52	0.12	0.00
P273	105.50	8.00	130.00	-0.83	0.01	0.00
P274	698.75	8.00	130.00	-4.17	0.03	0.000
P275	181.50	12.00	130.00	-573.86	1.63	0.16
P276	112.20	8.00	130.00	-66.66	0.43	0.01
P277	698.70	8.00	130.00	-37.95	0.24	0.03
P278	713.00	8.00	130.00	20.96	0.13	0.01
P279	422.00	8.00	130.00	-125.18	0.80	0.16
P280	117.50	8.00	130.00	22.33	0.14	0.00
P281	589.97	8.00	130.00	-271.49	1.73	0.96
P282	130.50	8.00	130.00	-302.42	1.93	0.26
P283	410.65	18.00	130.00	-2,321.52	2.93	0.69
P284	500.49	8.00	130.00	-213.38	1.36	0.52
P285	807.99	8.00	130.00	20.56	0.13	0.01
P286	193.00	8.00	130.00	22.97	0.15	0.00
P287	263.00	8.00	130.00	113.18	0.72	0.08
P288	738.30	8.00	130.00	25.06	0.16	0.01
P289	233.02	8.00	130.00	-55.16	0.35	0.02
P290	739.64	8.00	130.00	-155.10	0.99	0.43
P291	252.00	8.00	130.00	-18.63	0.12	0.00
P292	262.03	8.00	130.00	-104.19	0.66	0.07
P293	924.17	8.00	130.00	-20.02	0.13	0.01
P294	770.75	8.00	130.00	-52.97	0.34	0.06
P295	956.68	8.00	130.00	77.77	0.50	0.15

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P296	693.81	8.00	130.00	-384.04	2.45	2.15
P297	678.13	8.00	130.00	117.00	0.75	0.23
P298	837.42	8.00	130.00	48.96	0.31	0.06
P299	557.94	8.00	130.00	-335.82	2.14	1.35
P300	696.14	8.00	130.00	-8.73	0.06	0.00
P301	468.04	8.00	130.00	-2.70	0.02	0.000
P302	255.36	8.00	130.00	5.79	0.04	0.000
P303	247.32	8.00	130.00	-1.53	0.01	0.0000
P304	208.11	12.00	130.00	-1,315.12	3.73	0.88
P305	88.53	8.00	130.00	80.99	0.52	0.02
P306	193.00	8.00	130.00	-268.33	1.71	0.31
P307	582.27	8.00	130.00	7.53	0.05	0.00
P308	677.66	8.00	130.00	-175.24	1.12	0.49
P309	195.00	8.00	130.00	-62.64	0.40	0.02
P310	132.50	12.00	130.00	-347.09	0.98	0.05
P311	380.98	8.00	130.00	-229.48	1.46	0.46
P312	475.68	8.00	130.00	-203.54	1.30	0.46
P313	655.89	8.00	130.00	-69.44	0.44	0.09
P314	653.93	8.00	130.00	-103.08	0.66	0.18
P315	215.00	8.00	130.00	20.38	0.13	0.00
P316	195.01	8.00	130.00	92.49	0.59	0.04
P317	214.88	8.00	130.00	48.70	0.31	0.01
P318	252.22	8.00	130.00	-9.72	0.06	0.000
P319	245.38	8.00	130.00	22.49	0.14	0.00
P320	607.50	8.00	130.00	11.39	0.07	0.00
P321	574.53	8.00	130.00	13.10	0.08	0.00
P322	105.50	8.00	130.00	-8.32	0.05	0.000
P323	212.18	8.00	130.00	-2.01	0.01	0.0000
P324	105.50	8.00	130.00	2.69	0.02	0.0000
P325	211.00	8.00	130.00	-43.47	0.28	0.01
P326	211.30	8.00	130.00	-52.82	0.34	0.02
P327	209.82	8.00	130.00	-6.50	0.04	0.000
P328	728.60	8.00	130.00	108.13	0.69	0.22
P329	594.64	8.00	130.00	128.49	0.82	0.24
P330	258.06	8.00	130.00	-145.49	0.93	0.13
P331	499.01	8.00	130.00	118.84	0.76	0.18
P332	545.88	8.00	130.00	-41.99	0.27	0.03
P333	783.02	8.00	130.00	62.93	0.40	0.09
P334	260.55	12.00	130.00	355.76	1.01	0.10

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P335	255.00	8.00	130.00	-546.04	3.49	1.52
P336	255.00	8.00	130.00	-216.19	1.38	0.27
P337	255.07	8.00	130.00	-103.97	0.66	0.07
P338	255.00	12.00	130.00	1,149.74	3.26	0.84
P339	255.00	12.00	130.00	-804.55	2.28	0.43
P340	255.00	8.00	130.00	-77.59	0.50	0.04
P341	255.00	8.00	130.00	-70.41	0.45	0.03
P342	246.98	8.00	130.00	16.90	0.11	0.00
P343	253.00	8.00	130.00	-112.17	0.72	0.08
P344	147.50	12.00	130.00	87.35	0.25	0.00
P345	147.37	12.00	130.00	295.84	0.84	0.04
P346	147.50	12.00	130.00	317.46	0.90	0.04
P347	147.59	12.00	130.00	-577.00	1.64	0.14
P348	381.04	8.00	130.00	-153.96	0.98	0.22
P349	190.72	18.00	130.00	-1,183.95	1.49	0.09
P350	253.02	8.00	130.00	26.48	0.17	0.01
P351	233.00	8.00	130.00	37.99	0.24	0.01
P352	1,365.42	24.00	130.00	1,265.31	0.90	0.18
P353	1,505.76	30.00	130.00	-1,265.31	0.57	0.07
P354	369.99	8.00	130.00	-133.24	0.85	0.16
P355	369.99	8.00	130.00	-153.02	0.98	0.21
P356	117.50	8.00	130.00	-50.23	0.32	0.01
P357	195.00	8.00	130.00	-90.72	0.58	0.04
P358	193.00	8.00	130.00	-90.07	0.57	0.04
P359	500.49	8.00	130.00	-196.33	1.25	0.45
P360	500.78	8.00	130.00	-252.68	1.61	0.72
P361	677.66	8.00	130.00	-160.75	1.03	0.42
P362	482.45	12.00	130.00	1,290.47	3.66	1.96
P363	677.66	8.00	130.00	-173.07	1.10	0.48
P364	1,180.18	30.00	130.00	-785.32	0.36	0.02
P365	1,577.01	24.00	130.00	-1,844.15	1.31	0.42
P366	701.50	24.00	130.00	-2,149.15	1.52	0.25
P367	242.00	18.00	130.00	2,355.13	2.97	0.42
P368	738.68	18.00	130.00	2,037.67	2.57	0.97
P369	253.00	8.00	130.00	-95.74	0.61	0.06
P370	660.09	8.00	130.00	-135.65	0.87	0.30
P371	193.00	18.00	130.00	1,742.16	2.20	0.19
P372	595.91	18.00	130.00	1,505.05	1.90	0.45
P373	191.34	18.00	130.00	1,331.48	1.68	0.11

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PIPE REPORT - GREENBRIAR

ID	Length (ft)	Diameter (in)	Roughness	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P374	105.50	8.00	130.00	49.41	0.32	0.01
P375	607.50	8.00	130.00	-10.23	0.07	0.00
P376	438.00	18.00	130.00	1,299.56	1.64	0.25
P377	650.57	18.00	130.00	1,003.72	1.27	0.23
P378	112.20	8.00	130.00	-187.90	1.20	0.09
P379	117.50	8.00	130.00	-22.79	0.15	0.00
P380	348.36	8.00	130.00	16.54	0.11	0.00
P381	178.10	12.00	130.00	-300.02	0.85	0.05
P382	1,122.42	24.00	130.00	-4,470.67	3.17	1.56
P383	93.09	8.00	130.00	-228.75	1.46	0.11
P384	195.01	8.00	130.00	128.90	0.82	0.08
P385	4,416.05	30.00	130.00	1,569.82	0.71	0.30
P386	3,100.00	24.00	130.00	-4,498.78	3.19	4.35
P388	1,581.75	18.00	130.00	1,048.42	1.32	0.61
P389	621.96	18.00	130.00	1,059.29	1.34	0.24
P990	235.86	99.00	130.00	1,569.82	0.07	0.0000
P991	377.34	99.00	130.00	1,569.82	0.07	0.0000
P992	233.99	99.00	130.00	4,498.78	0.19	0.000
P993	232.72	99.00	130.00	4,498.78	0.19	0.000

MAXIMUM DAY DEMANDS WITH FIRE FLOW AT GB-427 - PUMP REPORT - GREENBRIAR

ID	Elevation (ft)	Downstream Pressure (psi)	Flow (gpm)	Head Gain (ft)
PUMP105	22.00	24.89	1,569.82	79.45
PUMP107	26.00	26.00	4,498.78	86.01

Appendix E

Boundary Conditions

DEPARTMENT
OF UTILITIES

ENGINEERING
SERVICES DIVISION

CITY OF SACRAMENTO
CALIFORNIA

1395 35th AVENUE
SACRAMENTO, CA
95822-2911

PH (916) 264-1400
FAX (916) 264-1497

July 14, 2005
BE:be

MEMORANDUM

TO: Joshua Wolf, Project Engineer

FROM: Brett Ewart, Assistant Engineer

SUBJECT: **DISTRIBUTION SYSTEM BOUNDARY CONDITIONS FOR GREENBRIAR**

The GREENBRIAR project has been incorporated into the City's regional model to verify boundary conditions and fireflow capacity at three proposed connections to the existing distribution system. Please refer to the attached map and graphs for location of analysis points and associated results.

The following assumptions were incorporated into this review:

1. The developer appropriately allocated demands and required fireflow.
2. Max Day conditions were prevalent.
3. The conditioned T-main alignment of 24 & 30–inch main was added to the proposed project.

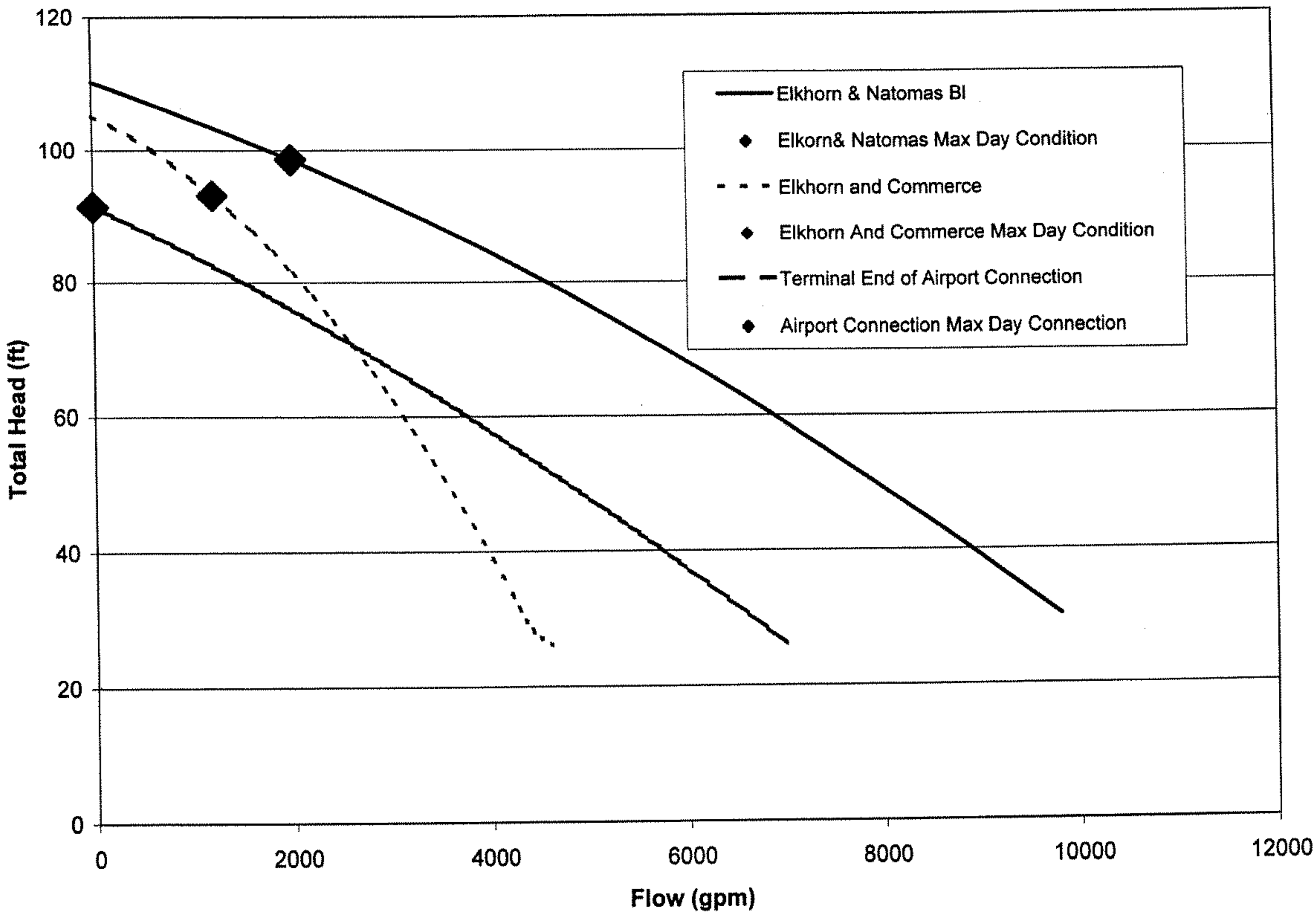
Based on these criteria, a Maximum Day Demand condition, steady state modeling analysis was performed. Three (3) hydraulic capacity curves were prepared for the proposed development to represent the general capacity of the existing system at the three connections. This assumes that the proposed development has been constructed with Max Day demands allocated by Wood Rodgers.

Wood Rogers is encouraged to review the conditions placed upon the proposed project. A new 24/30-inch transmission main traveling west from the existing 24-inch main at the corner of Natomas Bl and Elkhorn Bl will need to terminate at the 30-inch T-main currently being constructed to serve the Airport and Metro Air Park.

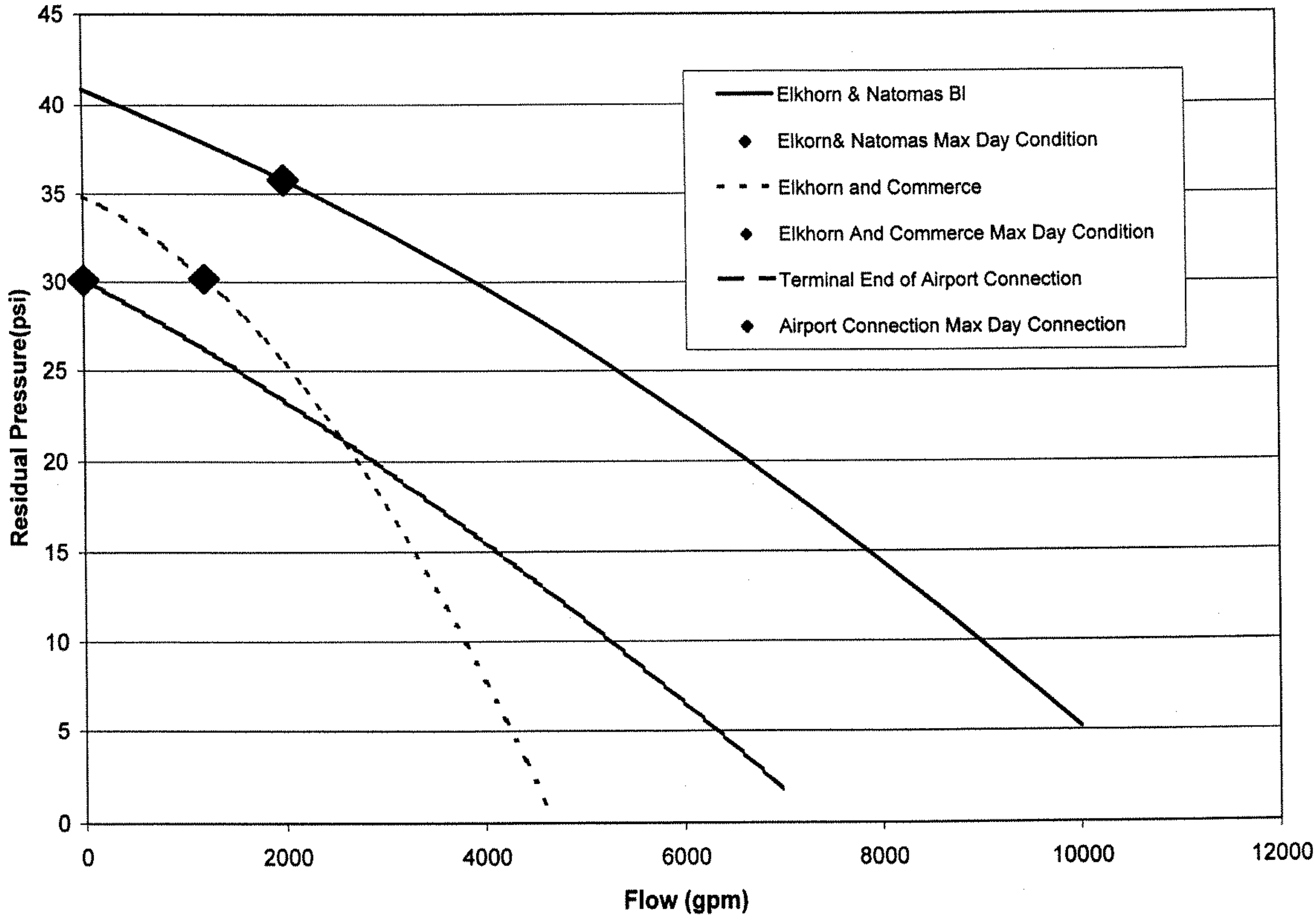
This analysis does not represent a verification of the proposed hydraulic model, rather it is the existing boundary conditions should such demands be placed upon the distribution system at proposed location.

Should you have any further questions please do not hesitate to contact me at 808-1725.

Greenbriar: Max Day Boundary Conditions
Total Head vs. Flow



Greenbriar: Max Day Boundary Conditions
Residual Pressure vs. Flow



Terminal End of Airport Connection			Elkhorn and Commerce			Elkhorn & Natomas Bl			Elkhorn and Commerce (with future 24" to Natomas Bl)		
Node Elevation (ft)	22		Node Elevation (ft)	26		Node Elevation (ft)	16		Node Elevation (ft)	26	
Max Day Boundary Condition											
Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)
0	30	91	1200	30	93	2000	36	99	3200	30	96
Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)
0	30	91	0	35	105	0	41	110	0	38	115
200	29	90	200	34	104	200	40	109	200	38	114
400	29	89	400	34	102	400	40	108	400	38	113
600	28	87	600	33	100	600	39	107	600	37	112
800	28	86	800	32	98	800	39	106	800	37	111
1000	27	84	1000	31	96	1000	38	105	1000	36	110
1200	26	82	1200	30	93	1200	38	103	1200	36	109
1400	26	81	1400	29	91	1400	37	102	1400	35	107
1600	25	79	1600	28	88	1600	37	101	1600	35	106
1800	24	78	1800	27	85	1800	36	100	1800	34	105
2000	23	76	2000	25	81	2000	36	99	2000	34	104
2200	23	74	2200	24	78	2200	35	97	2200	33	103
2400	22	72	2400	23	74	2400	35	96	2400	33	101
2600	21	71	2600	21	71	2600	34	95	2600	32	100
2800	20	69	2800	19	67	2800	33	93	2800	32	99
3000	20	67	3000	18	62	3000	33	92	3000	31	97
3200	19	65	3200	16	58	3200	32	90	3200	30	96
3400	18	63	3400	14	54	3400	32	89	3400	30	94
3600	17	62	3600	12	49	3600	31	88	3600	29	93
3800	16	60	3800	10	44	3800	30	86	3800	28	92
4000	16	58	4000	8	39	4000	30	85	4000	28	90
4200	15	56	4200	6	34	4200	29	83	4200	27	88
4400	14	54	4400	3	28	4400	28	81	4400	26	87
4600	13	52	4600	1	26	4600	28	80	4600	26	85
4800	12	50				4800	27	78	4800	25	84
5000	11	48				5000	26	77	5000	24	82
5200	10	46				5200	26	75	5200	24	80
5400	9	44				5400	25	73	5400	23	79
5600	8	41				5600	24	72	5600	22	77
5800	8	39				5800	23	70	5800	21	75
6000	7	37				6000	23	68	6000	20	73
6200	6	35				6200	22	66	6200	20	71
6400	5	33				6400	21	64	6400	19	69
6600	4	30				6600	20	63	6600	18	68
6800	3	28				6800	19	61	6800	17	66
7000	2	26				7000	19	59	7000	16	64
						7200	18	57	7200	15	62
						7400	17	55	7400	15	60
						7600	16	53	7600	14	58
						7800	15	51	7800	13	56
						8000	14	49	8000	12	53
						8200	13	47	8200	11	51
						8400	13	45	8400	10	49
						8600	12	43	8600	9	47
						8800	11	41	8800	8	45
						9000	10	39	9000	7	43
						9200	9	37	9200	6	40
						9400	8	35	9400	5	38
						9600	7	32	9600	4	36
						9800	6	30	9800	3	33
						10000	5	28	10000	2	31
						10200	4	26	10200	1	29
						10400	3	23			
						10600	2	21			
						10800	1	19			

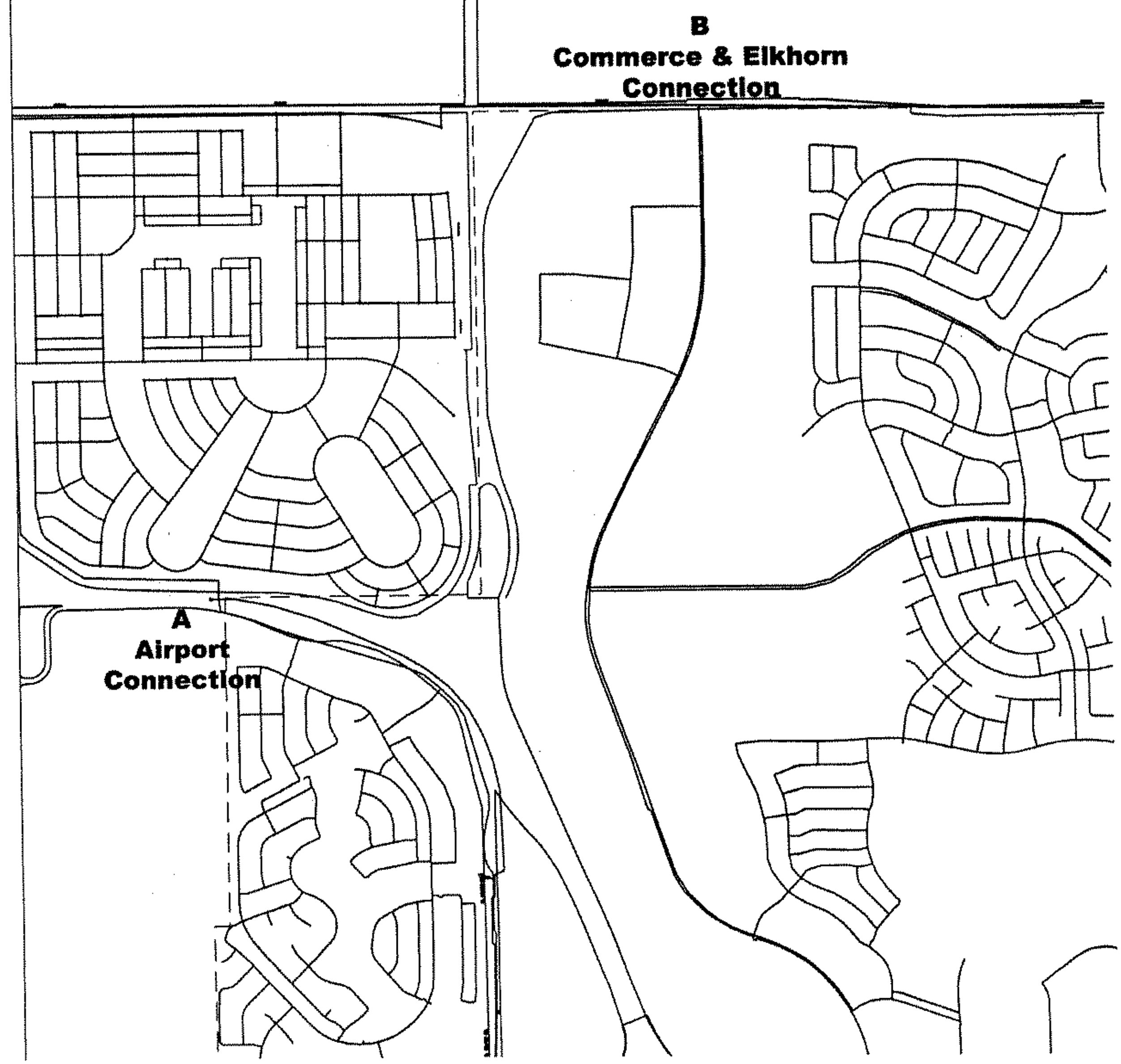
.URVE

SEE ATTACHED HYDRANT CURVE

HGL (FT)	FIRE FLOW @ 20 PSI	FLOW (GPM)	
	N-A	2800	
JRVE	N-B	2700	
	N-C	6600	

MAX DAY DEMANDS

NODE	FLOW (GPM)	
N-A	(35)	
N-A	1200	
N-A	2000	



Terminal End of Airport Connection - PUMP-105 (XNG5)			Elkhorn and Commerce (with future 24" to Natomas Blvd - PUMP-107 (XNG7)		
Node Elevation (ft)		22	Node Elevation (ft)		25
Max Day Boundary Conditions					
Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)
0	**30.1**	**91.4**	**3069**	**30.6**	**96.7**
Available Flow (gpm)	**Residual Pressure (psi)**	**Residual Head (ft)**	**Available Flow (gpm)**	**Residual Pressure (psi)**	**Residual Head (ft)**
0	30.1	91.42	0	38.5	115
200	29.4	89.99	200	38.1	114
400	28.8	88.53	400	37.7	113
600	28.2	87.06	600	37.2	112
800	27.5	85.53	800	36.8	111
1000	26.8	83.99	1000	36.4	110
1200	26.2	82.42	1200	35.9	109
1400	25.5	80.83	1400	35.1	107
1600	24.8	79.21	1600	34.6	106
1800	24.0	77.55	1800	34.2	105
2000	23.3	75.89	2000	33.8	104
2200	22.6	74.18	2200	33.3	103
2400	21.8	72.45	2400	32.5	101
2600	21.1	70.72	2600	32.0	100
2800	20.3	68.95	2800	31.6	99
3000	19.5	67.15	3000	30.7	97
3200	18.7	65.3	3200	30.3	96
3400	17.9	63.46	3400	29.4	94
3600	17.1	61.59	3600	29.0	93
3800	16.3	59.67	3800	28.6	92
4000	15.5	57.76	4000	27.7	90
4200	14.6	55.8	4200	26.8	88
4400	13.8	53.84	4400	26.4	87
4600	12.9	51.83	4600	25.5	85
4800	12.0	49.8	4800	25.1	84
5000	11.1	47.75	5000	24.2	82
5200	10.3	45.69	5200	23.4	80
5400	9.3	43.59	5400	22.9	79
5600	8.4	41.47	5600	22.1	77
5800	7.5	39.33	5800	21.2	75
6000	6.5	37.13	6000	20.3	73
6200	5.6	34.94	6200	19.5	71
6400	4.6	32.73	6400	18.6	69
6600	3.7	30.49	6600	18.2	68
6800	2.7	28.23	6800	17.3	66
7000	1.7	25.92	7000	16.5	64
			7200	15.6	62
			7400	14.7	60
			7600	13.9	58
			7800	13.0	56
			8000	11.7	53
			8200	10.8	51
			8400	10.0	49
			8600	9.1	47
			8800	8.2	45
			9000	7.4	43
			9200	6.1	40
			9400	5.2	38
			9600	4.3	36
			9800	3.0	33
			10000	2.2	31
			10200	1.3	29

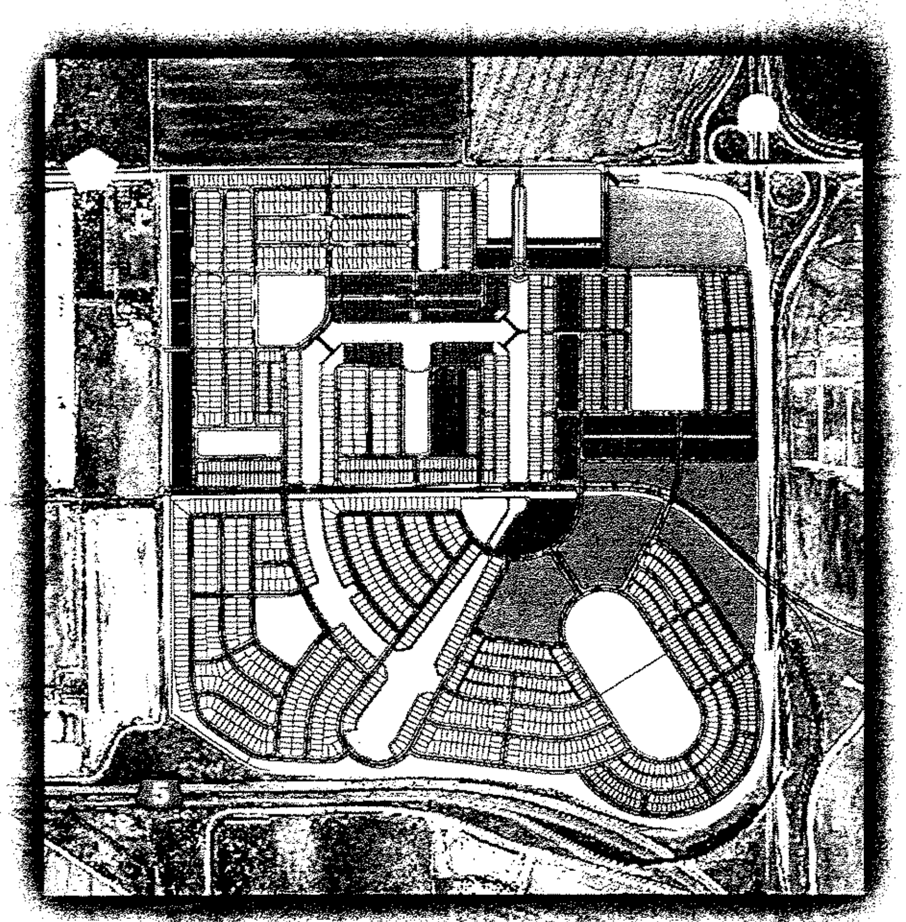
Terminal End of Airport Connection - PUMP-105 (XNG5B)			Elkhorn and Commerce (with future 24" to Natomas Blvd - PUMP-107 (XNG7B)		
Node Elevation (ft)		[illegible]	Node Elevation (ft)		[illegible]
Peak Hour Boundary Conditions					
Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)
407	30.0	91.2	3582	30.2	95.9
Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)	Available Flow (gpm)	Residual Pressure (psi)	Residual Head (ft)
0	31.2	94.18	0	39.7	117.8
200	30.6	92.8	200	39.3	116.8
400	30.0	91.3	400	38.9	115.8
600	29.4	89.8	600	38.4	114.8
800	28.7	88.3	800	38.0	113.8
1000	28.0	86.8	1000	37.6	112.8
1200	27.4	85.2	1200	37.1	111.8
1400	26.7	83.6	1400	36.3	109.8
1600	26.0	82.0	1600	35.8	108.8
1800	25.2	80.3	1800	35.4	107.8
2000	24.5	78.7	2000	35.0	106.8
2200	23.8	76.9	2200	34.5	105.8
2400	23.0	75.2	2400	33.7	103.8
2600	22.3	73.5	2600	33.2	102.8
2800	21.5	71.7	2800	32.8	101.8
3000	20.7	69.9	3000	31.9	99.8
3200	19.9	68.1	3200	31.5	98.8
3400	19.1	66.2	3400	30.6	96.8
3600	18.3	64.4	3600	30.2	95.8
3800	17.5	62.4	3800	29.8	94.8
4000	16.7	60.5	4000	28.9	92.8
4200	15.8	58.6	4200	28.0	90.8
4400	15.0	56.6	4400	27.6	89.8
4600	14.1	54.6	4600	26.7	87.8
4800	13.2	52.6	4800	26.3	86.8
5000	12.3	50.5	5000	25.4	84.8
5200	11.5	48.5	5200	24.6	82.8
5400	10.5	46.4	5400	24.1	81.8
5600	9.6	44.2	5600	23.3	79.8
5800	8.7	42.1	5800	22.4	77.8
6000	7.7	39.9	6000	21.5	75.8
6200	6.8	37.7	6200	20.7	73.8
6400	5.8	35.5	6400	19.8	71.8
6600	4.9	33.3	6600	19.4	70.8
6800	3.9	31.0	6800	18.5	68.8
7000	2.9	28.7	7000	17.6	66.8
			7200	16.8	64.8
			7400	15.9	62.8
			7600	15.0	60.8
			7800	14.2	58.8
			8000	12.9	55.8
			8200	12.0	53.8
			8400	11.2	51.8
			8600	10.3	49.8
			8800	9.4	47.8
			9000	8.6	45.8
			9200	7.3	42.8
			9400	6.4	40.8
			9600	5.5	38.8
			9800	4.2	35.8
			10000	3.4	33.8
			10200	2.5	31.8

Note: Boundary conditions for peak hour demands were derived from the maximum day demand boundary conditions at the recommendation of the City of Sacramento's Department of Utilities staff. Rating curves were increased by a constant head of 2.8 ft to account for booster pumps and to give a minimum residual pressure of 30 psi at the boundary points during peak hour demands.

APPENDIX I

GREENBRIAR SEWER STUDY

Greenbriar
Sewer Study



July 2005

Prepared by

WOOD RODGERS

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Sewer Study

For

Greenbriar

Sacramento County, California

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Executive Summary

Purpose Statement

This sewer study is a preliminary study for the purpose of the preparing the Environmental Impact Report (EIR) and to provide support documentation for the use in the Greenbriar improvement plans. This study will demonstrate the ability of the required facilities to service the site by a combination of gravity and force main and provide a general guideline of the domestic and commercial collection system for the Greenbriar development. This analysis will ensure that the proposed sewer system will be designed appropriately to meet or exceed the County Sanitation District 1 (CSD-1) system design criteria.

Major Project and Study Characteristics

The Greenbriar project will consist of mixed land use and densities. Mixed use includes low, medium and high-density residential, parks, open space, commercial and school land use. The project site is located west of the North Natomas area, bordered to the south by Interstate 5 and bordered to the north by Elkhorn Boulevard. The project site is currently located outside the City of Sacramento limits, but the application process for annexation has been initiated. This study depicts the ultimate service design; therefore interim facilities are not required. Offsite flows include two 16-inch force main sewer lines from Metro Air Park that will converge with on site sewerage at the most easterly on-site manhole.

The methodology used in this analysis was consistent with the County Sanitation District-1 design standards. The total acreage to be served is approximately 577 acres designed for approximately 4,650 equivalent dwelling units yielding an on-site peak wet weather design flow (PWWF) of 3.05 mgd. The ESD's differ from the 3,723 units depicted on the Tentative Subdivision Map dated May 2, 2005 due to the CSD-1 minimum design criteria of 6 ESD's per acre.

Upstream flows from Metro Air Park (MAP and Sacramento International Airport (SIA) will be conveyed by two 16-inch force mains that will be located in the open space buffer adjacent to Elkhorn Boulevard, following the buffer south adjacent to Highway 99. The force mains will convey design 8.73 mgd PWWF as presented in the Metro Air Park Sanitary Sewer Study prepared by Stantec Consulting, Inc.

The Greenbriar and Metro Air Park upstream sewerage converge with a combined design PWWF of 11.78 mgd, gravity across cross Highway 99 into the 33–inch diameter North Natomas Interceptor located in Greg Thatch Circle.

Development phasing will likely occur, however this study looked at build out conditions.

A lift station and 10-inch force main will be required to service approximately 75% of the site. This facility is anticipated to be permanent and no interim facilities will be needed.

The Greenbriar project has not been considered in the CSD-1 Sewerage Facilities Master Expansion Master Plan shed delineation due to being outside the current Urban Services Boundary.

Conclusion

The upstream flow of 11.78 mgd (including Greenbriar and Metro Air Park) does not appear to adversely affect the North Natomas Interceptor. Capacity was verified in the existing downstream 33, 36, and 42-inch diameter pipe lines extending south to Del Paso Boulevard. Our project team will be working with SCRSD to analyze the existing capacity in the SCRSD system south of Del Paso Boulevard. This will involve coordination with SCRSD and their regional sewer system model. It is anticipated that this report will be updated in the future based on the review, analysis and comments from SCRSD and CSD-1.

Details regarding the proposed on-site lift station, proposed on-site gravity service and connection to the existing system will also be provided pending comments from SCRSD and CSD-1.

INTRODUCTION

Level of Study

The Greenbriar sewer system analysis presented in this document is consistent with the Tentative Subdivision Map dated May 2, 2005 (**Exhibit B**) for the Greenbriar development project. This study is intended to provide a general guideline of the domestic and commercial collection system for the Greenbriar development. This analysis will ensure that the proposed sewer lines will be designed appropriately to meet or exceed the County Sanitation District-1 (CSD-1) system design criteria.

Detail Description

The Greenbriar site boundary contains Lone Tree Canal along the western border. This canal is of special interest and will be preserved due to the Giant Garder snake habitat. There is currently an unused RD-1000 canal at the east border adjacent to Highway 99/70. The site will require bore and jacking under Highway 99/70 in order to connect to the North Natomas Interceptor.

The adjacent Metro Air Park (MAP) and Sacramento International Airport (SIA) will be utilizing the same interceptor connection under Highway 99/70. Metro Air Park has proposed pumping sewerage to the crossing location.

Location

Interstate 5 binds Greenbriar to the south, Elkhorn Boulevard to the North, and Highway 99/70 to the east and Sacramento Metro Airport to the west. The project site is outside the City of Sacramento limits, however the annexation application process has been initiated. Refer to **Figure 1 - Location Map** for the project location. **Exhibit A** for a scaled vicinity map.

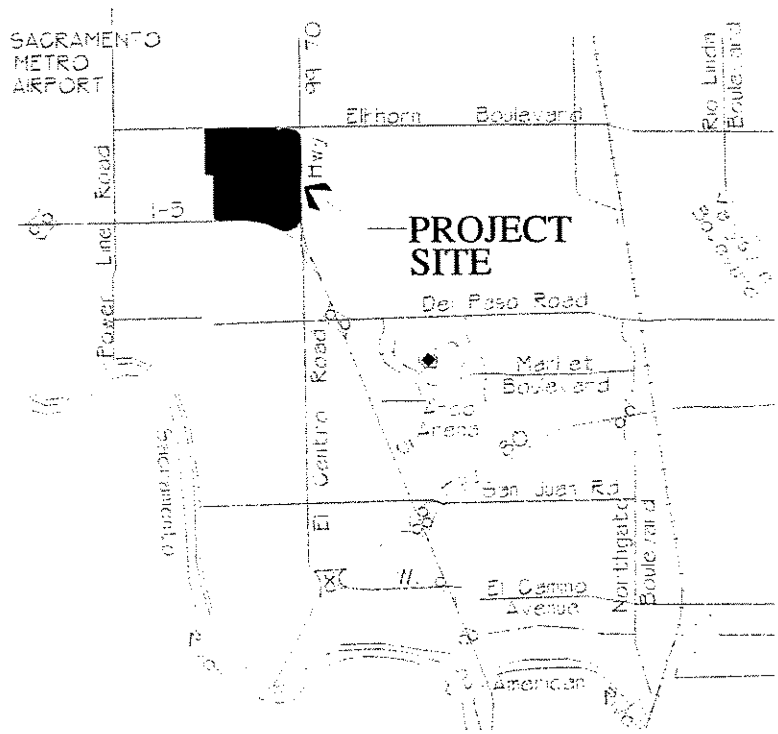

Figure 1 - Location Map

Topography

The existing site's topography is characterized by its previous agricultural use. The geometry of the several pond areas previously used for growing rice are still evident and render the site's existing ground elevations as exceptionally irregular particularly in the change in elevation between adjacent pond areas where these may change from 3-5 feet in elevation. Despite the sites irregular topography, the drainage pattern is still clear and can be classified as draining in a north-east to south-west direction. The existing ground elevations range from elevation 21.3 feet to 10.5 feet (NGVD 29). There is a dirt oval track in the upper northwest section of the site with adjacent stables structures.

The adjacent lands are very similar in nature, with erratic elevation differences due to the levy / channelizing of drains and water for agricultural uses.

Land Use and Zoning

The projects site's current land use is classified as agricultural. The site is predominantly vacant with a few horse stables and other structures located at the northwest corner of the site. The annexation application includes an amendment to the General Plan land use.

The proposed development will consist of approximately 577 acres of mixed land uses and densities. Mixed use includes low, medium, and high density residential, commercial, parks, light rail and school consistent with the Tentative Subdivision Map dated May 2, 2005. These proposed land uses were the basis of the sewer flower flow calculations within this study.

The property to the north of Elkhorn Boulevard is outside the City of Sacramento limits and still used for agriculture consistent with the General Plan. Metro Air Park to the west is considered as heavy industrial use in the General Plan, but is proposed as mixed land use including industrial and commercial uses.

DESIGN

The Greenbriar sewer analysis consisted of calculating the sewer flows and of designing the sewer system that would service the site.

Assumptions

The following assumptions were used as part of this analysis:

- Offsite sewer flows will not be served by the onsite sewer system until converging at the manhole prior to crossing Highway 99/70.
- The downstream North Natomas Interceptor does have capacity to carry the study area flows based on the Schumacher Property North Natomas Sanitary Sewer Master Plan dated February 20,2003 prepared by Wood Rodgers, Inc and the CSD-1 Sewerage Facilities Final Report.
- The North Natomas Interceptor extension is built to within 550 feet east of Highway 99/70. This study assumes the gravity extension will be built by others to the west of Highway 99/70 prior to the construction of the Greenbriar project.
- Groundwater is relatively high in the project area, and will be confirmed through future geotechnical studies for the project.

- The school site was assumed to be an elementary school site.
- The North Natomas Interceptor has capacity downstream without surcharge conditions.

Approach

The following approach was used to calculate the project site's sewer flows:

- Gross areas based on the Greenbriar Tentative Subdivision Map dated May 2, 2005 were used to calculate sewer flows.
- The centerline of the street adjacent to the service area was used as the shed boundary.
- Sub-shed areas were defined by service line and land use.
- Land use densities were determined by calculating the ratio of dwelling units to shed area.
- 310 gpd per unit was assumed to be the average flow for all land use densities.
- Sewer lines and services were placed in alley ways as required to avoid parallel lines.
- Slope adjustments to the sewer lines were used in preference to drop connections to shallow sewer lines were needed.
- The proposed rough grading ground elevations were used to set sewer depth.
- Minimum sewer line slopes were used to set vertical alignment, except at the end of each of the runs were slopes were doubled.
- For large area sites (i.e. commercial) 8-inch lines with a minimum slope of 0.006 were used to serve the site. Lines were run from connecting node to furthest shed line boundary distance.
- Minimum sewer depth was set between 5-6 feet from proposed ground elevation at centerline.
- Flows were determined based on the County improvement standards and on the design criteria listed in this study

Design Criteria

Section 7 of the County of Sacramento Public Works Agency Improvement Standards dated June 1, 1999 and Chapter 7 of the County Sanitation District 1 Sanitary Trunk Sewer design manual dated April 2002 were used as the basis for this design. The flows were generated using the guidelines found in the design flow criteria table located in section 7-3 of the County of Sacramento Public improvement standards. That table was modified to include CSD-1 Peak flow criteria for the use of this report and is presented as Table 1.

Table 1 Design flow criteria

Category	Conditions				Modifiers
Development Density	Low Density Residential	Medium Density Residential	Commercial/Industrial	Transit Oriented Development	Minimum Plan density shall be RD-6
Flow generation (310 gpd/ESD)	6 ESD/Ac	15 ESD/Ac	6 ESD/Ac	11 ESD/Ac	Rainfall dependent I/I: Existing Areas -1,600 gpd/Ac *New areas - 1,200 gpd/Ac
Peaking Factor	PF=3.5-1.8Qa$^{0.05}$ (Qa=ADWF,mgd) –Collectors PF=3.3-1.8Q$^{0.04}$ (Q=BWF, MGD) - Trunk				Minimum shall be 1.2
Velocity Criteria	Minimum 2 fps at Peak Dry Weather Flow				
Hydraulic Grade Line	Maximum HGL at crown of pipe at Peak Wet Weather Flow				
Friction Factor	n=0.013				
Minimum Depth	5' at periphery of service area				8" sewer from periphery to collection point

For the onsite elementary school site, the greater of the specified average daily flow was used as stated in section 7-2A.4 of the Sacramento County Improvement standards.

Sewer flows were calculated by land use in accordance with the Tentative Subdivision Map. Collector peaking factors were used until the flows exceeded 1 mgd. After the flows exceeded 1 mgd, the trunk peaking factor was utilized. Greenbriar sewer study calculations are included in spreadsheet form in **Exhibit E.**

SEWER FLOW INFORMATION

Flow data from this project were calculated within this study. Upstream flow data was obtained from the Metro Air Park CSD-1 Sanitary Sewer Study prepared by Stantec Consulting Inc.

Onsite Flows (Total Project Acreages, ESD's & PWWF)

The combined sewer system for the Greenbriar project site will serve approximately 577 acres (4650 ESD's). The proposed development will produce approximately 3.05 mgd PWWF of which an onsite lift station will service approximately 2.07 mgd. Development phasing was not considered at this time.

The lift station design is not included in this study and will be a separate design report. The lift station is expected to be located generally in the middle of the site as shown on the schematic sewer study, **Exhibit F**. The depth of the lift station will be roughly 25 feet. A 10-inch force main will convey flows from the wet well approximately 200 feet to a transition manhole. Flows of 2 mgd will produce velocities of roughly 6 fps.

Offsite Flows

The upstream flows from Metro Air Park and the Sacramento International Airport are considered at full development to be 8.73 mgd based on the Metro Air CSD-1 Sewer Study prepared by Stantec Consulting, Inc. Upstream flows were considered at build out conditions and phasing was not considered. The upstream flows converge with onsite flows for combined flow of 11.78 mgd at Node 1 (located in **Exhibit F**) before connecting with the North Natomas Interceptor. Upstream flows will be conveyed to Node 1 by two 16-inch force mains proposed to be located within the Greenbriar green space buffer adjacent to Elkhorn Boulevard and Highway 99/70. Upstream flows will not be conveyed through the onsite system until Node 1 shown on **Exhibit F**) where flows cross the Highway to the existing interceptor.

The downstream connection to the North Natomas Interceptor is at the end of Greg Thatch Circle on the east side of Highway 99/70. Our connection is to a 33-inch interceptor with a slope of 0.0020 with an available capacity of 15.28 mgd PWWF. The 33-inch continues at this slope connecting to a 36-inch section of interceptor (at minimum slope S=0.0010) with a capacity of 11.78 mgd in Greg Thatch Circle.

Estimated flows from the west of Highway 99/70 were higher than those reflected in the Schumacher Property North Natomas Sanitary Sewer Master Plan dated February 20, 2003 prepared by Wood Rodgers, Inc. Estimated flows from the west of Highway 99/70 in the Schumacher study were 7.70 mgd PWWF (not including the Greenbriar project). The flows reflected in the CSD-1 Sewerage Facilities Expansion Master Plan for the area west of Highway 99 (not including the Greenbriar project) are 9.79 mgd (**Exhibit C**). Though the actual flows from the combined west area (MAP, SIA, and the Greenbriar project) are higher than those originally assumed, it appears that the North Natomas Interceptor has capacity for the additional flows down to Del Paso Boulevard.

The impact to the existing downstream interceptor (south of Del Paso Road) is not known at this time. CSD-1 / SRCSD are in the process of initiating modeling of this interceptor conditions downstream and searching for the interceptor studies and design reports. We expect to update this study when the information is available.

SEWER ALIGNMENT AND FACILITIES

Ultimate Sewer Alignment

The Greenbriar site will be served by a combination of gravity flow and force main sewer system. Approximately ¼ of the project area will be able to gravity flow to the existing North Natomas interceptor. The remaining project site area will gravity flow to a centrally located lift station lift station (**Exhibit D**). Flows from the lift station will be conveyed to the gravity line via an 18-inch sewer force main or combination 16 and 12-inch force mains. A preliminary location for the lift station has been selected. A detailed design report for the lift station will be prepared for submittal as the project progresses.

For the purpose of presenting this analysis, the Greenbriar sewer system was divided into two major sewer systems: System A and System B. System A is a gravity system that will convey the onsite flows to the existing 33-inch sewer line bypassing the lift station. System B is also a gravity system; however, this system will convey the onsite flows to the lift station which will subsequently connect to System A via a sewer force main. **Exhibit D** shows the System A and System B service areas.

System A
Sewer system A will serve approximately 123.5 Acres. Approximately 0.98 mgd will bypass the lift station and gravity flow directly into the existing 33-inch sewer trunk line. Minimum sewer line depth from existing ground to the top of pipe for this system is of 6.0 feet.

System B
Two separate pipe systems will convey flows to the lift station. The first system approaches the lift station from the west and services approximately 45% of the lift station flows. This system will convey approximately 0.86 mgd via a 15-inch sewer line. The second system B sub shed approaches the lift station from the south and services the remaining 55% of the lift station service area. This system will convey approximately 0.62 mgd by means of a 10-inch sewer line. The sewer invert entering the lift station is approximately 22.2 feet and 22.9 feet respectively. Flows from the lift station will be conveyed via an 10-inch sewer force main line to the nearest manhole, Node 4 on **Exhibit F**, and will gravity flow under Highway 99-70 to the existing North Natomas Interceptor. The hydraulic head between the lift station's sump elevation and the manhole's sump elevation is 13.6 feet. The length of the 10-inch sewer force main is approximately 200 feet, producing velocities of approximately 6 fps.

The flows from Metro Air Park, Sacramento International Airport and the Greenbriar development converge at Node 1, **Exhibit F**, prior to crossing Highway 99/70. The depth of the sewer line crossing Highway 99/70 is 17.0 feet to top of pipe. The slope of the 33-inch interceptor crossing is designed to convey the flows at a velocity of 3 ft/s.

CONCLUSIONS

This sewer study is a preliminary study for the purpose of the preparing the Environmental Impact Report (EIR) and to provide support documentation for the use in the Greenbriar improvement plans. As configured, the on site project flows and off site shed flows converge and ultimately gravity sewer to the North Natomas interceptor.

The overall Greenbriar project of 577 acres account for 4,650 ESD's producing a peak wet weather flow of 3.05 mgd. Off site flows from the MAP and SIA include 1,911 acres accounting for 8.726 mgd PWWF. The combined flow of 11.78 mgd does not appear to adversely affect the North Natomas Interceptor. Conditions downstream of the North Natomas Interceptor are unclear and under investigation and further analysis by CSD-1 and not considered in this analysis.

EXHIBIT A
GREENBRIAR VICINITY MAP

VICINITY MAP

GREENBRIAR

AKT DEVELOPMENT

CITY OF SACRAMENTO CALIFORNIA

JULY 2005

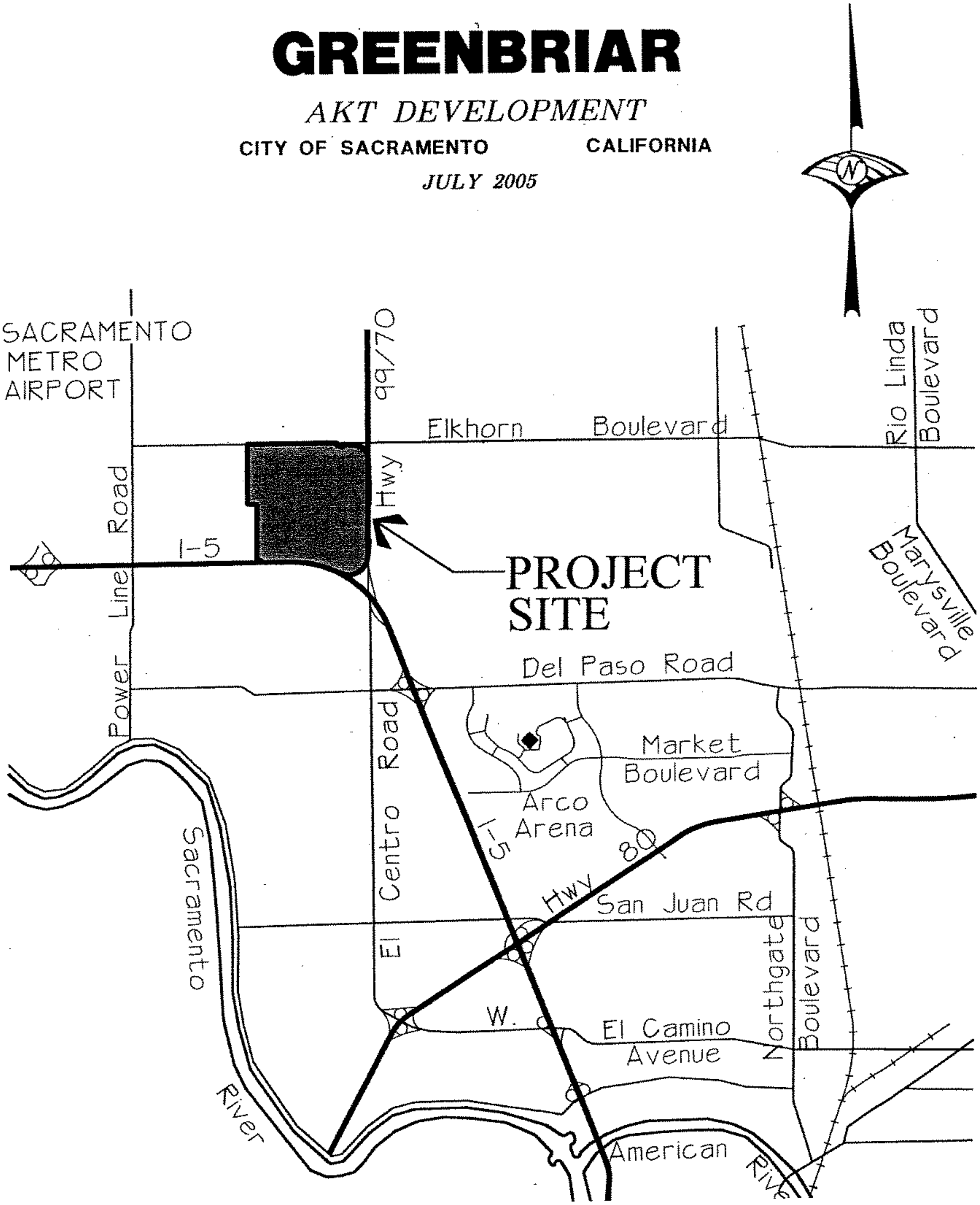

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EXHIBIT B
PRELIMINARY GREENBRIAR TENTATIVE MAP

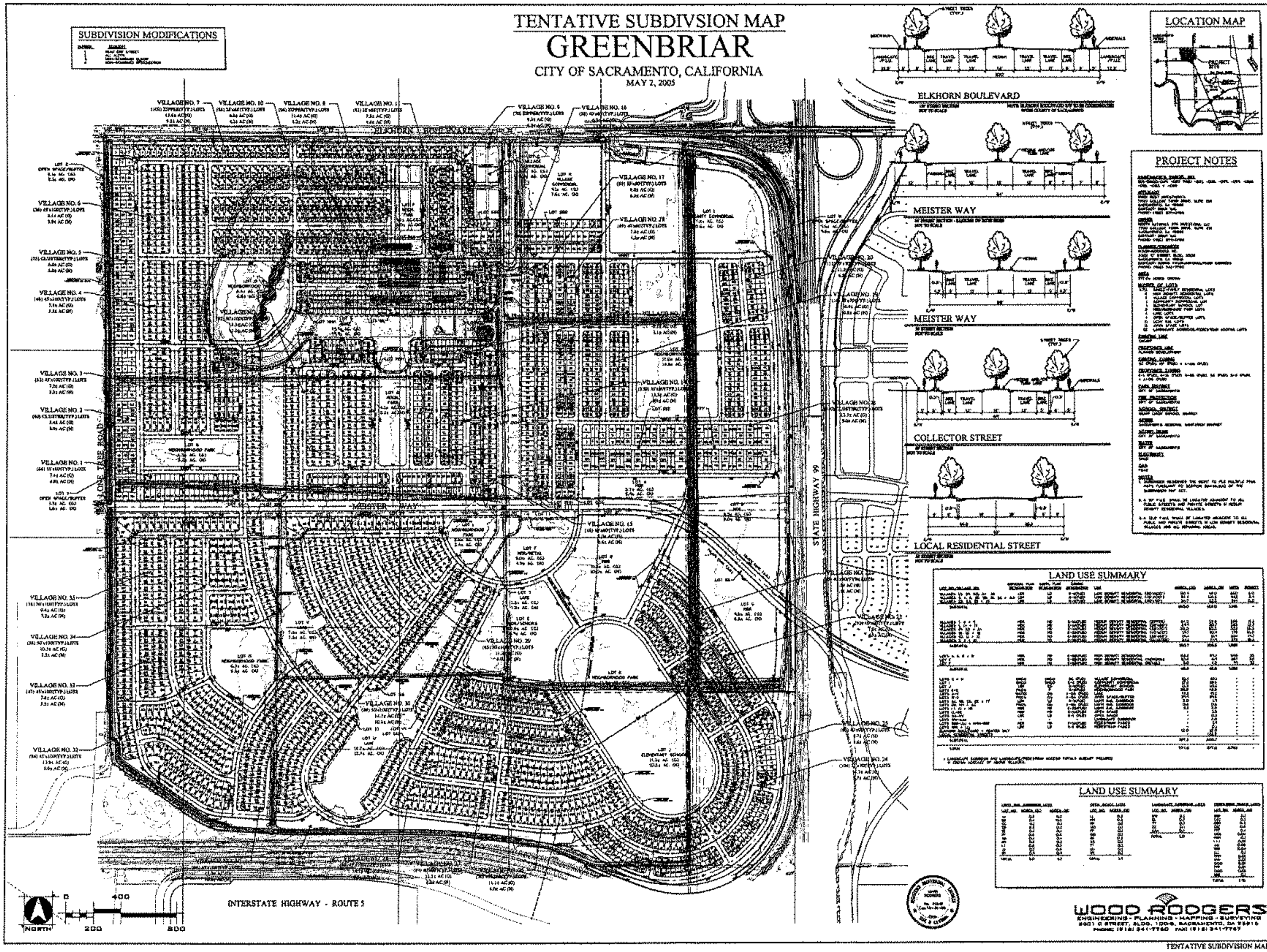

TENTATIVE SUBDIVSION MAP
GREENBRIAR
CITY OF SACRAMENTO, CALIFORNIA
MAY 2, 2005
SUBDIVISION MODIFICATIONS
LOCATION MAP
PROJECT NOTES
ELKHORN BOULEVARD
MEISTER WAY
MEISTER WAY
COLLECTOR STREET
LOCAL RESIDENTIAL STREET
LAND USE SUMMARY
LAND USE SUMMARY
STATE HIGHWAY 99
INTERSTATE HIGHWAY - ROUTE 5
LONE TREE ROAD
MEISTER WAY
NORTH
0
200
400
800
WOOD RODGERS
TENTATIVE SUBDIVISION MAP

EXHIBIT C

CSD-1 SEWERAGE FACILITIES EXPANSION MASTER PLAN

(PORTIONS OF)

CSD-1 SEWERAGE FACILITIES EXPANSION MASTER PLAN

NN NATOMAS NORTH TRUNK SHED

Area Description

The NN Natomas North Trunk Shed is located east of Highway 99, north of Del Paso Road, and south of Elkhorn Boulevard. The Trunk Shed includes the Schumacher, Northborough, and a portion of the Northpointe Park developments, which are located, respectively, in the western, central, and eastern portions of the trunk shed. The Schumacher and Northborough developments are anticipated to develop within the 2000 to 2005 year time frame. The portion of the Northpointe Park development contained in the NN Natomas North Trunk Shed is anticipated to start developing within the 2005 to 2010 year time frame.

Trunk System Facilities

A major trunk sewer (Trunk NNI) extending north along the western side of the East Drainage Canal and a permanent pump station would serve most of the Northborough development. This trunk would connect into the recently constructed trunk sewer that discharges to the existing North Natomas Interceptor. Minor trunk sewers that cross the East Drainage Canal and connect to Trunk NNI would serve the portion of the Northpointe Park development that is part of this trunk shed. The Schumacher development would be served by minor trunks and local collectors that would connect to the future extension of the North Natomas Interceptor.

Since the downstream trunk and interceptor sewers that would serve the Northborough and Northpoint Park developments are already constructed, interim facilities would not be required for these areas. Similarly, because the extension of the North Natomas Interceptor is expected to be on line prior to the time trunk sewer connections are required to serve the Schumacher Development, there would be no need for interim facilities for this area.

Trunk Projects

Four trunk projects are identified for this trunk shed, as shown in the table below.

Project ID	Diam. (in.)	Length (ft.)	Phase	Estimated Construction Cost ($)	Estimated Capital Cost ($)
NNH	12-15	1,650	1	489,000	611,000
NNI	15-27	7,300	1	3,801,000	4,751,000
NNJ-3	18	2,450	1	665,000	831,000
NNJ-4	15	3,050	1	1,003,000	1,254,000

NN Natomas North Trunk Shed

Attachments

- Trunk shed map showing proposed trunk sewers, sizes, model manhole ID numbers, and sewersheds.
- Project map showing trunk projects and interim facilities (if needed).
- Trunk shed ESD projections by sewershed.
- Sewershed load manholes.
- Cross-reference sewershed manholes to recently constructed manholes (as of February 2002).
- Trunk sewer data and model results.
- Profile(s) of major trunk sewers.
- Trunk project cost estimates.

NN Natomas N

Trunk Shed Buildout Projections

	ESDs				Area (acres)			
Sewershed	2005	2010	2020	Buildout	2005	2010	2020	Buildout
NNH-01	0	0	281	490	0	0	45	78
NNH-02	0	0	335	585	0	0	34	59
NNH-03	0	0	177	309	0	0	24	42
NNH-04	0	0	687	1,199	0	0	89	156
NNH-05	351	351	351	1,459	36	36	36	150
NNH-06	87	246	307	377	9	26	32	40
NNH-07	184	184	184	764	21	21	21	87
NNH-08	97	97	97	403	16	16	16	67
NNH-09	71	71	71	297	12	12	12	49
NNH-10	169	475	592	728	19	54	68	83
NNI-01	50	57	64	86	8	10	11	14
NNI-02	568	647	729	974	74	84	95	126
NNI-03	256	719	896	1,102	31	87	109	134
NNI-04	435	495	558	746	70	80	90	121
NNI-05	257	293	330	441	37	42	47	63
NNI-06	85	240	299	368	9	24	30	37
NNI-07	63	177	221	272	8	21	27	33
NNI-08	159	448	558	687	26	73	91	112
NNI-09	312	878	1,095	1,346	49	137	171	211
NNI-10	94	264	330	405	16	44	55	68
NNJ-04	1	588	1,521	1,836	0	74	191	230
NNJ-05	1	1	11	531	0	0	2	85
NNJ-06	0	144	373	451	0	24	62	75
NNJ-07	0	371	959	1,158	0	55	141	170
NNJ-08	1	1	11	577	0	0	2	96
Total	**3,243**	**6,748**	**11,038**	**17,591**	**441**	**921**	**1,501**	**2,387**

Trunk Shed NN Natomas North
Sewershed Load Manholes

Sewershed	Load Manhole
NNH-01	NNH120
NNH-02	NNH120
NNH-03	NNH910
NNH-04	NNH210
NNH-05	NNH320
NNH-06	NNH310
NNH-07	NNH430
NNH-08	NNH440
NNH-09	NNH430
NNH-10	NNH420
NNI-01	NNI9030
NNI-02	NNI9090
NNI-03	NNI910
NNI-04	NNI9230
NNI-05	NNI010
NNI-06	NNI020
NNI-07	NNI030
NNI-08	NNI040
NNI-09	NNI070
NNI-10	NNI060
NNJ-04	NNJ120
NNJ-05	NNJ140
NNJ-06	NNJ910
NNJ-07	NNJ220
NNJ-08	NNJ240

Trunk Shed NN Natomas North
Cross-reference Sewershed Manholes to Recently Constructed Manholes
(as of February 2002)

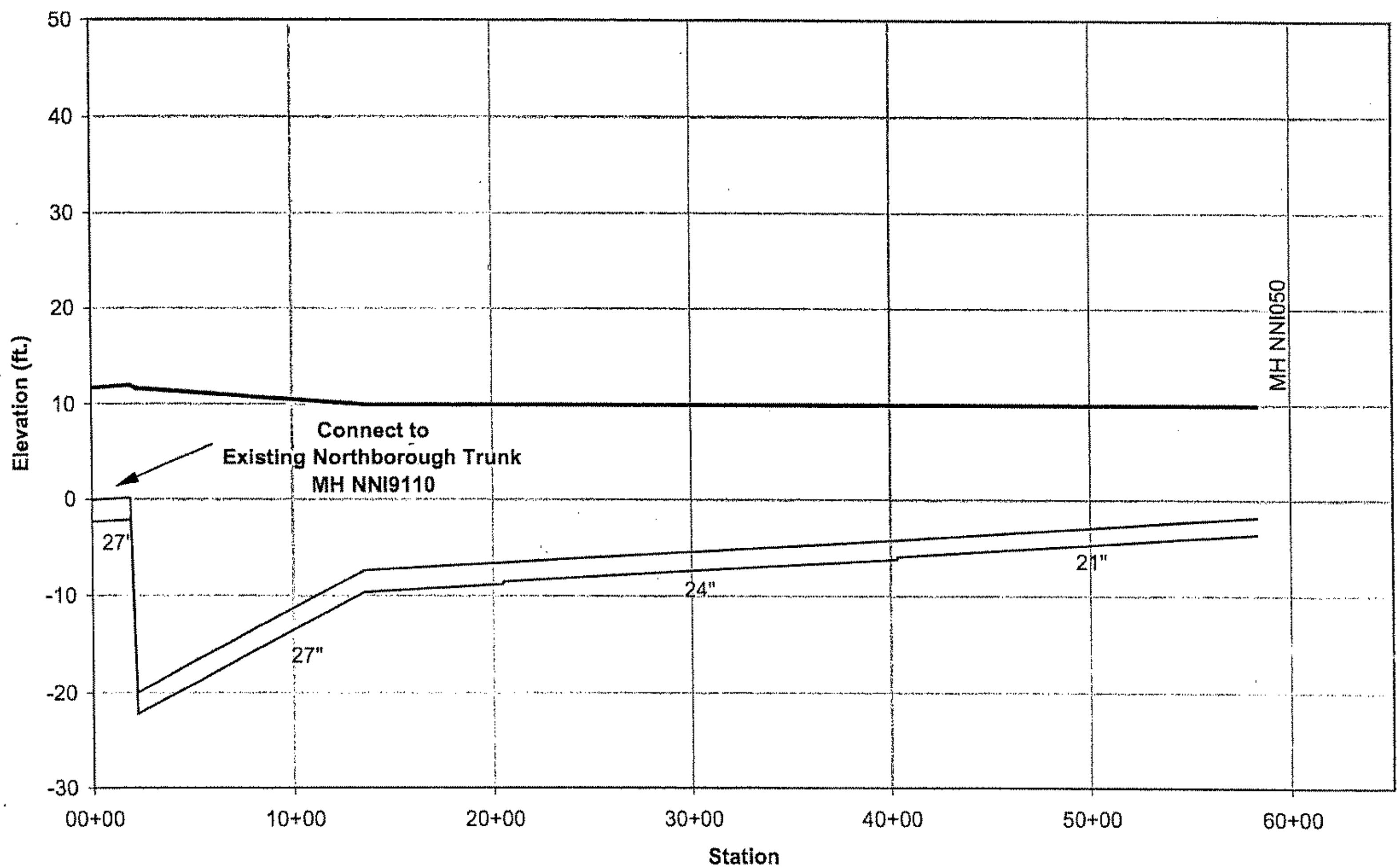
Trunk Shed	MH No. in Future Trunk Model [1]	GIS MH No. [2]
NN Natomas North	NN1040	22500406
NN Natomas North	NNI9010	22500405
NN Natomas North	NNI9020	22500404
NN Natomas North	NNI9030	22500403
NN Natomas North	NNI9040	22500402
NN Natomas North	NNI9210	22500401
NN Natomas North	NNI9220	20103515
NN Natomas North	NNI9230	20103514
NN Natomas North	NNI9240	20103513
NN Natomas North	NNI9250	20103511
NN Natomas North	NNI9260	20103516
NN Natomas North	NNI9050	20103617
NN Natomas North	NNI9060	20103614
NN Natomas North	NNI9070	20103616
NN Natomas North	NNI9080	22511403
NN Natomas North	NNI9090	22511402
NN Natomas North	NNI9110	22511401
NN Natomas North	NNJ9210	[3]
NN Natomas North	NNJ9220	[3]
NN Natomas North	NNJ9230	[3]
NN Natomas North	NNJ9240	[3]
1) The Trunk Shed Maps do not show all manholes below		
2) Closest manhole to future model node		
3) Not available		

Trunk Shed NN Natomas North
Buildout 10-Year Design Storm

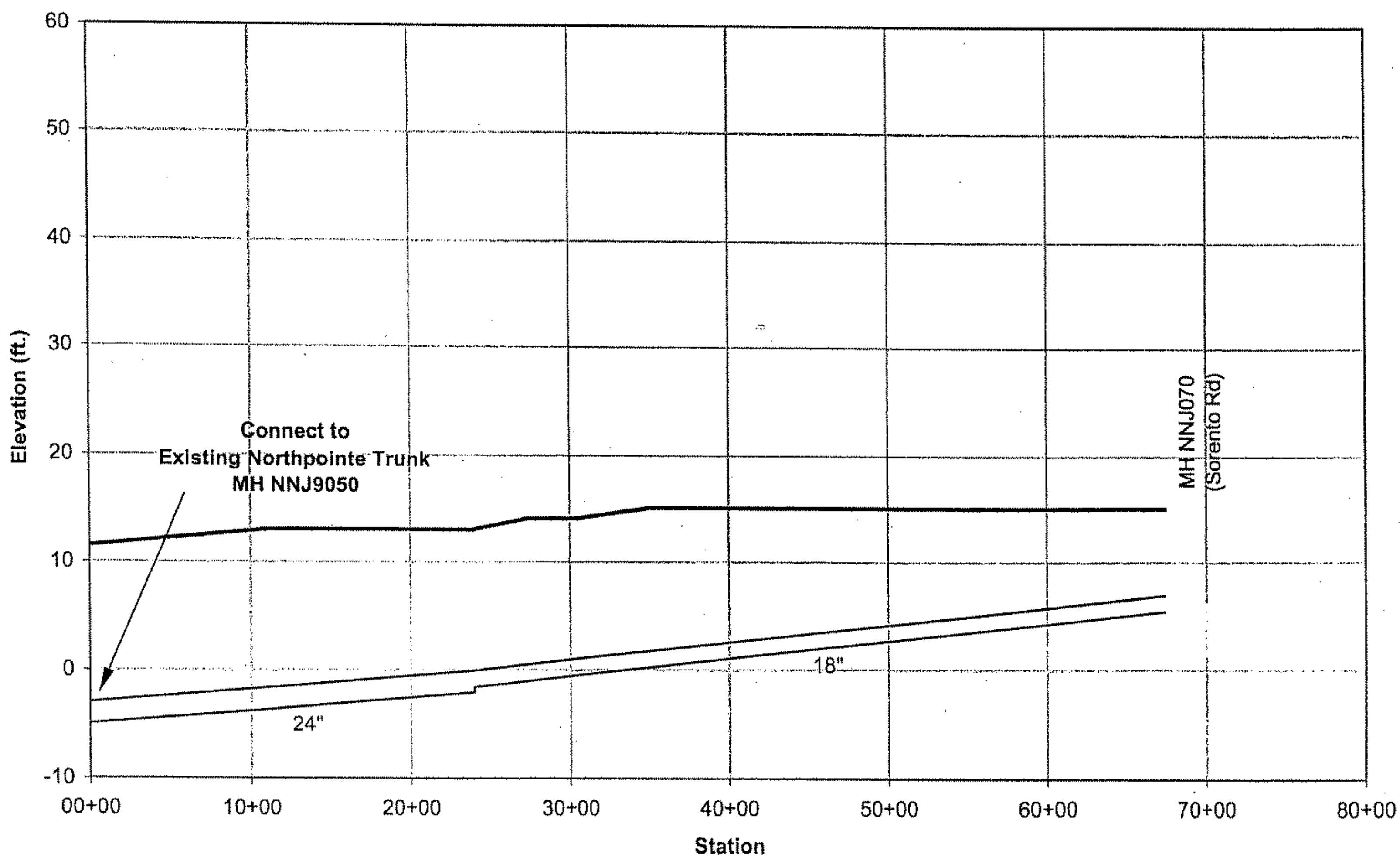
US Manhole	DS Manhole	Dia. (in.)	Length (ft.)	US Rim Elev.	DS Rim Elev.	US Invert Elev.	DS Invert Elev.	Slope	Full Cap. (mgd)	Peak Flow (mgd)	% Full Cap.	DS d/D
NNH110	NN1010	12	151	20	22	-2.46	-2.80	0.0022	1.1	0.78	71	0.47
NNH120	NNH110	12	591	20	20	-1.04	-2.46	0.0024	1.1	0.78	68	0.61
NNH910	NN1050	10	299	20	10	-1.12	-2.17	0.0035	0.8	0.23	27	0.32
NNH210	NN1060	12	591	20	10	0.07	-1.35	0.0024	1.1	0.87	76	0.49
NNH410	NN1080	42	541	20	10	-3.29	-3.62	0.0006	16.0	10.34	65	0.35
NNH420	NNH410	42	1040	20	20	-2.67	-3.29	0.0006	15.9	10.38	65	0.51
NNH430	NNH420	42	1460	20	20	-1.80	-2.67	0.0006	15.9	10.11	63	0.57
NNH440	NNH430	42	2139	20	20	-0.51	-1.80	0.0006	16.0	9.65	60	0.58
NNH310	NN1080	15	659	20	10	1.16	-0.09	0.0019	1.8	1.23	68	0.44
NNH320	NNH310	12	991	20	20	3.78	1.41	0.0024	1.1	0.98	88	0.52
NNI9010	NN1040	36	440	15	15	-5.29	-5.53	0.0006	10.1	8.01	79	0.37
NNI9020	NNI9010	36	479	17	15	-5.05	-5.29	0.0005	9.6	8.01	83	0.55
NNI9030	NNI9020	36	479	18	17	-4.80	-5.05	0.0005	9.8	8.01	81	0.61
NNI9040	NNI9030	36	469	17	18	-4.56	-4.80	0.0005	9.7	7.94	81	0.64
NNI9050	NNI9040	36	961	12	17	-4.09	-4.56	0.0005	9.5	6.64	70	0.66
NNI9060	NNI9050	36	230	12	12	-3.97	-4.09	0.0005	9.9	6.64	67	0.64
NNI9070	NNI9060	36	509	11	12	-3.72	-3.97	0.0005	9.5	6.64	70	0.63
NNI9080	NNI9070	36	449	12	11	-3.49	-3.72	0.0005	9.7	6.64	68	0.63
NNI9090	NNI9080	36	341	12	12	-3.32	-3.49	0.0005	9.6	6.64	69	0.62
NNI9110	NNI9090	36	469	12	12	-3.09	-3.32	0.0005	9.5	5.98	63	0.62
NNIFM1	NNI9110	27	194	30	12	-2.11	-2.34	0.0012	6.9	6.00	87	0.48
NNIFM2	NNIFM1	24	30	12	30	-21.96	-2.11	-0.6616	-120.2	6.00	-5	0.68
NNI9210	NNI9040	15	279	16	17	-2.88	-3.30	0.0015	1.6	1.37	85	0.57
NNI9220	NNI9210	15	459	16	16	-2.20	-2.88	0.0015	1.6	1.37	86	0.68
NNI9230	NNI9220	15	381	16	16	-1.63	-2.20	0.0015	1.6	1.37	85	0.71
NNI9240	NNI9230	15	381	16	16	-1.06	-1.63	0.0015	1.6	0.78	48	0.71
NNI9250	NNI9240	15	180	19	16	-0.69	-0.96	0.0015	1.6	0.78	48	0.44
NNI9260	NNI9250	15	331	20	19	-0.20	-0.69	0.0015	1.6	0.78	49	0.49
NNI910	NNI9260	12	591	20	20	1.22	-0.20	0.0024	1.1	0.78	68	0.62
NNI010	NNIPS1	27	1129	10	12	-9.61	-10.96	0.0012	6.9	6.05	87	0.70
NNI020	NNI010	27	699	10	10	-8.77	-9.61	0.0012	7.0	5.73	82	0.72
NNJ9210	NNI020	18	200	19	10	-0.60	-0.92	0.0016	2.7	1.73	64	0.42
NNJ9220	NNJ9210	18	69	19	19	-0.49	-0.60	0.0016	2.7	1.73	63	0.56
NNJ9230	NNJ9220	18	390	14	19	0.13	-0.49	0.0016	2.7	1.73	64	0.57
NNJ9240	NNJ9230	18	341	15	14	0.67	0.13	0.0016	2.7	1.73	64	0.58
NNJ110	NNJ9240	18	1260	11	15	2.69	0.67	0.0016	2.7	1.73	64	0.58
NNJ120	NNJ110	18	1201	13	11	4.61	2.69	0.0016	2.7	1.73	64	0.58
NNJ130	NNJ120	10	1381	11	13	10.10	5.27	0.0035	0.8	0.41	49	0.43
NNJ140	NNJ130	10	679	15	11	12.48	10.10	0.0035	0.8	0.41	49	0.50
NNI030	NNI020	24	1030	10	10	-7.28	-8.52	0.0012	5.1	3.77	74	0.67
NNI040	NNI030	24	951	10	10	-6.14	-7.28	0.0012	5.1	3.58	71	0.64
NNJ910	NNI040	10	322	11	10	-2.35	-3.48	0.0035	0.8	0.37	43	0.40
NNI050	NNI040	21	1801	10	10	-3.55	-5.89	0.0013	3.7	2.69	73	0.58
NNJ210	NNI050	15	2090	11	10	0.92	-3.05	0.0019	1.8	1.35	74	0.50
NNJ220	NNJ210	15	971	11	11	2.76	0.92	0.0019	1.8	1.35	74	0.64
NNJ230	NNJ220	10	761	11	11	5.84	3.18	0.0035	0.8	0.46	54	0.46
NNJ240	NNJ230	10	699	25	11	8.29	5.84	0.0035	0.8	0.46	54	0.54
NNI060	NNI050	15	322	10	10	-2.43	-3.05	0.0019	1.8	1.37	75	0.50
NNI070	NNI060	15	1181	10	10	-0.18	-2.43	0.0019	1.8	1.05	57	0.64

Note: Pipes with peak flow less than 1 mgd are considered local collectors and are labeled "LC" on the trunk shed maps.

Trunk NNI


50
40
30
20
10
0
-10
-20
-30
Elevation (ft.)
00+00
10+00
20+00
30+00
40+00
50+00
60+00
Station
Connect to
Existing Northborough Trunk
MH NNI9110
MH NNI050
27"
27"
24"
21"

Trunk NNJ



Elevation (ft.)
60
50
40
30
20
10
0
-10
00+00
10+00
20+00
30+00
40+00
50+00
60+00
70+00
80+00
Station
Connect to
Existing Northpointe Trunk
MH NNJ9050
24"
18"
MH NNJ070
(Sorento Rd)

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	NNH TRUNK SHED........ NN Natomas North
LOCATION:	South of Elkhorn Boulevard and east of Interstate 5. Connects to North Natomas Interceptor at MH NN1080.
BRIEF PROJECT DESCRIPTION:	1,650 feet of 12" and 15" pipe
MODEL REFERENCE:	NNH320 to NN1080
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:	Expansion for future development (Schumacher)
DESIGN FLOW:	1.0 mgd (upstream) to 1.26 mgd (downstream)
PERCENT FOR EXISTING FLOW:	0%
PERCENT FOR FUTURE FLOW:	100%
SPECIAL CONSIDERATIONS:	Project requires the North Natomas Interceptor.
ASSUMPTIONS:	Assumes easements granted by developer and interceptor/trunk junction structure constructed with interceptor.
ALTERNATIVES:	Pipeline location could be modified to accommodate development patterns.

MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNH320 to NNH310	12	16-20	990'	120 $/ft	$118,800
NNH310 to NN1080	15	16-20	660'	130 $/ft	$85,800
Geotechnical Factors					
Increased Dewatering			1,650'	53 $/ft	$87,450
Increased Sheeting/Shoring					
Partially Laid Back Trench			1,650'	40 $/ft	$66,000
Traffic and Productivity Factors					
Surface Restoration					
Structures, Pits, and Pump Stations					
Subtotal					$358,050
Mobilization and Demobilization				5%	$17,903
Construction Cost Subtotal					**$375,953**
Contingencies for Unknown Subsurface Conditions				30%	$112,786
Construction Cost Total					**$488,738**
Engineering, Administration, and Legal Costs				25%	$122,185
Capital Improvement Cost Total					$610,923
				rounded	**$611,000**

ENR =6474 (Average of S.F. and 20 Cities, January 2000)

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	NNI TRUNK SHED........ NN Natomas North
LOCATION:	South of Elkhorn Boulevard and west of the East Drainage Canal. Connects to existing trunk at MH NNI9110.
BRIEF PROJECT DESCRIPTION:	7,300 feet of 15" to 27" pipe and 6.5 mgd pump station
MODEL REFERENCE:	NNI070 to NNI9110
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:	Expansion for future development (Northborough)
DESIGN FLOW:	1.05 mgd (upstream) to 6.0 mgd (downstream)
PERCENT FOR EXISTING FLOW:	0%
PERCENT FOR FUTURE FLOW:	100%
SPECIAL CONSIDERATIONS:	The flow from the east side of the canal provides the initial start-up flow for the North Natomas Interceptor and maintains cleaning velocities. The NNI trunk should be designed at a depth that enables trunks from east side of the Main Drainage Canal to connect and maintain clearance under the canal and the Upper Northwest Interceptor.
ASSUMPTIONS:	Assumes easements granted by developer and trunk junction structure constructed with existing trunk.
ALTERNATIVES:	Pipeline location could be modified to accommodate development patterns.

MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNI070 to NNI060	15	8-16	1,180'	110 $/ft	$129,800
NNI060 to NNI050	15	8-16	320'	110 $/ft	$35,200
NNI050 to NNI040	21	8-16	1,800'	140 $/ft	$252,000
NNI040 to NNI030	24	8-16	950'	160 $/ft	$152,000
NNI030 to NNI020	24	16-20	1,030'	185 $/ft	$190,550
NNI020 to NNI010	27	16-20	700'	210 $/ft	$147,000
NNI010 to **NNIPS1**	27	20-24	1,130'	240 $/ft	$271,200
NNIPS1 to NNI9110	27	20-24	194'	240 $/ft	$46,560
Geotechnical Factors					
Increased Dewatering			7,304'	53 $/ft	$387,112
Increased Sheeting/Shoring Partially Laid Back Trench			7,304'	40 $/ft	$292,160
Traffic and Productivity Factors					
Surface Restoration					
Structures, Pits, and Pump Stations					
2-Trunk Junction Structure (24- to 36-inch dia outlet pipe)					$16,000
Pump Station - 6.5 mgd					$865,000
Subtotal					$2,784,582
Mobilization and Demobilization				5%	$139,229
Construction Cost Subtotal					**$2,923,811**
Contingencies for Unknown Subsurface Conditions				30%	$877,143
Construction Cost Total					**$3,800,954**
Engineering, Administration, and Legal Costs				25%	$950,239
Capital Improvement Cost Total					**$4,751,193**
				rounded	**$4,751,000**

ENR = 6474 (Average of S.F. and 20 Cities, January 2000)

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..NNJ-3 TRUNK SHED........ NN Natomas North

LOCATION:... South of Elkhorn Boulevard and east of the East Drainage Canal. Connects to existing trunk at MH NNJ9240.

BRIEF PROJECT DESCRIPTION:................. 2,450 feet of 18" pipe

MODEL REFERENCE:................................NNJ120 to NNJ9240

LOCATION OF CAPACITY DEFICIENCY: ....N/A

REASON FOR PROJECT:.......................... Expansion for future development (Northpoint)

DESIGN FLOW:...................................... 1.73 mgd

PERCENT FOR EXISTING FLOW:.............. 0%

PERCENT FOR FUTURE FLOW:............. 100%

SPECIAL CONSIDERATIONS:......................Project requires Trunk Project NNI.

ASSUMPTIONS:... Assumes easements granted by developer and trunk junction structure constructed with existing trunk.

ALTERNATIVES:..Pipeline location could be modified to accommodate development patterns.

MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNJ120 to NNJ110	18	8-16	1,200'	125 $/ft	$150,000
NNJ110 to NNJ9240	18	8-16	1,260'	125 $/ft	$157,500
Geotechnical Factors					
Increased Dewatering			2,460'	53 $/ft	$130,380
Increased Sheeting/Shoring					
Partially Laid Back Trench			2,460'	20 $/ft	$49,200
Traffic and Productivity Factors					
Surface Restoration					
Structures, Pits, and Pump Stations					
Subtotal					$487,080
Mobilization and Demobilization				5%	$24,354
Construction Cost Subtotal					**$511,434**
Contingencies for Unknown Subsurface Conditions				30%	$153,430
Construction Cost Total					**$664,864**
Engineering, Administration, and Legal Costs				25%	$166,216
Capital Improvement Cost Total					$831,080
				rounded	**$831,000**

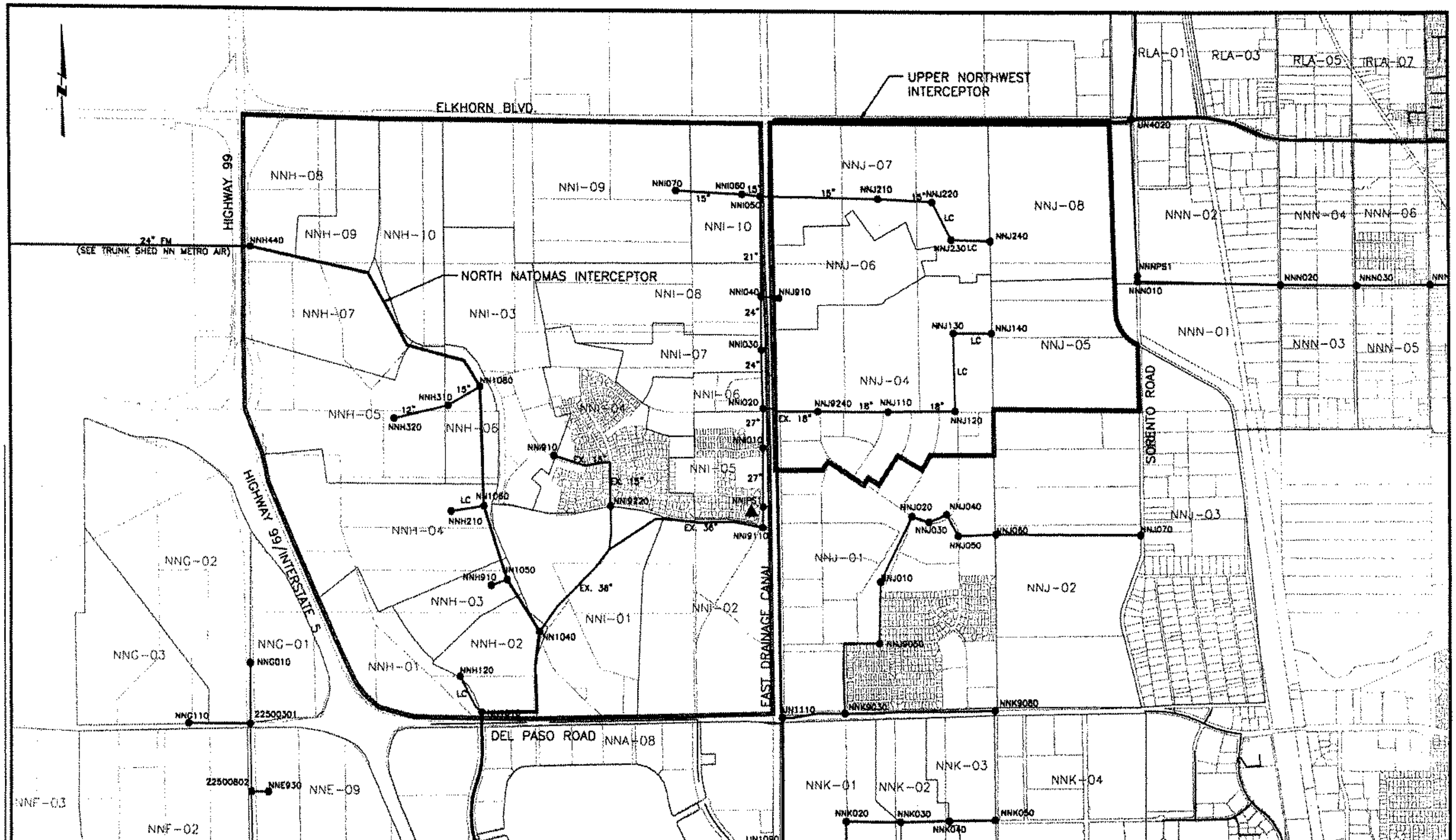
ENR = 6474 (Average of S.F. and 20 Cities, January 2000)

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:...	NNJ-4 TRUNK SHED....... NN Natomas North
LOCATION:...	South of Elkhorn Boulevard and east of the East Drainage Canal. Connects to Project NNI at MH NNI050.
BRIEF PROJECT DESCRIPTION:.................	3,050 feet of 15" pipe
MODEL REFERENCE:................................	NNJ220 to NNI050
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:...........................	Expansion for future development (Northpoint)
DESIGN FLOW:..	1.35 mgd
PERCENT FOR EXISTING FLOW:..............	0%
PERCENT FOR FUTURE FLOW:.............	100%
SPECIAL CONSIDERATIONS:......................	Project requires Trunk Project NNI-1.
ASSUMPTIONS:..	Assumes easements granted by developer.
ALTERNATIVES:.......................................	Pipeline location could be modified to accommodate development patterns.

MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNJ220 to NNJ210	15	8-16	970'	110 $/ft	$106,700
NNJ210 to NNI050	15	8-16	2,090'	110 $/ft	$229,900
Channel Crossing (36" casing)	15	Microtunnel	100'	800 $/ft	$80,000
Jacking Pit					$60,000
Receiving Pit					$35,000
Geotechnical Factors					
Increased Dewatering			3,060'	53 $/ft	$162,180
Increased Sheeting/Shoring					
Partially Laid Back Trench			3,060'	20 $/ft	$61,200
Traffic and Productivity Factors					
Surface Restoration					
Structures, Pits, and Pump Stations					
Subtotal					$734,980
Mobilization and Demobilization				5%	$36,749
Construction Cost Subtotal					**$771,729**
Contingencies for Unknown Subsurface Conditions				30%	$231,519
Construction Cost Total					**$1,003,248**
Engineering, Administration, and Legal Costs				25%	$250,812
Capital Improvement Cost Total					**$1,254,060**
				rounded	**$1,254,000**

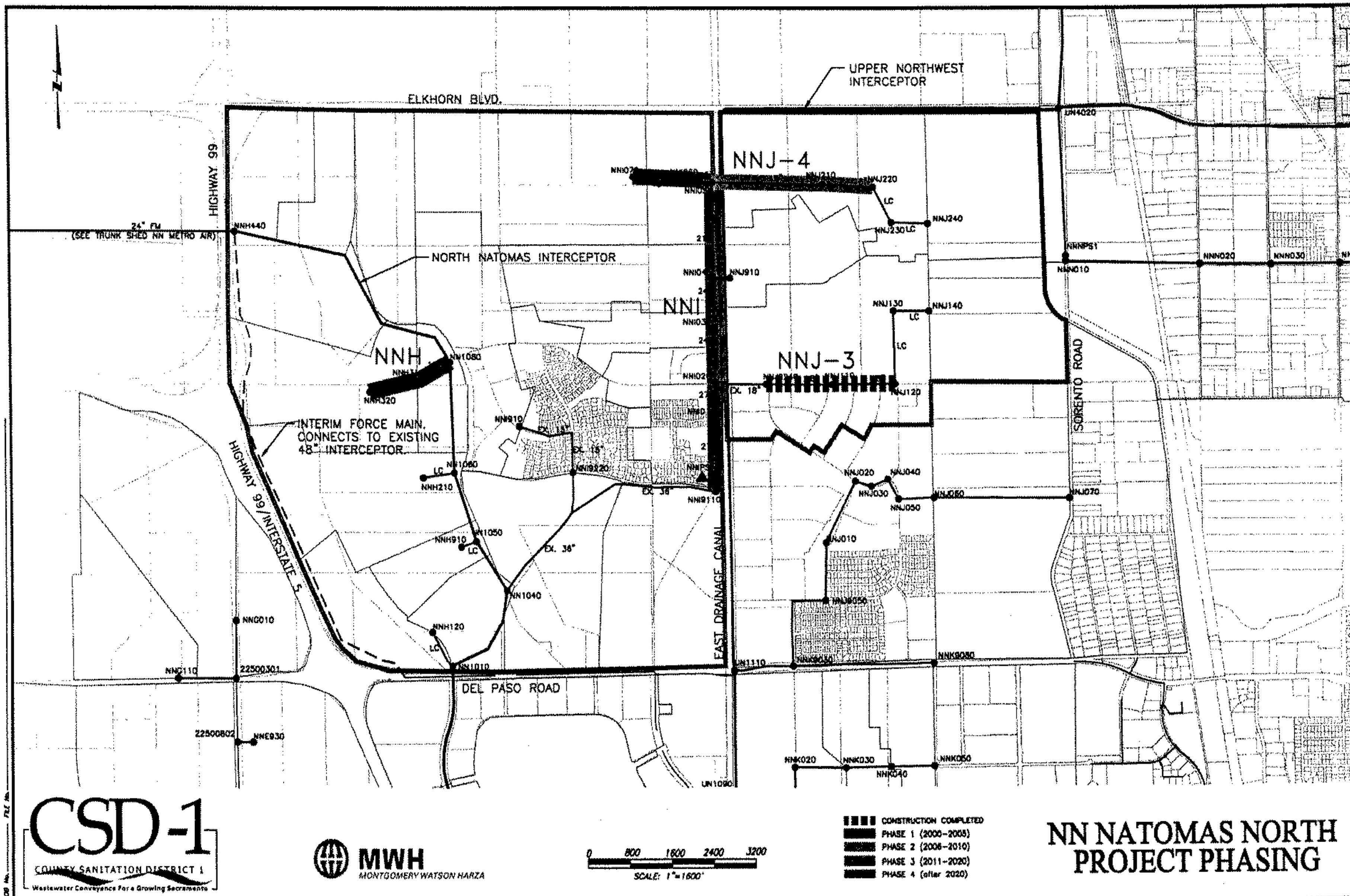
ENR = 6474 (Average of S.F. and 20 Cities, January 2000)



CSD-1
COUNTY SANITATION DISTRICT 1
Wastewater Conveyance For a Growing Sacramento

MWH
MONTGOMERY WATSON HARZA

NN NATOMAS NORTH TRUNK SHED


UPPER NORTHWEST INTERCEPTOR
ELKHORN BLVD.
HIGHWAY 99
24" FM (SEE TRUNK SHED NN METRO AIR)
NORTH NATOMAS INTERCEPTOR
INTERIM FORCE MAIN. CONNECTS TO EXISTING 48" INTERCEPTOR.
HIGHWAY 99/INTERSTATE 5
DEL PASO ROAD
EAST DRAINAGE CANAL
SORENTO ROAD
NNJ-4
NNJ-3
NNI
NNH
EX. 18"
EX. 36"
NNH440
NNH320
NN1080
NN1060
NNH210
NNH910
NN1050
NN1040
NNH120
NN1010
NN1110
NNG010
NNG110
22500301
22500802
NNE930
NNJ910
NNJ220
NNJ230
NNJ240
NNJ130
NNJ140
NNJ120
NNJ020
NNJ030
NNJ040
NNJ050
NNJ060
NNJ070
NNJ010
NNK020
NNK030
NNK040
NNK050
NNK9080
NNNPS1
NNN010
NNN020
NNN030
UN4020
UN1090
LC
CSD-1
COUNTY SANITATION DISTRICT 1
Wastewater Conveyance For a Growing Sacramento
MWH
MONTGOMERY WATSON HARZA
0 800 1600 2400 3200
SCALE: 1"=1600'
CONSTRUCTION COMPLETED
PHASE 1 (2000-2005)
PHASE 2 (2006-2010)
PHASE 3 (2011-2020)
PHASE 4 (after 2020)
NN NATOMAS NORTH PROJECT PHASING

CSD-1 SEWERAGE FACILITIES EXPANSION MASTER PLAN

NN METRO AIR TRUNK SHED

Area Description

The NN Metro Air Trunk Shed is located north of Interstate 5 and west of Lone Tree Road. The Trunk Shed includes the Metro Air Park development and the Sacramento International Airport. Metro Air Park is anticipated to start developing within the 2000 to 2005 year time frame. It is anticipated that Sacramento International Airport will cease treating their wastewater on-site and convey wastewater to the CSD-1 system when the Metro Air Park trunk facilities come on line.

Trunk System Facilities

The trunk shed would be served by a major trunk sewer (Trunk NNM) and a permanent pump station located in the Metro Air Park development. This gravity trunk sewer would discharge to the pump station located in the south portion of the development, and a force main would connect to the future extension of the North Natomas Interceptor at El Centro Road.

If the North Natomas Interceptor extension to El Centro Road is not on line by the time the trunk facilities are constructed to serve this trunk shed, an interim connection could be made extending the force main to the existing upstream end of the North Natomas Interceptor north of Del Paso Road .

Trunk Project

Three trunk projects are identified for this trunk shed, as shown in the table below.

Project ID	Diam. (in.)	Length (ft.)	Phase	Estimated Construction Cost ($)	Estimated Capital Cost ($)
NNM-1	27-33 & 24 (FM)	2,900	1	6,665,000	8,973,000
NNM-2	12-24	10,500	1	4,903,000	6,128,000
NNM-3	15-18	5,500	1	2,396,000	2,995,000

Attachments

- Trunk shed map showing proposed trunk sewers, sizes, model manhole ID numbers, and sewersheds.
- Project map showing trunk projects and interim facilities (if needed).
- Trunk shed ESD projections by sewershed.
- Sewershed load manholes.
- Trunk sewer data and model results.
- Profile(s) of major trunk sewers.
- Trunk project cost estimates.

NN Metro Air
Trunk Shed Buildout Projections

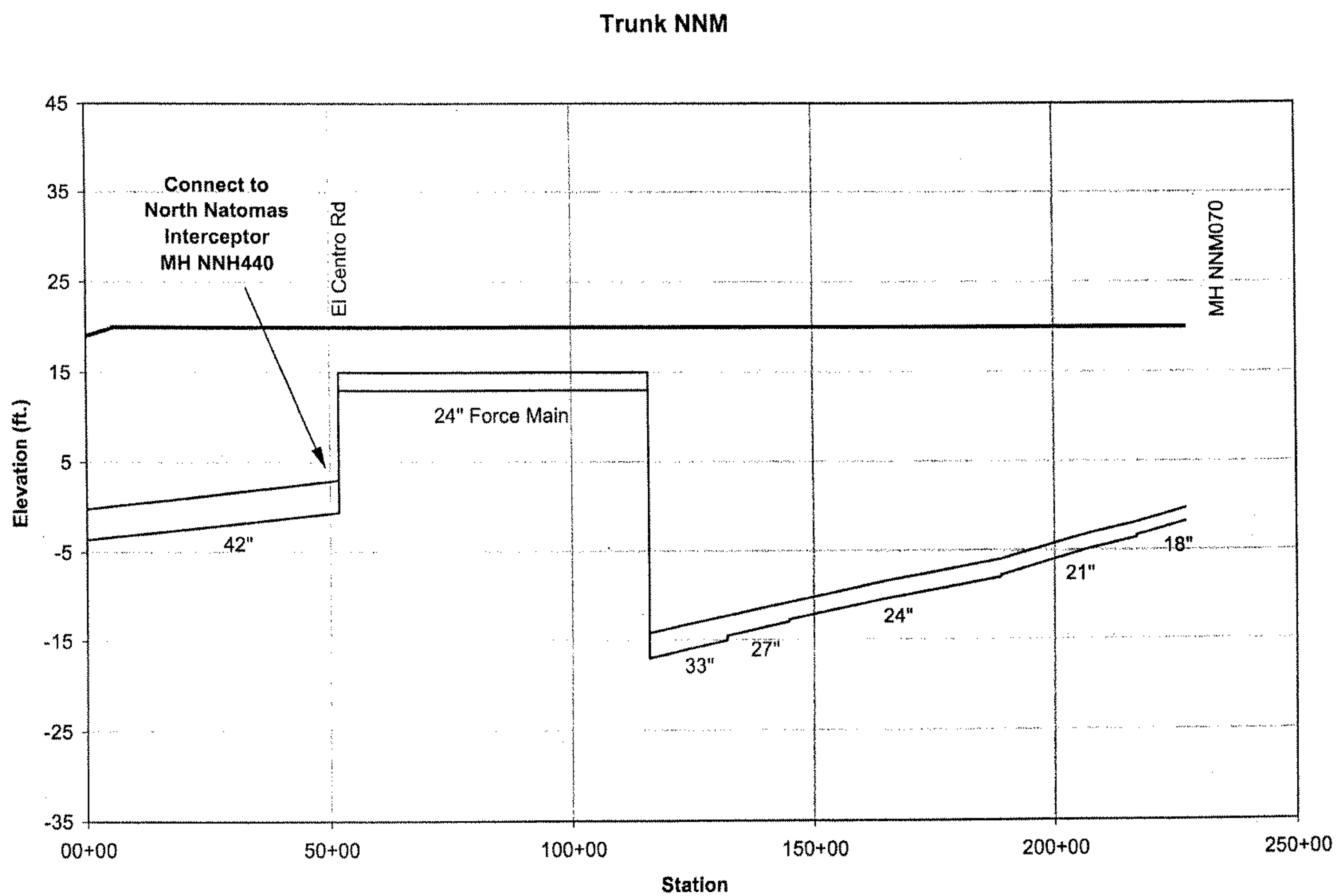
	ESDs				Area (acres)			
Sewershed	**2005**	**2010**	**2020**	**Buildout**	**2005**	**2010**	**2020**	**Buildout**
NNM-01	0	0	0	594	0	0	0	99
NNM-02	0	0	0	289	0	0	0	48
NNM-03	0	0	0	171	0	0	0	28
NNM-04	0	0	0	229	0	0	0	38
NNM-05	0	0	0	778	0	0	0	130
NNM-06	0	0	0	584	0	0	0	97
NNM-07	1	1	1	907	0	0	0	151
NNM-08	0	0	0	470	0	0	0	78
NNM-09	0	0	0	796	0	0	0	133
NNM-10	1	1	1	906	0	0	0	151
NNM-11	1	1	1	574	0	0	0	96
NNM-12	2	2	2	1,025	0	0	0	171
NNM-13	1	1	1	1,071	0	0	0	179
NNM-14	2	2	2	728	0	0	0	121
NNM-15	0	0	0	0	0	0	0	0
Total	**9**	**9**	**9**	**9,122**	**1**	**1**	**1**	**1,520**
Note: ESDs reflect residential development only.								

Trunk Shed NN Metro Air
Sewershed Load Manholes

Sewershed	Load Manhole
NNM-01	NNM090
NNM-02	NNM090
NNM-03	NNM080
NNM-04	NNM080
NNM-05	NNM070
NNM-06	NNM070
NNM-07	NNM060
NNM-08	NNM060
NNM-09	NNM040
NNM-10	NNM040
NNM-11	NNM120
NNM-12	NNM010
NNM-13	NNMPS1
NNM-14	NNM010
NNM-15	NNM130

Trunk Shed NN Metro Air
Buildout 10-Year Design Storm

US Manhole	DS Manhole	Dia. (in.)	Length (ft.)	US Rim Elev.	DS Rim Elev.	US Invert Elev.	DS Invert Elev.	Slope	Full Cap. (mgd)	Peak Flow (mgd)	% Full Cap.	DS d/D
NNMFM1	NNH440	24	6414	20	20	-27.35	-2.51	-0.0039	-9.1	9.79	-107	1.00
NNM010	NNMPS1	33	1601	20	20	-15.08	-17.00	0.0012	11.8	8.35	71	0.54
NNM020	NNM010	27	1299	20	20	-13.02	-14.58	0.0012	7.0	6.34	91	0.49
NNM030	NNM020	24	2001	20	20	-10.37	-12.77	0.0012	5.1	4.50	89	0.71
NNM040	NNM030	24	2402	20	20	-7.99	-10.37	0.0010	4.6	4.50	98	0.73
NNM050	NNM040	21	1860	20	20	-4.82	-7.24	0.0013	3.7	3.17	86	0.50
NNM060	NNM050	21	951	20	20	-3.58	-4.82	0.0013	3.7	3.17	86	0.72
NNM070	NNM060	18	1001	20	20	-1.73	-3.33	0.0016	2.7	2.10	77	0.67
NNM080	NNM070	12	2349	20	20	4.40	-1.23	0.0024	1.1	1.03	90	0.53
NNM090	NNM080	12	1499	20	20	8.00	4.40	0.0024	1.1	0.71	62	0.76
NNM110	NNM020	18	2369	20	20	-7.35	-11.14	0.0016	2.7	1.85	68	0.43
NNM120	NNM110	18	699	20	20	-6.23	-7.35	0.0016	2.7	1.85	68	0.61
NNM130	NNM120	15	2500	20	20	-1.23	-5.98	0.0019	1.8	1.39	76	0.54


Trunk NNM
Connect to
North Natomas
Interceptor
MH NNH440
El Centro Rd
MH NNM070
24" Force Main
42"
33"
27"
24"
21"
18"
Elevation (ft.)
45
35
25
15
5
-5
-15
-25
-35
00+00
50+00
100+00
150+00
200+00
250+00
Station

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	NNM-1 TRUNK SHED........ NN Metro Air
LOCATION:	North of Interstate 5 and east of Powerline Road. Connects to North Natomas Interceptor at MH NNH440.
BRIEF PROJECT DESCRIPTION:	2,900 feet of 27" to 33" pipe and 9.6 mgd pump station
MODEL REFERENCE:	NNM020 to NNH440
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:	Expansion for future development (Metro Air Park)
DESIGN FLOW:	6.34 mgd (upstream) to 9.79 mgd (downstream)
PERCENT FOR EXISTING FLOW:	14%
PERCENT FOR FUTURE FLOW:	86%
SPECIAL CONSIDERATIONS:	Project requires the future North Natomas Interceptor. Sewer studies showed oversized trunks to minimize slope. The CSD-1 Master Plan designed trunks and the slopes consistent with the master plan design criteria.
ASSUMPTIONS:	Assumes easements granted by developer with the exception of the area east of the Metro Air Park development (force main alignment). The interceptor/junction structure will be constructed with interceptor. Pipes designed to accommodate existing flow from the Sacramento International Airport.
ALTERNATIVES:	Pipeline location could be modified to accommodate development patterns.

MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNM020 to NNM010	27	>28	1,300'	345 $/ft	$448,500
NNM010 to **NNMPS1**	33	>28	1,600'	360 $/ft	$576,000
NNMFM1 to NNH440	24	8-16	6,415'	140 $/ft	$898,100
Highway 99 (49" casing)	24	Microtunnel	375'	1,040 $/ft	$390,000
Jacking Pit					$60,000
Receiving Pit					$35,000
Geotechnical Factors					
Increased Dewatering			9,315'	53 $/ft	$493,695
Increased Sheeting/Shoring					
Partially Laid Back Trench			9,315'	80 $/ft	$745,200
Traffic and Productivity Factors					
Surface Restoration					
Revegetation		80' wide	6,415'	0.25 $/sf	$128,300
Structures, Pits, and Pump Stations					
Pump Station - 9.6 mgd					$1,108,000
Subtotal					$4,882,795
Mobilization and Demobilization				5%	$244,140
Construction Cost Subtotal					**$5,126,935**
Contingencies for Unknown Subsurface Conditions				30%	$1,538,080
Construction Cost Total					**$6,665,015**
Land Acquisition - Temporary Easement Cost		80' wide	6,415'	0.50 $/sf	$256,600
Land Acquisition - Permanent Easement Cost		30' wide	6,415'	2 $/sf	$384,900
Engineering, Administration, and Legal Costs				25%	$1,666,254
Capital Improvement Cost Total					**$8,972,769**
ENR = 6474 (Average of S.F. and 20 Cities, January 2000)				rounded	**$8,973,000**

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	NNM-2 TRUNK SHED........ NN Metro Air
LOCATION:	North of Interstate 5 and east of Powerline Road. Connects to Project NNM-1 at MH NNM020.
BRIEF PROJECT DESCRIPTION:	10,500 ft of 12 to 24-inch pipe
MODEL REFERENCE:	NNM080 to NNM020
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:	Expansion for future development
DESIGN FLOW:	1.03 mgd to 4.50 mgd
PERCENT FOR EXISTING FLOW:	0%
PERCENT FOR FUTURE FLOW:	100%
SPECIAL CONSIDERATIONS:	Project requires NNM-1 and future North Natomas Interceptor. Sewer studies showed oversized trunks to minimize slope. The CSD-1 Master Plan designed trunks and the slopes consistent with the master plan design criteria.
ASSUMPTIONS:	Assumes easements granted by developer and high groundwater.
ALTERNATIVES:	Pipeline location could be modified to accommodate development patterns.

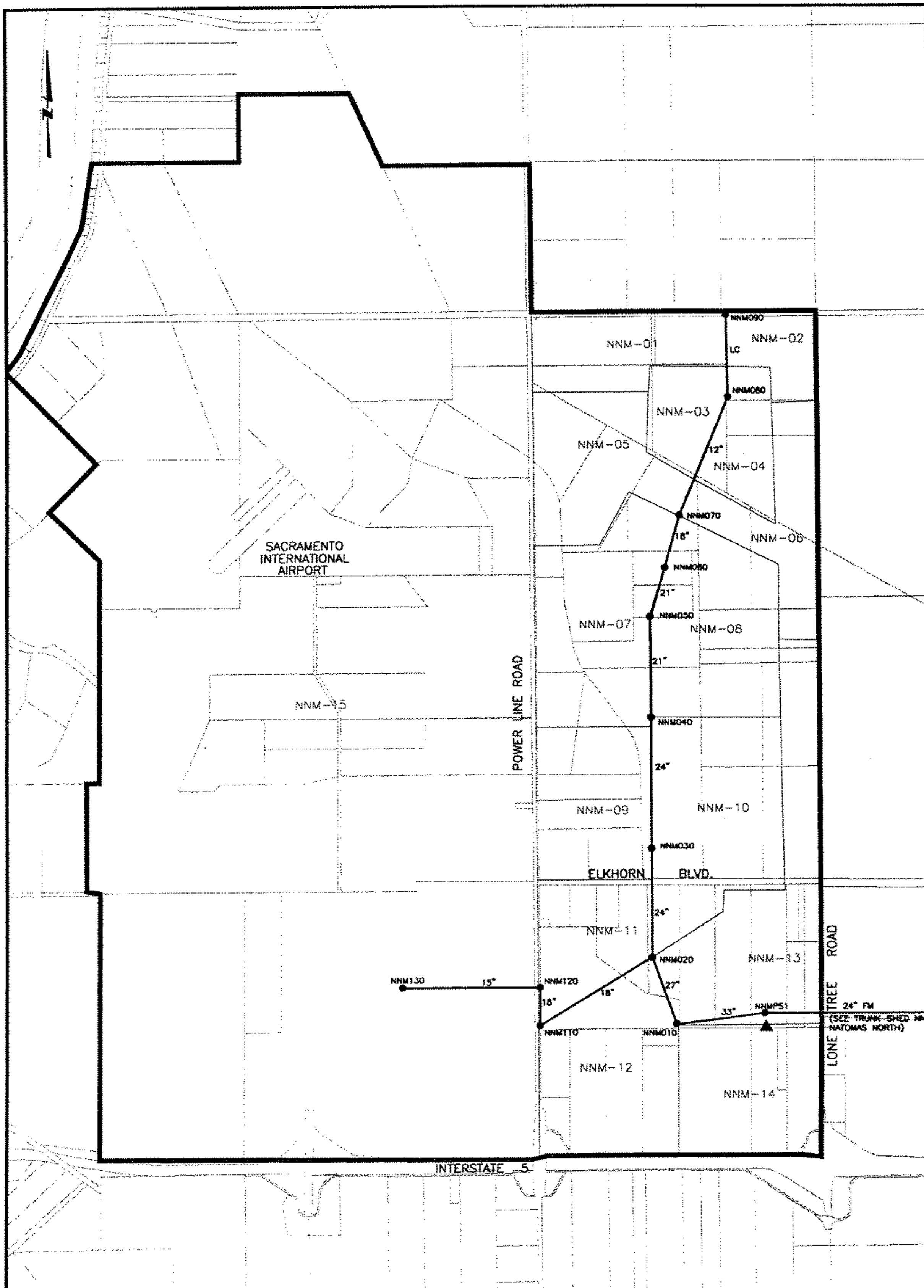
MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNM080 to NNM070	12	16-20	2,350'	120 $/ft	$282,000
NNM070 to NNM060	18	20-24	1,000'	165 $/ft	$165,000
NNM060 to NNM050	21	24-28	950'	215 $/ft	$204,250
NNM050 to NNM040	21	24-28	1,860'	215 $/ft	$399,900
NNM040 to NNM030	24	24-28	2,400'	245 $/ft	$588,000
NNM030 to NNM020	24	>28	2,000'	270 $/ft	$540,000
Geotechnical Factors					
Increased Dewatering			10,560'	53 $/ft	$559,680
Increased Sheeting/Shoring Partially Laid Back Trench			10,560'	80 $/ft	$844,800
Traffic and Productivity Factors					
Surface Restoration					
Structures, Pits, and Pump Stations					
Trunk Sewer Junction Structures (24- to 36-inch dia. outlet pipe)					$8,000
Subtotal					$3,591,630
Mobilization and Demobilization				5%	$179,582
Construction Cost Subtotal					**$3,771,212**
Contingencies for Unknown Subsurface Conditions				30%	$1,131,363
Construction Cost Total					**$4,902,575**
Engineering, Administration, and Legal Costs				25%	$1,225,644
Capital Improvement Cost Total					**$6,128,219**
				rounded	**$6,128,000**

ENR = 6474 (Average of S.F. and 20 Cities, January 2000)

TRUNK SEWER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	NNM-3 TRUNK SHED........ NN Metro Air
LOCATION:	North of Interstate 5 and east of Powerline Road. Connects to Project NNM-1 at MH NNM020.
BRIEF PROJECT DESCRIPTION:	5,500 feet of 15" and 18" pipe
MODEL REFERENCE:	NNM130 to NNM020
LOCATION OF CAPACITY DEFICIENCY:	N/A
REASON FOR PROJECT:	Convey Sacramento International Airport flow to CSD-1 system.
DESIGN FLOW:	1.4 mgd (upstream) to 1.85 mgd (downstream)
PERCENT FOR EXISTING FLOW:	80%
PERCENT FOR FUTURE FLOW:	20%
SPECIAL CONSIDERATIONS:	Project requires North Natomas Interceptor and Trunk Project NNM-1. Sewer studies showed oversized trunks to minimize slope. The CSD-1 Master Plan designed trunks and the slopes consistent with the master plan design criteria.
ASSUMPTIONS:	Costs assume easements granted by developer.
ALTERNATIVES:	Pipeline location could be modified to accommodate development patterns.

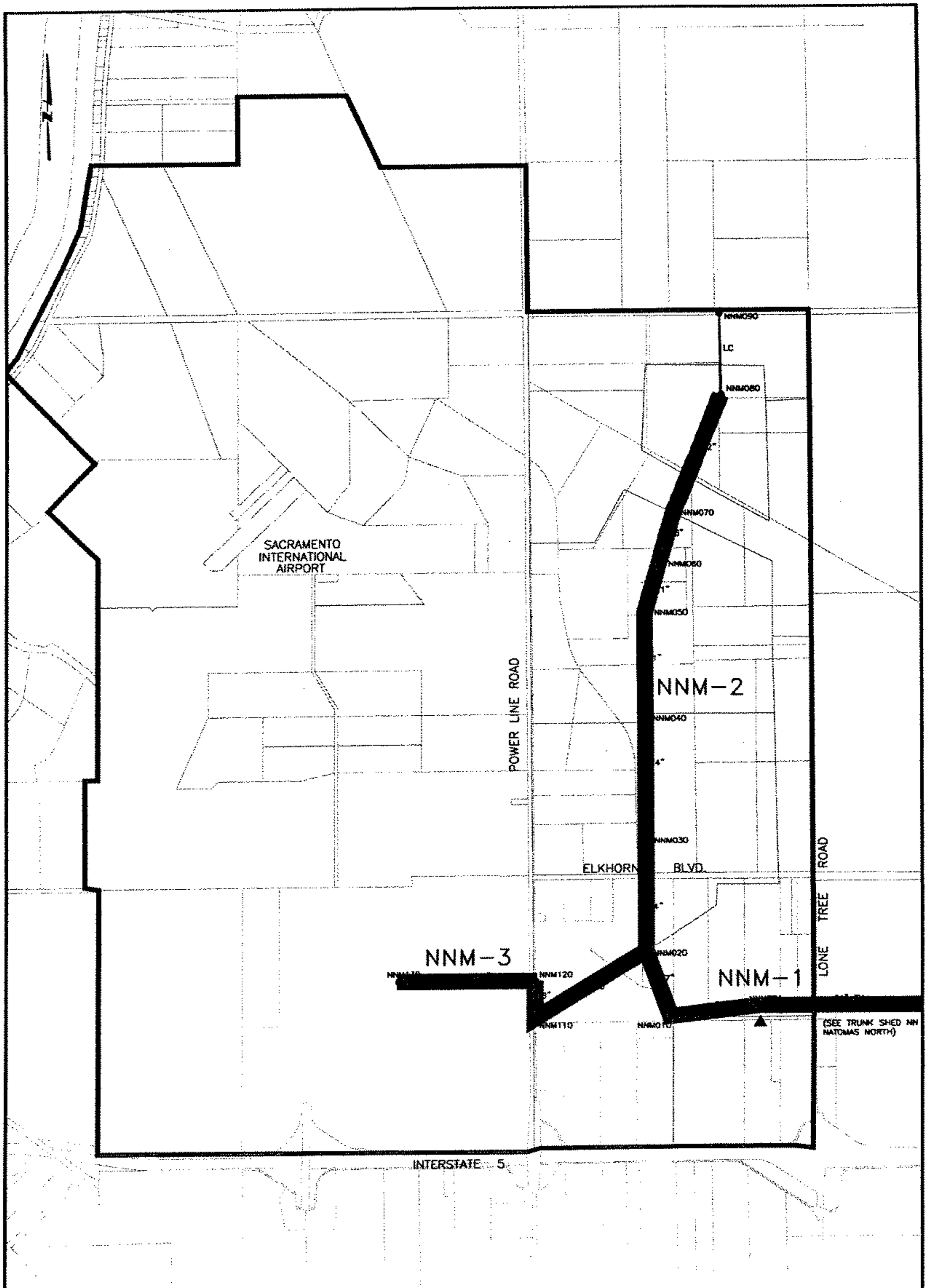
MAJOR ITEMS	DIA. (in.)	DEPTH (feet)	LENGTH (feet)	UNIT COST	COST
Baseline Pipe Construction Cost					
NNM130 to NNM120	15	20-24	2,500'	150 $/ft	$375,000
NNM120 to NNM110	18	24-28	700'	185 $/ft	$129,500
NNM110 to NNM020	18	24-28	2,370'	185 $/ft	$438,450
Geotechnical Factors					
Increased Dewatering			5,573'	53 $/ft	$295,369
Increased Sheeting/Shoring					
Partially Laid Back Trench			5,573'	80 $/ft	$445,840
Traffic and Productivity Factors					
Surface Restoration					
Pavement Restoration		15' wide	700'	2.00 $/sf	$21,000
Revegetation		80' wide	2,500'	0.25 $/sf	$50,000
Structures, Pits, and Pump Stations					
Subtotal					$1,755,159
Mobilization and Demobilization				5%	$87,758
Construction Cost Subtotal					**$1,842,917**
Contingencies for Unknown Subsurface Conditions				30%	$552,875
Construction Cost Total					**$2,395,792**
Engineering, Administration, and Legal Costs				25%	$598,948
Capital Improvement Cost Total					**$2,994,740**
ENR = 6474 (Average of S.F. and 20 Cities, January 2000)				rounded	**$2,995,000**



CSD-1
COUNTY SANITATION DISTRICT 1
Wastewater Conveyance For a Growing Sacramento

MWH
MONTGOMERY WATSON HARZA

NN METRO AIR TRUNK SHED



CSD-1
COUNTY SANITATION DISTRICT 1
Wastewater Conveyance For a Growing Sacramento

0 800 1600 2400 3200
SCALE: 1"=1600'

MWH
MONTGOMERY WATSON HARZA

PHASE 1 (2000–2005)
PHASE 2 (2006–2010)
PHASE 3 (2011–2020)
PHASE 4 (after 2020)

NN METRO AIR PROJECT PHASING

EXHIBIT D
GREENBRIAR SEWER SYSTEM EXHIBITS

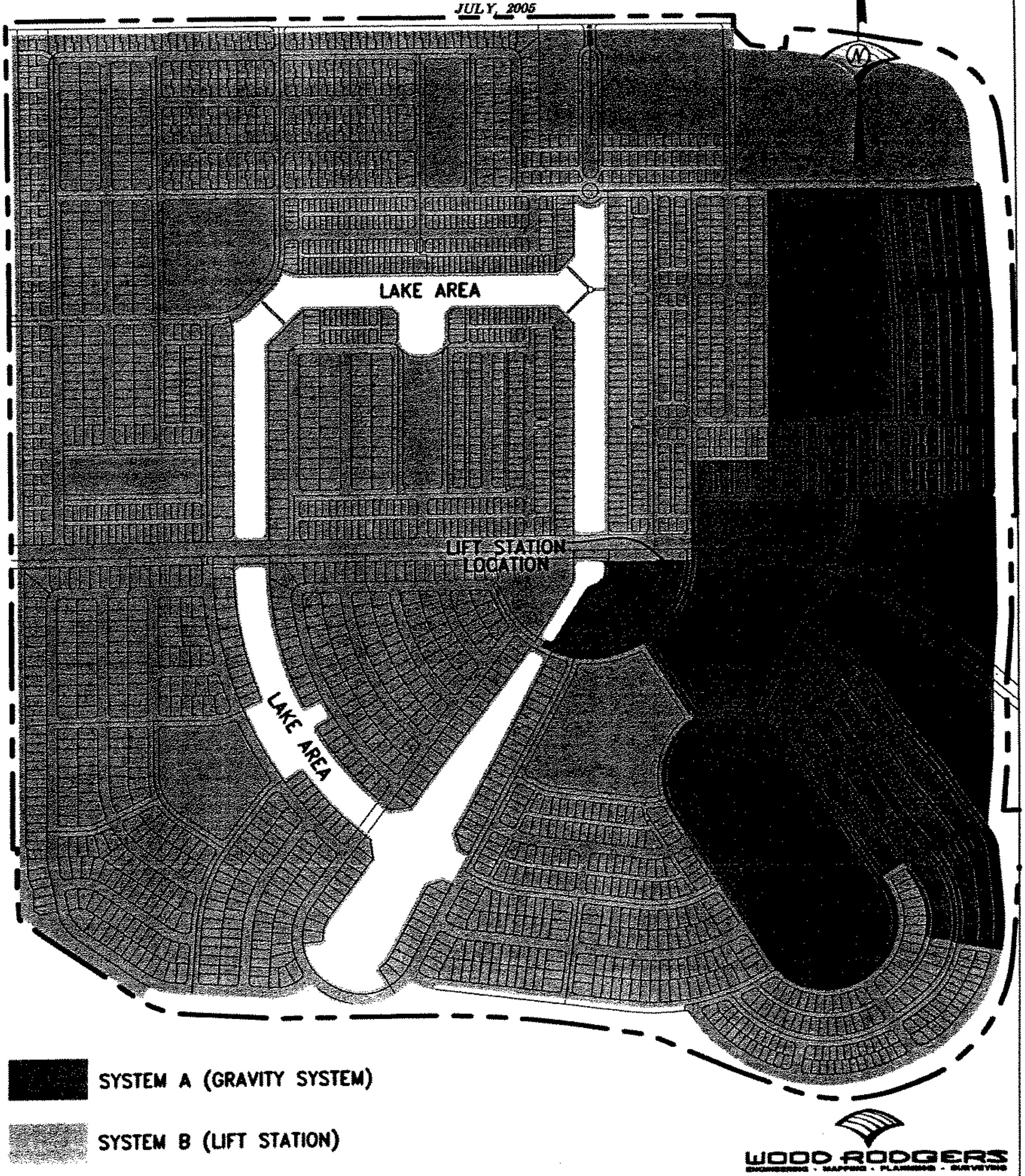
EXHIBIT D

GREENBRIAR SEWER SYSTEM SHEDS

AKT DEVELOPMENT

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005



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3301 C St. Bldg. 100-B Tel 916.341.7760
Sacramento, CA 95816 Fax 916.341.7767

EXHIBIT D

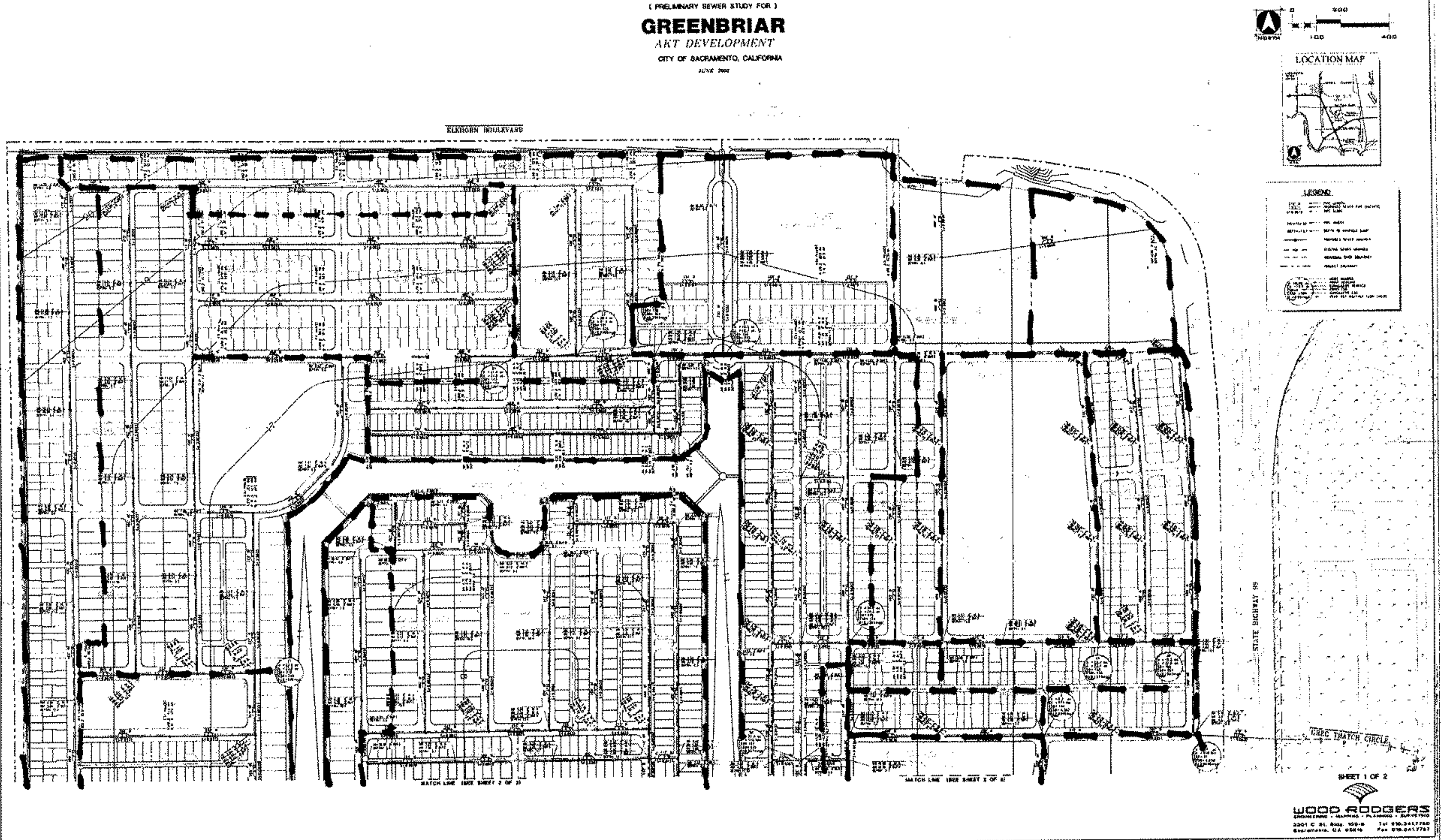
(PRELIMINARY SEWER STUDY FOR)

GREENBRIAR

AKT DEVELOPMENT

CITY OF SACRAMENTO, CALIFORNIA

JUNE 2006



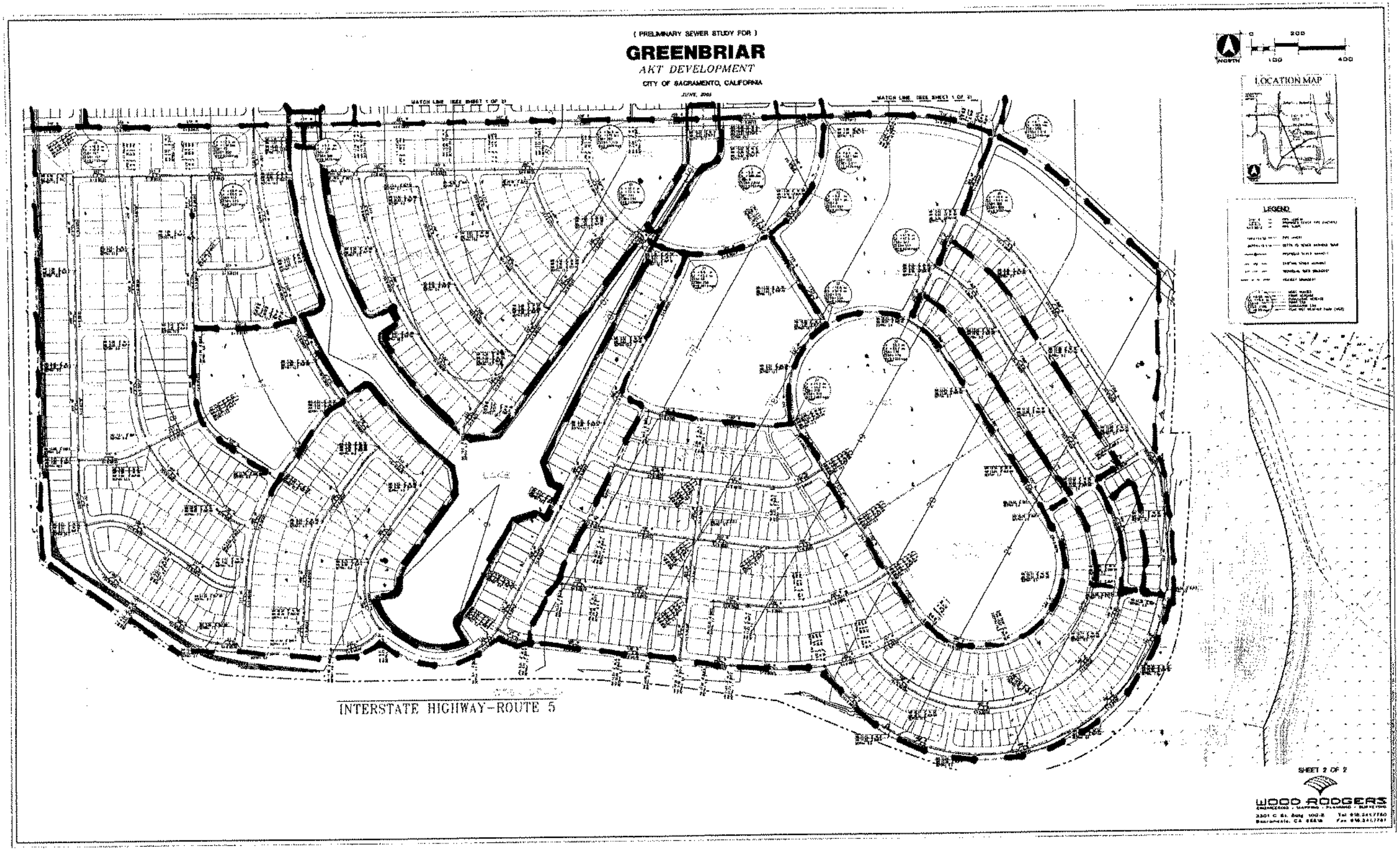

(PRELIMINARY SEWER STUDY FOR)
GREENBRIAR
AKT DEVELOPMENT
CITY OF SACRAMENTO, CALIFORNIA
LOCATION MAP
LEGEND
MATCH LINE (SEE SHEET 1 OF 2)
NORTH
0
100
200
400
INTERSTATE HIGHWAY-ROUTE 5
LAKE
SHEET 2 OF 2
WOOD RODGERS

EXHIBIT E

GREENBRIAR SEWER STUDY CALCULATIONS

GREENBRIAR 1116.003
JBeltran
17-Jun-05

Node		Land Use Area (AC)																									
Upstream Node	Downstream Node	RD-6	ESD's	RD-7	ESD's	RD-8	ESD's	RD-9	ESD's	RD-10	ESD's	RD-12	ESD's	RD-22	ESD's	RD-30	ESD's	School	ESD's	Commercial	ESD's	WQP	ESD's	Park	ESD's	Offsite	ESD
60	50									7.3	73									17.2	103.2						
54	53					19.5	156					1.5	18														
53	52					14.9	119.2					1.4	16.8											4.1	24.6		
52	51											10.7	128.4														
51	50											6.8	81.6							11.8	70.8						
50	5					10.1	80.8	6.5	58.5	4.8	48																
41	40									5.4	54													17	102		
40	1									10.5	105																
32	31			3.1	21.7													11.3	80.6					11.3	67.8		
31	30			8.1	56.7					1.1	11			12.7	279.4												
30	3			3.7	25.9					2.1	21			11	242												
24	23	17.5	105	18.3	128.1					8.5	85																
23	20															10.8	318										
22	21	28.9	173.4																					3.5	21		
21	20	8.2	49.2	1.6	11.2																						
20	5																										
11	8	20.1	120.6			3.5	28					1	12											8.2	49.2		
10	8	5.8	34.8							12.2	122																
9	8	62	372																					6.9	41.4		
8	7	1.9	11.4			4.3	34.4																	4.1	24.6		
7	6	5.6	33.6																					0.6	3.6		
6	5	6.8	40.8			15.4	123.2	5	45			4.7	56.4											4.4	26.4		
5	4																										
4	3															5.4	162										
3	2													9.1	200.2												
2	1							1.4	12.6	3.5	35			4.4	96.8												
1	Trunk									2.7	27																
	Σ	156.8	940.8	34.8	243.6	67.7	541.6	12.9	116.1	58.1	581	26.1	313.2	37.2	818.4	16	480	11.3	80.6	29	174	0	0	80.1	360.6	0	0

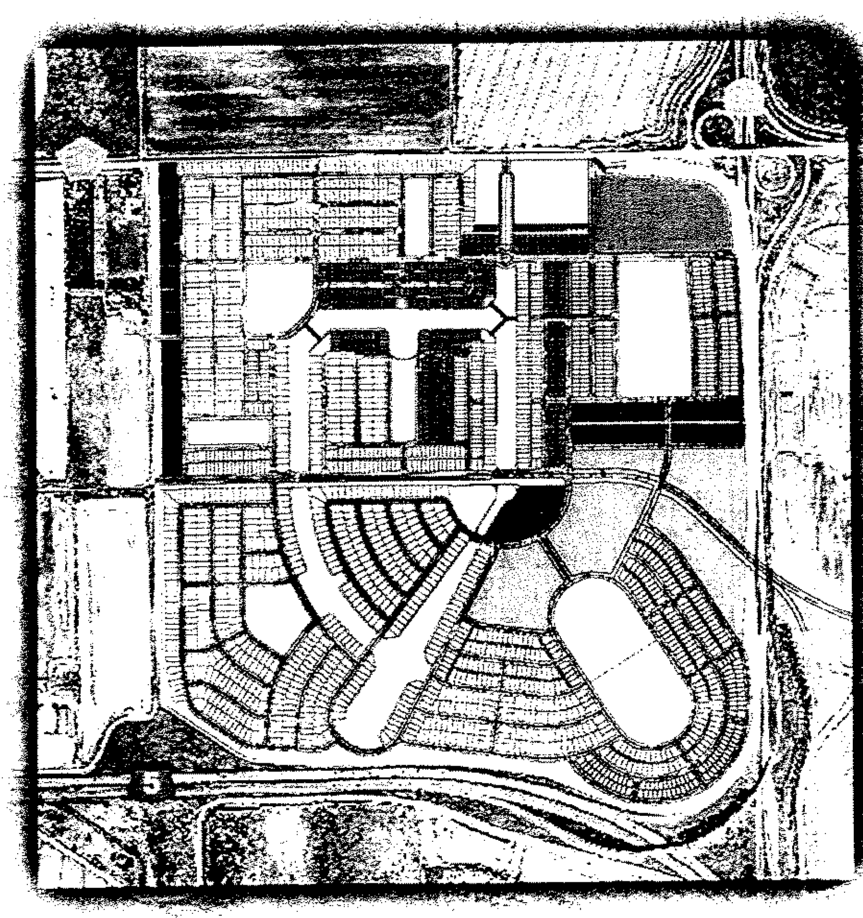
Node		Areas				Flows					Pipe Size		
Upstream Node	Downstream Node	Total Area	Total ESD	Cumulative Area	Cumulative ESD	Qavg (MGD)	QI/I (MGD)	Peaking Factor	PDWF (MGD)	PWWF (MGD)	Diameter (in)	Slope (ft/ft)	Velocity (ft/s)
60	50	24.5	176.2	24.5	176.2	0.055	0.029	1.944	0.106	0.136	8	0.0035	1.8
54	53	21	174	21	174	0.054	0.025	1.945	0.105	0.130	8	0.0035	1.8
53	52	20.4	160.6	41.4	334.6	0.104	0.050	1.893	0.196	0.246	8	0.0035	2.1
52	51	10.7	128.4	52.1	463	0.144	0.063	1.866	0.268	0.330	8	0.0035	2.2
51	50	18.6	152.4	70.7	615.4	0.191	0.085	1.843	0.352	0.436	10	0.0025	2.1
50	5	21.4	187.3	116.6	978.9	0.303	0.140	1.804	0.547	0.687	12	0.0020	2.2
41	40	22.4	156	22.4	156	0.048	0.027	1.953	0.094	0.121	8	0.0035	1.7
40	1	10.5	105	32.9	261	0.081	0.039	1.913	0.155	0.194	8	0.0035	1.9
32	31	25.7	170.1	25.7	170.1	0.053	0.031	1.946	0.103	0.133	8	0.0035	1.8
31	30	21.9	347.1	47.6	517.2	0.160	0.057	1.857	0.298	0.355	8	0.0035	2.3
30	3	16.8	288.9	64.4	806.1	0.250	0.077	1.821	0.455	0.532	10	0.0025	2.2
24	23	44.3	318.1	44.3	318.1	0.099	0.053	1.897	0.187	0.240	8	0.0035	2.1
23	20	10.6	318	54.9	636.1	0.197	0.066	1.840	0.363	0.429	10	0.0025	2.1
22	21	32.4	194.4	32.4	194.4	0.060	0.039	1.936	0.117	0.156	8	0.0035	1.8
21	20	9.8	60.4	42.2	254.8	0.079	0.051	1.915	0.151	0.202	8	0.0035	2.0
20	5	0	0	97.1	890.9	0.276	0.117	1.812	0.500	0.617	12	0.0020	2.1
11	8	32.8	209.8	32.8	209.8	0.065	0.039	1.930	0.126	0.165	8	0.0035	1.9
10	8	18	156.8	18	156.8	0.049	0.022	1.953	0.095	0.117	8	0.0035	1.7
9	8	68.9	413.4	68.9	413.4	0.126	0.083	1.876	0.240	0.323	8	0.0035	2.2
8	7	10.3	70.4	130	850.4	0.264	0.156	1.816	0.479	0.635	12	0.0020	2.1
7	6	6.2	37.2	136.2	887.6	0.275	0.163	1.812	0.499	0.662	12	0.0020	2.2
6	5	36.3	291.8	172.5	1179.4	0.366	0.207	1.788	0.654	0.861	15	0.0015	2.1
5	4	0	0	386.2	3049.2	0.945	0.463	1.705	1.612	2.075	18	0.0012	2.3
4	3	5.4	162	391.6	3211.2	0.995	0.470	1.700	1.693	2.163	18	0.0012	2.3
3	2	9.1	200.2	465.1	4217.5	1.307	0.558	1.676	2.191	2.749	21	0.0011	2.4
2	1	9.3	144.4	474.4	4361.9	1.352	0.569	1.673	2.262	2.831	21	0.0011	2.4
1	Trunk	2.7	27	510	4649.9	1.441	0.612	1.667	2.403	3.015	21	0.0011	2.5
	Σ	510	4649.9										

APPENDIX J

GREENBRIAR MASTER DRAINAGE STUDY

Preliminary

Greenbriar
Master Drainage Study



July2005

Prepared by

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EXECUTIVE SUMMARY

Greenbriar is a proposed residential development of approximately 577 acres located in the County of Sacramento, California. The project has initiated the application process into the City of Sacramento.

The purpose of this report is to present the design of required on-site and off-site drainage facilities.

The proposed development will require an on-site detention basin, outfall structure and gravity storm drain systems which will mitigate the outfall runoff to the existing RD1000 system at a peak discharge value set by RD1000 at 0.1 cfs/acre.

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LIST OF PLATES

1. INTRODUCTION

1.1 OVERVIEW

Greenbriar is a proposed mix-use development of approximately 577 acres located in the County of Sacramento, California. There are approximately an additional 50 acres of offsite freeway drainage area draining into the site under existing conditions. The site is bordered by Elkhorn Blvd. along the north boundary, the future Metro Air Park on the west boundary, Interstate-5 along the south, and Highway 99 to the east. See **FIGURES 1, 2,** and **3** for the vicinity map, site plan, and the proposed land use plan.

1.2 PURPOSE

This Drainage Study analyzes drainage systems in pre-development conditions and documents the design of the post-development onsite storm drainage system, detention basin, and outfall structure to mitigate storm runoff in post-development conditions.

1.3 PREVIOUS STUDIES

The 2002 Final Metro Air Park Master Drainage Study, prepared by Watermark Engineering, was developed to address drainage associated with the future Metro Airport Park project west of Greenbriar.

The Metro Air Park Off-Site Drainage Improvements Plans by Stantec (formerly known as The Spink Corporation) were developed to improve the drainage facilities from the proposed Metro Air Park pump station outfall to the West Drainage Canal. The data from the improved channel and Interstate 5 crossing was used to analyze the developed Greenbriar downstream condition.

1.4 EXISTING CONDITIONS

The existing site is flat and used for agriculture. The drainage on the site consists of several drainage/irrigations ditches which ultimately convey flows south. The site slopes from westward and southward. Elevations range from approximately 5 to 25 feet mean sea level (MSL).

The existing project site consists of two major watersheds. A narrow eastern shed drains into the existing Natomas Mutual channel, under Highway 99, then southward towards the West Drainage Canal. The western part of the site drains into the Lone Tree Canal, joins runoff from the southern part of the site, and flows under Interstate-5 through three existing 5-ft by 8-ft box culverts towards the West Drainage Canal. The West Drainage Canal drains south and terminates in the Natomas Main Drainage Channel, which is pumped into the Sacramento River.

1.5 FEMA INFORMATION

The most recent Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) Flood Insurance Rate Maps (FIRMs), revised July 06, 1998, shows the site in Zone X, which is designated as outside of a special flood hazard zone. The Flood Insurance Rate Map is displayed in **FIGURE 4**.

1.6 SOILS INFORMATION

Based on the Soil Survey of Sacramento County, the Greenbriar watershed consists primarily of soil classified by the Natural Resources Conservation Service (NRCS) as Hydrologic Soil Group "D". Type "D" soil generally has a high runoff rate and low infiltration rate. (See **FIGURE 5**)

1.7 PROPOSED CONDITIONS ONSITE GRADING

It is intended that the proposed development will not be required to import fill. Earthwork cut and fill volumes were balanced onsite using an Autocad Digital Terrain Model. The model included a soil shrinkage factor of 0.85 to depict the potential shrinkage when the excavated soil is spread and compacted over the site.

1.8 CRITERIA AND METHODOLOGY

1.8.a Existing Conditions

Under Existing Conditions, the 100-year and 10-year storms with 10-day and 24-hour durations were examined. These storms utilized the historic West Drain Canal 100-year 10-day stage hydrograph provided by RD1000 as the downstream boundary condition in the southerly RD1000 Canal. With the Greenbriar site's peak flow discharging into the channel much earlier than the channel's peak flow, the assumption of using the first 24 hours of the 10-day stage hydrograph as the 24-hour storm's boundary condition is conservative. Hydrographs were developed using SACCALC software as documented in the City of Sacramento Drainage Manual, Volume 2 Hydrology Standards (City of Sacramento Standards).

Hydrographs at outlets and places of interest were developed to depict the existing condition. However, no hydraulic model was developed under this condition as there are no significant drainage facilities present at the site.

1.8.b Ultimate Conditions

100-year and 10-year storm hydrographs with 10-day and 24-hour durations were developed for this study reflecting Ultimate Conditions. Hydrology was computed using SACCALC as documented in the City of Sacramento Hydrology Standards.

The 10-year storm was used to analyze the onsite pipe drainage system while the 100-year storm was used to size the detention pond and outfall structure.

To determine detention storage and system outflow, the system was analyzed using an unsteady HEC-RAS model per City of Sacramento Standards. SACCALC output hydrographs were used as input hydrographs in the HEC-RAS model. The outfall structure was modeled such that the peak outflow from the site would be lower than 0.1 cfs per acre or total of 62cfs (set forth by RD1000). The maximum pond water surface was designed to have one foot of freeboard to the top of the pond.

A preliminary on-site storm drain trunk system was designed according to City of Sacramento standards using the Sacramento method for quantifying 10-year peak runoff and hydraulic grade lines. Only major trunk systems were analyzed and those pipes were designed based on the proposed grading pad and minimum pipe velocity. For the downstream end boundary condition, the 10-year peak stage in the pond from the HEC-RAS model was used.

2. ANALYSIS AND RESULTS

2.1 ANALYSIS OF EXISTING CONDITIONS

The drainage pattern of Greenbriar and its adjacent properties are illustrated in **FIGURE 6**. Part of the existing drainage area as reported in the "Metro Air Park Master Drainage Study," 2002, prepared by Watermark Engineering, are included. Aerial photographs and topographic maps were utilized to determine the drainage trends of the project site and its surroundings. A site visit determined the approximate size of drainage features.

FIGURE 7 shows the results of the Existing Conditions analysis of the project site. The Existing Conditions SACCALC peak flow is summarized in **Table 1**.

TABLE 1. Existing Conditions 100-Year Peak Flow

Subbasin	Area (ac)	*100yr-10day Peak Flow (cfs)	*100yr-24hr Peak Flow (cfs)
East Basin – E1	448	199	307
West Basin – E2 (Different drainage system)	173	82	134
Metro Offsite – E4	735	253	327
North Offsite – E5	538	252	407
Outflow @ HWY 5 Crossing (Excludes E2)	1721	660	904

*Note that these flows do not reflect onsite and offsite storage that would likely considerably reduce peak flows.

See **APPENDIX A** for watershed flows, land use summaries, watercourse lengths, and rainfall hyetographs in the SACCALC output file.

2.1a Interstate-5 Crossing Drainage Conditions

There are three existing 5-ft by 8-ft box culverts at the I-5 crossing with inverts at approximately 5.5 ft (**REFERENCE NO. 5**). With 904 csf passing through the three existing box culverts, the headwater stage is 13.0 ft (see **APPENDIX C**) which is about a foot lower than the edge of the I-5 pavement. The adjacent low-lying area would likely provide enough storage attenuation to the high water surface and most likely lower headwater elevation.

2.1b Offsite Drainage Conditions

Runoff from the 540 ac offsite watershed north of the project site discharges into the Lone Tree Canal during storms. The drainage ditch parallels the west property boundary and drains from north to south. The ditch will remain in place under post-development conditions to convey runoff from the offsite watershed. The ditch measures approximately 12 ft wide at bottom and 6 ft deep with 1.5 horizontal to 1 vertical side slopes and 0.0007 ft/ft bottom slope (**REFERENCE NO. 5**). With a 100-year peak flow of 355 cfs in the channel, it is at capacity but not overflowing.

2.2 ANALYSIS OF ULTIMATE CONDITIONS

2.2a Ultimate Detention Basins

Under ultimate conditions, the Greenbriar watershed consists of approximately 620 acres of low, medium, and high-density residential land use, parks, commercial land use and offsite highway drainage.

FIGURE 8 shows the proposed ultimate condition drainage in the context of surrounding drainage features. **FIGURE 9** shows drainage within the project site as developed.

A hydrologic model was developed in SACCALC and its output hydrographs were entered in HEC-RAS around the detention pond.

As shown in **FIGURE 10**, the stormwater detention storage ranges from a water surface of 11.0 ft to 16.0 ft while the permanent pool ranges from a water surface of 3.0 ft to 11.0 ft. The outflow from the detention pond is constrained to 62 cfs with two eight-foot wide Rubicon gates, a 48" reinforced concrete pipe and a flap gate. During the peak stage in the pond, water will overtop the fully closed Rubicon gates. (see **APPENDIX D)**

2.2b Proposed Ultimate Peak Flows, Stages, and Volumes

Required stormwater detention storage volumes and peak stages were developed in the HEC-RAS model. Ultimate conditions runoff and storage results are summarized in **Table 2**.

TABLE 2. Pond Ultimate Condition Results

Peak Parameter Values	100-yr 10-day	100-yr 24-hr	10-yr 24-hr
1. Total Inflow to pond (cfs)	408	912	609
2. Stage (ft)	14.9	14.9	13.5
3. Storage (ac-ft)	330	330	279
4. Outflow (cfs)	62	62	61

See **APPENDIX B** for ultimate condition SACCALC and HEC-RAS input and output files.

2.2c Water Quality

Water quality treatment will be provided in the detention pond per the requirements set out in the "North Natomas Design and Procedures Manual" (**REFERENCE NO.6**). The water quality storage was sized using the Sato Design Curve for Sizing of Water Quality Wet Pond per section 11.6222b of the Sacramento County Hydrology Standards (**REFERENCE NO. 6**). Based on the 620 ac drainage area and 50% percent imperviousness, Sato volume was determined to be 25 ac-ft. The volume was then multiplied by 1.25 and rounded up for a 35 ac-ft permanent pool requirement. The proposed permanent pool depth of 8.0 ft in the detention pond yields a total wet pool volume of 198 ac-ft, which exceeds the required 35 ac-ft.

2.2d Interstate-5 Crossing Drainage Conditions

The future Metro Air Park plans to improve the Interstate 5 undercrossing by adding two- 78" reinforced concrete pipes. Upstream to downstream flowlines will be 5.6 ft to 5.5 ft, respectively. All of the HEC-RAS models presented in this report were simulated with the proposed pipes.

For the worst-case scenario, a 100-year 24-hr model was simulated without the proposed pipes to reflect that the construction of the two undercrossing pipes did not occur. Differences were only found at the immediate upstream of the crossing where the water surface was about a foot higher and flow was about ten percent more than the existing condition. These changes did not project far enough to influence the hydraulic conditions at the Greenbriar site and in the Lone Tree Channel.

TABLE 3. I-5 Crossing Analysis – Ultimate Conditions

	Proposed Crossing	**Existing Crossing**
I-5 Crossing Parameters	**2-78" RCP & 3-8'x5' Box**	**3-8'x5' Box**
Peak Flow (cfs)	376	391
Upstream Stage (ft)	8.9	9.7
Top of Bank (ft)	13	13

2.2e Offsite Drainage Conditions

Under the Ultimate Conditions, Lone Tree Channel was modeled utilizing HEC-RAS, yielding an average freeboard to top of bank of 0.5 ft during the 100-year storm. With the proposed house pad elevations at approximately 18.0 ft along the western site boundary, the freeboard below the house pads is 2.5 ft.

The proposed Metro Air Park 100-year peak pump outflow of 270 cfs was introduced into Lone Tree Channel in the HEC-RAS model during the whole storm duration. This conservative approach generates higher water surfaces than will likely occur.

3. PROPOSED ON-SITE STORM DRAINAGE PIPE SYSTEM

A preliminary design of the on-site storm drainage trunk system was developed consistent with the City of Sacramento requirements. Trunks were sized using the prorated SACCALC watershed flows and the 10-year detention pond water surface from HEC-RAS output results. The pipes were sized with approximately two feet of freeboard below the proposed grading.

See **FIGURE 9** and **APPENDIX E** for results and calculations.

4. CONCLUSION

Greenbriar can be developed under ultimate conditions with the proposed facilities outlined in this report. The proposed detention basins with permanent water quality features, outlet described and the on-site storm system will adequately convey runoff from the design storm.

The analyses of the adjacent offsite Lone Tree Channel and Interstate 5 crossing proved adequate for severe storms.

5. REFERENCES

1. Federal Emergency Management Agency, Flood Insurance Study, revised July 06, 1998 and Rate Map for West Sacramento, California, Community Panel Numbers 0602660020F, 060262004E, 0602620045E, Revised July 01, 1998.
2. Watermark Engineering, "Metro Air Park Master Drainage Study," Final 2002.
3. Aerials Express, Digital Aerial Viewer, 2003.
4. USGS Quadrangle Map.
5. Metro Air Park, Offsite Drainage Improvements, The Spin Corporation.
6. North Natomas Drainage Design & Procedures Manual, West Yost & Associates, July 1998.
7. Hydrology Standards, Vol.2 of the Sacramento City/County Drainage Manual, Dec. 1996.

FIGURE 1

VICINITY MAP

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005

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J:\Jobs\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_1-VICINITY-MAP.dwg 7/26/05 12:54pm jcornell

FIGURE 2

SITE PLAN

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005

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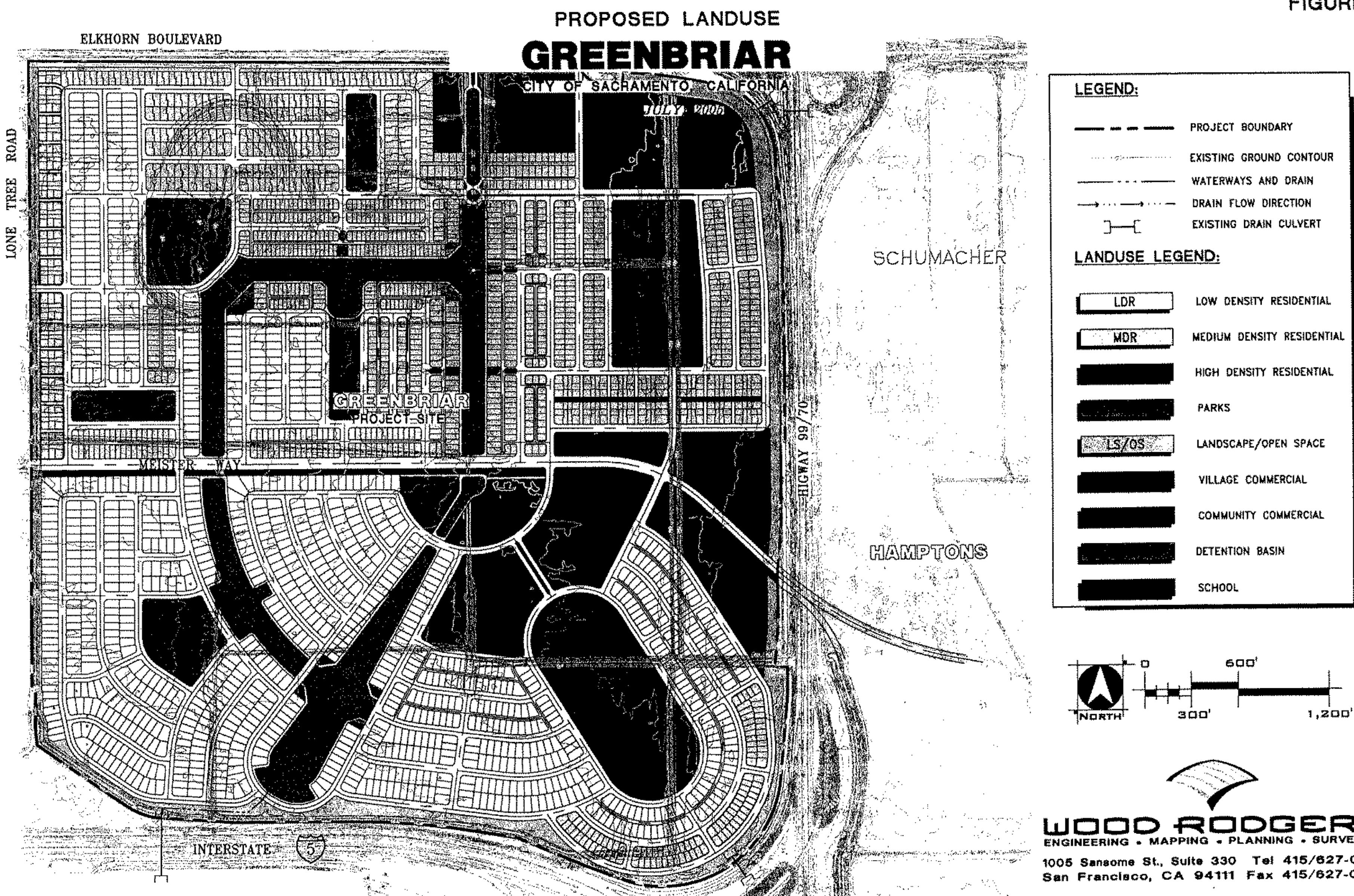
J:\Jobs\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_2-SITE-PLAN.dwg 7/26/05 12:42pm jcornell

FIGURE 3



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J:\Jobs\1116-GreenbriarForms\1116-GreenbriarForms\Civil\Exhibits\EXH-FIG_3-LANDUSE-PLAN.dwg 7/26/05 12:23pm jcornell

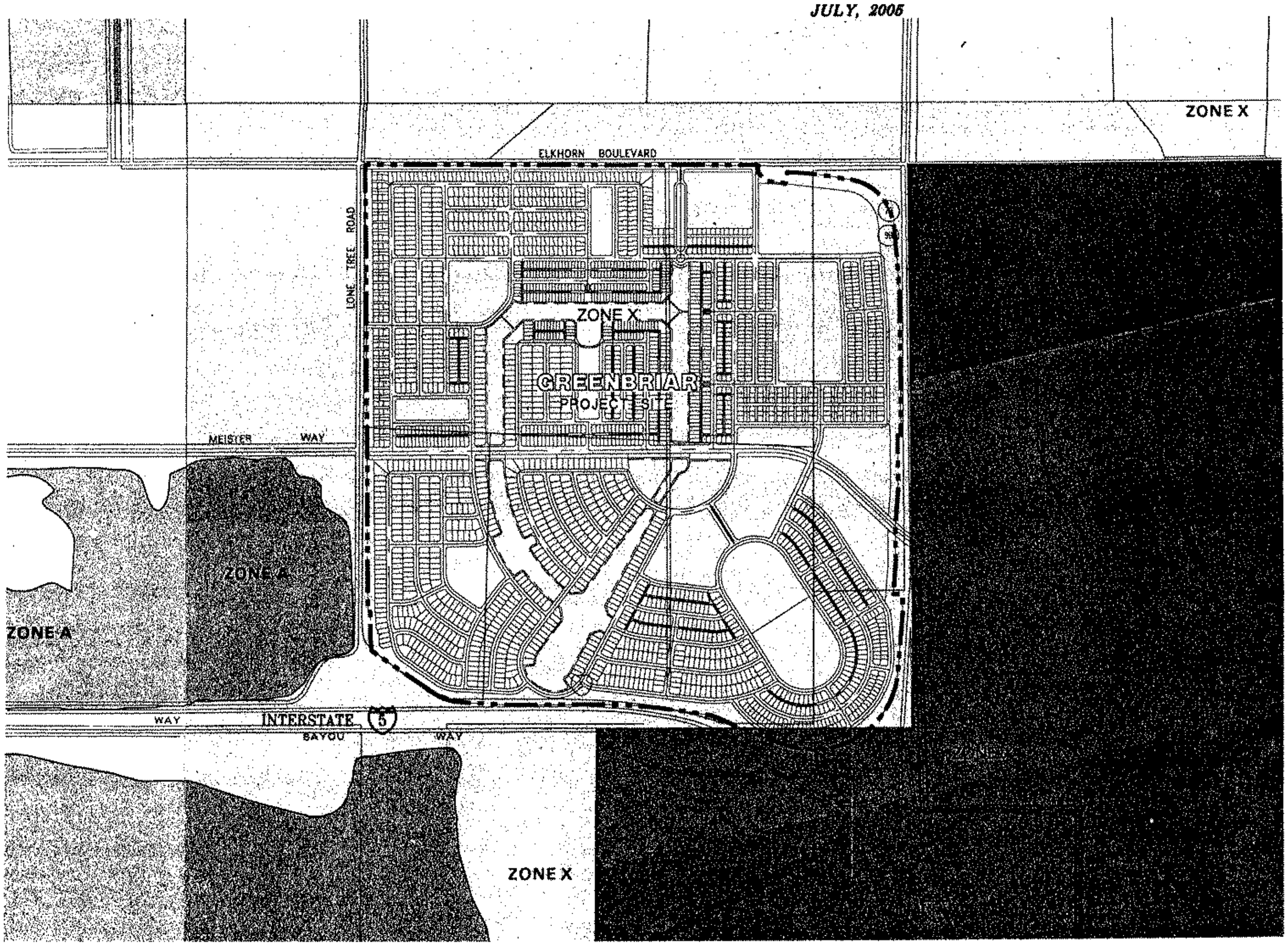
FIGURE 4

FEMA FLOODPLAIN

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005



LEGEND:

PROJECT BOUNDARY

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A	No base flood elevations determined.
ZONE AE	Base flood elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
ZONE A0	Flood depths of 1 to 3 feet,(usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding; velocities also determined.
ZONE A99	To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.
ZONE AR	Area of special flood hazard which results from the decertification of a previously accredited flood protection system which is determined to be in the process of being restored to provide a 100-year or greater level of flood protection.
ZONE V	Coastal flood with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood: areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X	Areas determined to be outside 500-year flood-plain.
ZONE D	Areas in which flood hazards are undetermined.

SOURCE:

1. FEMA FLOOD INSURANCE RATE MAP FOR WEST SACRAMENTO, CALIFORNIA, COMMUNITY PANEL NUMBER 0602660020F, 060262004E, 0602620045E, REVISED JULY 06, 1998.

NORTH

0 500' 1,000' 2,000'

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J:\Jobs\1116-GreenbriarForms\1116-GreenbriarForms\Civil\Exhibits\EXH-FIG_4-FEMA-FLOODPLAINS.dwg 7/26/05 2:39pm jcornell

HYDROLOGIC SOIL MAP

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005

LEGEND:

- PROJECT BOUNDARY
- EXITING GROUND CONTOUR
- EXISTING WATERSHED BOUNDARY
- SOIL GROUP 'D'
- SOIL GROUP 'B'
- SOIL GROUP 'C'
- ① BASIN IDENTIFIER

* SOURCES:

1. USGS QUADRANGLE MAP
2. AERIAL PHOTO: AERIALS EXPRESS PHOTO DATE: MARCH 2003
3. SOIL MAP: U.S. DEPARTMENT OF AGRICULTURE CONSERVATION SERVICE, DATED APRIL 1993

NORTH

0 2,000' 1,000' 4,000'

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FIGURE 5

J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_5-HYDROLOGIC-SOILS_GROUP.dwg 7/26/05 12:11pm jcornell

OVERALL EXISTING DRAINAGE CONDITIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005

LEGEND:

- PROJECT BOUNDARY
- WATERWAYS AND DRAIN
- DRAIN FLOW DIRECTION
- WATERSHED BOUNDARY
- EXISTING GROUND CONTOUR
- OVERLAND RELEASE PATH
- (E5) BASIN IDENTIFIER

* SOURCES:

1. USGS QUADRANGLE MAP
2. AERIALS EXPRESS PHOTO DATE: MARCH 2003

NORTH

0 1,000' 2,000' 4,000'

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FIGURE 6

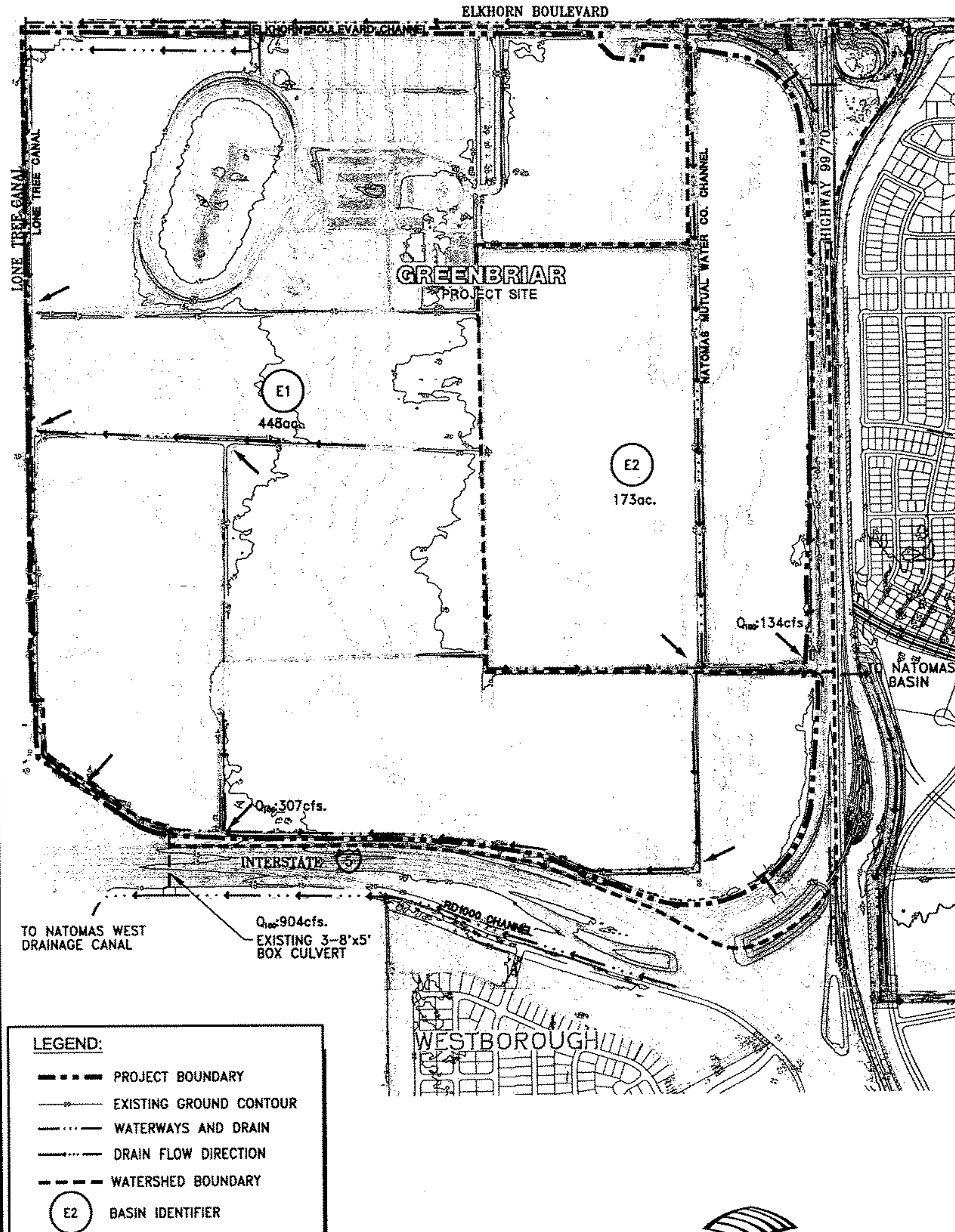
J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_6-OA-EXISTING_DRAINAGE_COND.dwg 7/26/05 1:22pm jcornell

EXISTING ONSITE DRAINAGE CONDITIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005



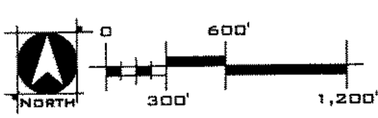


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FIGURE 7

J:\Jobs\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_7-EXIS_DRAINAGE_COND.dwg 7/26/05 12:07pm jcornell

OVERALL ULTIMATE DRAINAGE CONDITIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005

LEGEND:

- PROJECT BOUNDARY
- WATERWAYS AND DRAIN
- DRAIN FLOW DIRECTION
- EXISTING WATERWAYS W/ PROPOSED IMPROVEMENTS
- EXISTING GROUND CONTOUR
- OVERLAND RELEASE PATH
- PROPOSED DETENTION BASIN
- DEVELOPED PROPERTY
- BASIN IDENTIFIER
- PUMP STATION

* SOURCES:

1. USGS QUADRANGLE MAP
2. AERIALS EXPRESS PHOTO DATE: MARCH 2003

NORTH

0 | 1,000' | 2,000' | 4,000'

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FIGURE 8

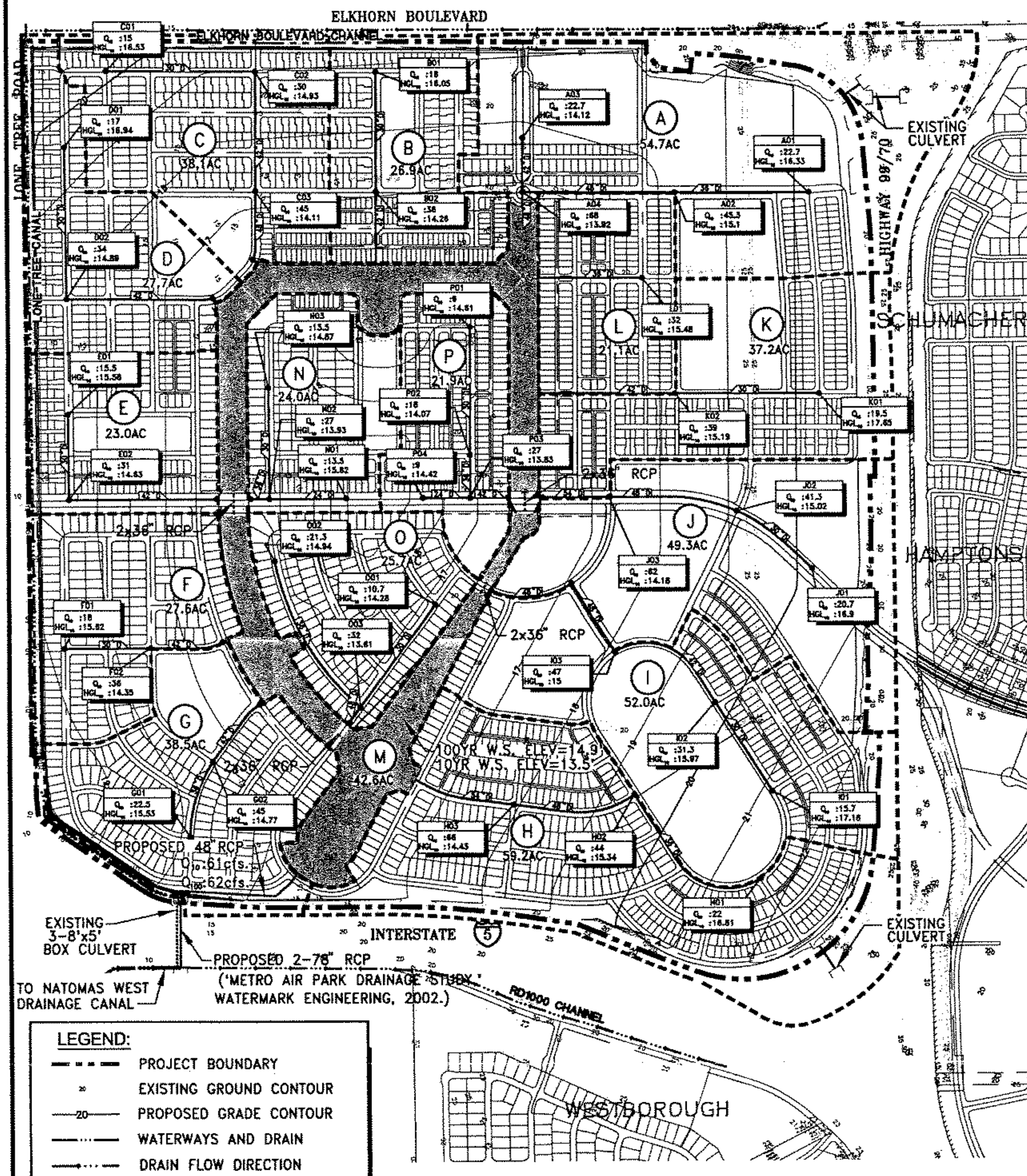
J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_8-OA_ULTIMATE_DRAINAGE_COND.dwg 7/26/05 11:45am jcornell

ULTIMATE ONSITE DRAINAGE CONDITIONS

GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA

JULY, 2005



LEGEND:

- PROJECT BOUNDARY
- EXISTING GROUND CONTOUR
- PROPOSED GRADE CONTOUR
- WATERWAYS AND DRAIN
- DRAIN FLOW DIRECTION
- EXISTING WATERWAYS W/ PROPOSED IMPROVEMENTS
- PROPOSED DRAIN PIPE
- PROPOSED ONSITE SHED
- PROPOSED DETENTION BASIN
- PROPOSED DRAIN PIPE SIZE
- (A) WATERSHED I.D.
- NODE NUMBER
- 10 yr PEAK FLOW
- 10 yr HGL ELEV

STAGE-STORAGE DATA		
ELEV. (ft)	STORAGE (ac-ft)	
3.0	0.0	
4.0	20.0	PERMANENT POOL
5.0	42.0	PERMANENT POOL
7.0	89.0	PERMANENT POOL
11.0	197.0	STORMWATER STORGAE
13.0	261.0	STORMWATER STORGAE
16.0	369.0	STORMWATER STORGAE

NORTH 0 300' 600' 1,200'

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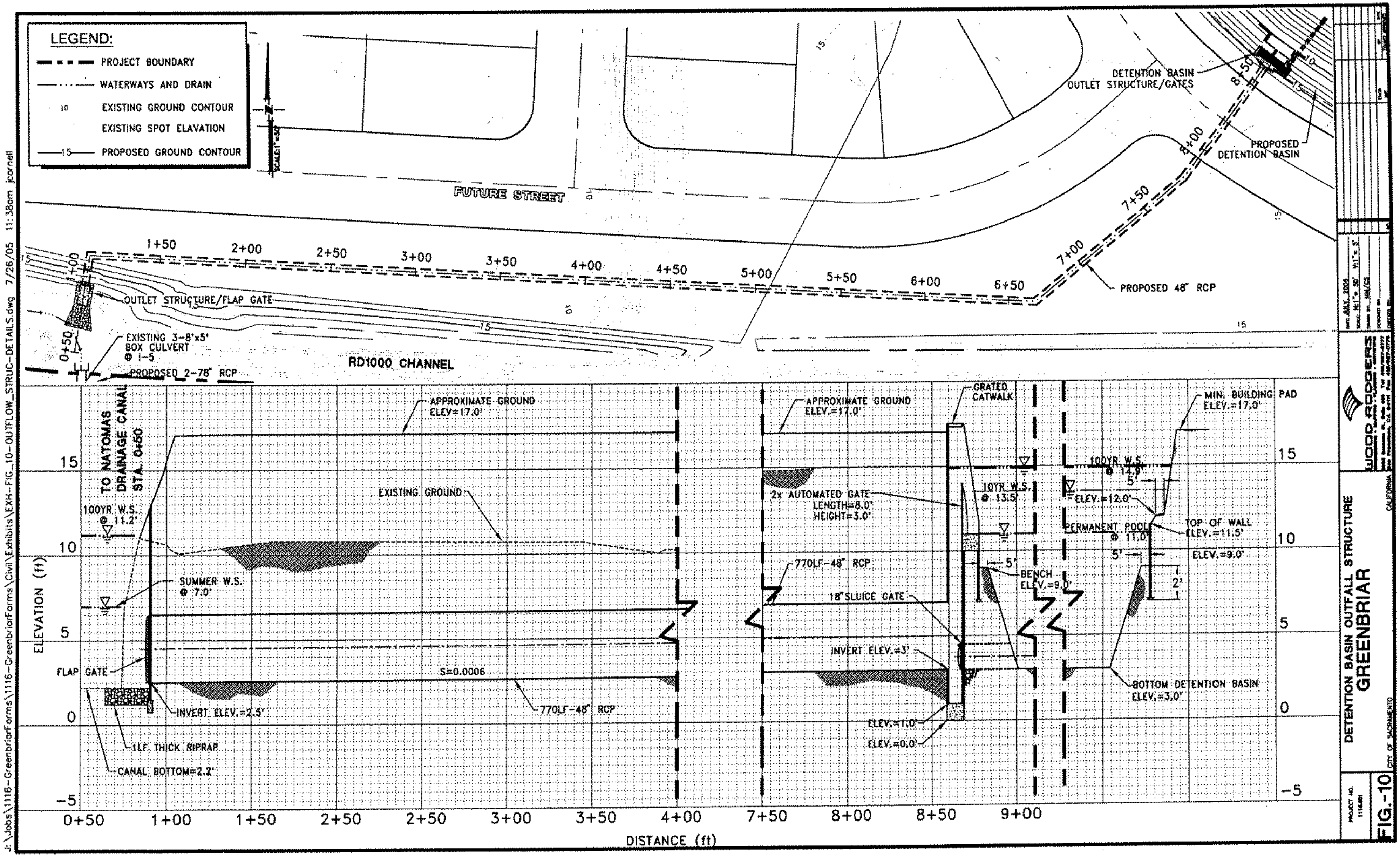
FIGURE 9

J:\Jobs\1116-GreenbriarForms\Civil\Exhibits\EXH-FIG_9-ULTIMATE_DRAINAGE_COND.dwg 7/26/05 11:42am jcornell

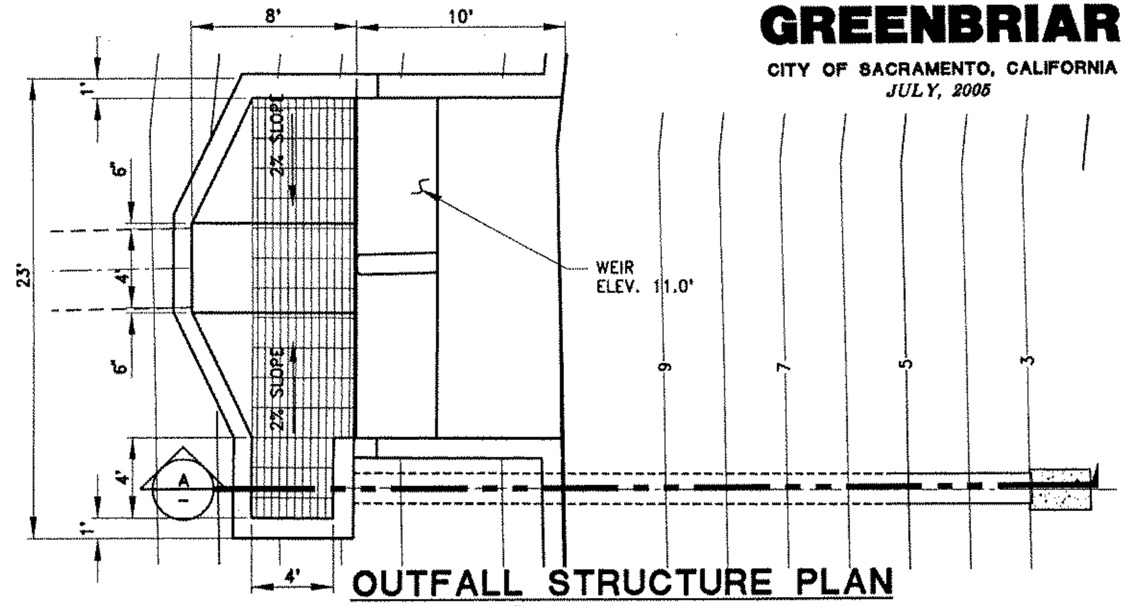


LEGEND:
PROJECT BOUNDARY
WATERWAYS AND DRAIN
EXISTING GROUND CONTOUR
EXISTING SPOT ELAVATION
PROPOSED GROUND CONTOUR
FUTURE STREET
RD1000 CHANNEL
OUTLET STRUCTURE/FLAP GATE
EXISTING 3-8'x5' BOX CULVERT @ 1-5
PROPOSED 2-78" RCP
PROPOSED 48" RCP
DETENTION BASIN OUTLET STRUCTURE/GATES
PROPOSED DETENTION BASIN
TO NATOMAS DRAINAGE CANAL STA. 0+50
100YR W.S. @ 11.2'
SUMMER W.S. @ 7.0'
FLAP GATE
1LF THICK RIPRAP
CANAL BOTTOM=2.2'
INVERT ELEV.=2.5'
APPROXIMATE GROUND ELEV=17.0'
EXISTING GROUND
S=0.0006
770LF-48" RCP
2x AUTOMATED GATE LENGTH=8.0' HEIGHT=3.0'
18" SLUICE GATE
INVERT ELEV.=3'
ELEV.=1.0'
ELEV.=0.0'
GRATED CATWALK
10YR W.S. @ 13.5'
BENCH ELEV.=9.0'
100YR W.S. @ 14.5'
ELEV.=12.0'
PERMANENT POOL @ 11.0'
TOP OF WALL ELEV.=11.5'
ELEV.=9.0'
MIN. BUILDING PAD ELEV.=17.0'
BOTTOM DETENTION BASIN ELEV.=3.0'
ELEVATION (ft)
DISTANCE (ft)
DETENTION BASIN OUTFALL STRUCTURE
GREENBRIAR
CITY OF SACRAMENTO
CALIFORNIA
WOOD RODGERS
FIG.-10
J:\Jobs\1116-GreenbriarForms\1116-GreenbriarForms\Civil\Exhibits\EXH-FIG_10-OUTFLOW_STRUC-DETAILS.dwg 7/26/05 11:38am jcornell

FIGURE 11

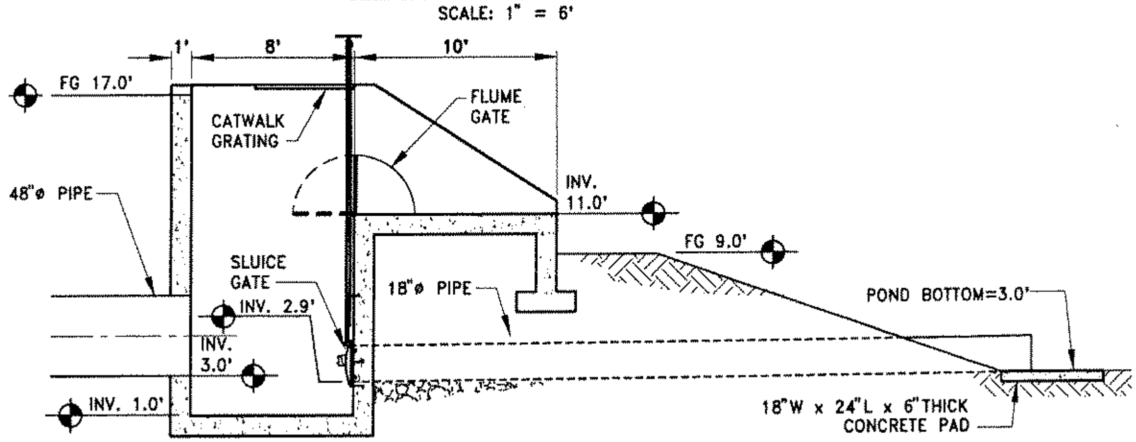
OUTFALL STRUCTURE
GREENBRIAR

CITY OF SACRAMENTO, CALIFORNIA
JULY, 2005



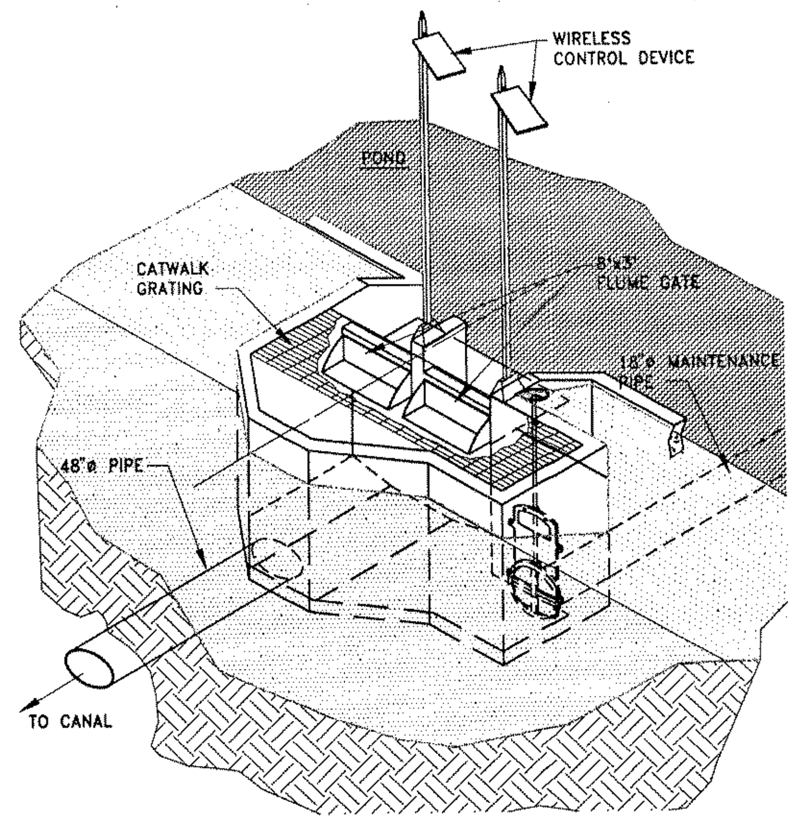
OUTFALL STRUCTURE PLAN

SCALE: 1" = 6'



OUTFALL STRUCTURE SECTION

SCALE: 1" = 6'



FLUME GATE ISOMETRIC

NOT TO SCALE

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J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Exhibits\EXH-FIG_11-FLUMEGATE-DETAILS.dwg 7/26/05 1:31pm jcornell

6. APPENDIX A –

Existing Conditions SacCalc Model

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OUTPUT FILENAME ===>J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\SACCALC\Existing\sc.hecout
DSS FILENAME ===>hcalc.dss
1*****************************************                                           ****************************************
*                                        *                                           *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)   *                                           *   U.S. ARMY CORPS OF ENGINEERS       *
*             JULY   1998                *                                           *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.1(L)               *                                           *         609 SECOND STREET            *
*                                        *                                           *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE   13JUL05  TIME  10:17:29    *                                           *         (916) 756-1104               *
*                                        *                                           *                                      *
******************************************                                           ****************************************


                              X      X  XXXXXXX   XXXXX           X   X
                              X      X  X        X     X         XX   X
                              X      X  X        X                X   X
                              XXXXXXX   XXXX     X        XXXXX   X   X
                              X      X  X        X                X   X
                              X      X  X        X     X          X   X
                              X      X  XXXXXXX   XXXXX          XXX  XXXX


        Special version of HEC-1 with Extra-large array
        Modified by David Ford Consulting Engineers (2000)
         Program dimensions:
         Number of hydrograph ordinates: 20000
         Unit hydrograph ordinates: 3000


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                              HEC-1L INPUT                                         PAGE  1

          LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                     * SacCalc, developed by David Ford Consulting Engineers
                     * File generated 07/13/2005 10:17:28
                     *
             1       ID   10010 & 1010 &10024&1024
                     * Lag computation for station E1
                     *   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
                     *   Basin "n" composition (based on Table 7-1)
                     *               Developed                    Undeveloped
                     *          n   adj n   fract            n   adj n   fract
                     *   --------------------------------------------------------
                     *      0.030  0.0300  0.0000        0.067  0.0670  0.0000
                     *      0.031  0.0310  0.0000        0.070  0.0700  0.0000
                     *      0.032  0.0320  0.0000        0.071  0.0710  0.0000
                     *      0.033  0.0330  0.0000        0.072  0.0720  0.0000
                     *      0.034  0.0340  0.0000        0.073  0.0730  0.0000
                     *      0.035  0.0350  0.0000        0.074  0.0740  0.0000
                     *      0.037  0.0370  0.0000        0.076  0.0760  0.0000
                     *      0.040  0.0400  0.0000        0.080  0.0800  0.0000
                     *      0.042  0.0420  0.0000        0.084  0.0840  0.0000
                     *      0.046  0.0460  0.0000        0.088  0.0880  0.0000
                     *      0.050  0.0500  0.0000        0.090  0.0900  0.0000
                     *      0.053  0.0530  0.0000        0.093  0.0930  0.0000
                     *      0.056  0.0560  0.0000        0.096  0.0960  0.0000
                     *      0.060  0.0600  0.0000        0.100  0.1000  0.0000
                     *      0.065  0.0650  0.0000        0.110  0.1100  0.0000
                     *      0.070  0.0700  0.5000        0.115  0.1150  0.5000
                     *      0.075  0.0750  0.0000        0.120  0.1200  0.0000
                     *      0.080  0.0800  0.0000        0.150  0.1500  0.0000
                     *   --------------------------------------------------------
                     *   Equation (7-1) with L=  1.1364, Lc=  0.5682, S=    6.864, n=0.0925
                     *   Resulting lag:   90.9 minutes
                     * Lag computation for station E2
                     *   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
                     *   Basin "n" composition (based on Table 7-1)
                     *               Developed                    Undeveloped
                     *          n   adj n   fract            n   adj n   fract
                     *   --------------------------------------------------------
                     *      0.030  0.0300  0.0000        0.067  0.0670  0.0000
                     *      0.031  0.0310  0.0000        0.070  0.0700  0.0000
                     *      0.032  0.0320  0.0000        0.071  0.0710  0.0000
                     *      0.033  0.0330  0.0000        0.072  0.0720  0.0000
                     *      0.034  0.0340  0.0000        0.073  0.0730  0.0000
```

```
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0000        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.5000        0.115  0.1150  0.5000
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.7576, Lc=  0.3822, S=    4.224, n=0.0925
*   Resulting lag:   75.6 minutes
* Lag computation for station E4
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                        Undeveloped
*          n   adj n   fract                n   adj n   fract
*   ---------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0000        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.5000        0.115  0.1150  0.5000
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  2.3674, Lc=  1.1364, S=    2.640, n=0.0925
*   Resulting lag:  170.4 minutes
* Lag computation for station E5
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                        Undeveloped
*          n   adj n   fract                n   adj n   fract
*   ---------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0000        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.5000        0.115  0.1150  0.5000
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.9470, Lc=  0.3788, S=    5.280, n=0.0925
*   Resulting lag:   78.2 minutes
* End of lag computations
*
*   NMIN  JXDATE  JXTIME        NQ
```

```
1                                                      HEC-1L INPUT                                             PAGE  2

LINE          ID.......1.......2.......3.......4.......5........6.......7.......8.......9......10

  2           IT       1 31DEC99    2400    15592
              *   IPRT    IPLT
  3           IO       3       0
              *

  4           KK  E2
              *  JXMIN    Time interval for input data
  5           IN      60
  6           KM
              *
              * Design storm construction details
              *
              * Regional multiplier (zone 2) applied:  1.000
              * Areal adjustment using area:  2.959
              *   multiplier from table 4-4: 0.9808
              *
              * Adjusted depths for each duration from table 4-1: frequency:  10
              * Duration----Regional------Elev-----Areal (adjustments)
```

```
             * 5 min          0.2500    0.2500    0.2452
             * 10 min         0.3600    0.3600    0.3531
             * 15 min         0.4300    0.4300    0.4217
             * 30 min         0.5700    0.5700    0.5591
             * 1 hour         0.7700    0.7700    0.7552
             * 2 hours        1.0400    1.0400    1.0196
             * 3 hours        1.2300    1.2300    1.2177
             * 6 hours        1.6500    1.6500    1.6335
             * 12 hours       2.2500    2.2500    2.2284
             * 24 hours       2.9800    2.9800    2.9800
             * 36 hours       3.5400    3.5400    3.5046
             * 2 days         3.9500    3.9500    3.9500
             * 3 days         4.6500    4.6500    4.6500
             * 5 days         5.7600    5.7600    5.7024
             * 10 days        7.5400    7.5400    7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
   7         PB       0
   8         PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
   9         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  10         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  11         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
  12         PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
  13         PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  14         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  15         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  16         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  17         PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
  18         PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
  19         PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
  20         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
  21         PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
  22         PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
  23         PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
  24         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  25         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  26         PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
1                                          HEC-1L INPUT                                           PAGE  3

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

  27         PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
  28         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  29         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  30         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
  31         PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
  32         BA  0.2703
             *  STRTL   CNSTL   RTIMP
  33         LU    0.20   0.070   2.000
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  75.6 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 76.07659
             *   Volume of runoff (Step 4) V=     7.268403
  34         UI    0.96    1.93    2.89    3.94    5.33    6.71    8.10    9.51   10.96   12.40
  35         UI   13.85   15.38   16.96   18.54   20.12   21.40   22.59   23.78   24.97   27.12
  36         UI   29.29   31.46   33.55   35.29   37.02   38.75   40.64   42.80   44.95   47.11
  37         UI   49.32   51.56   53.81   56.05   58.48   60.97   63.46   65.94   68.46   70.97
  38         UI   73.49   76.08   79.08   82.08   85.08   88.16   91.39   94.61   97.84  100.90
  39         UI  103.84  106.78  109.72  110.99  111.70  112.41  113.12  113.53  113.92  114.31
  40         UI  114.59  114.20  113.81  113.42  112.92  112.21  111.50  110.80  109.22  106.89
  41         UI  104.55  102.22   99.83   97.41   95.00   92.59   90.15   87.71   85.27   82.86
  42         UI   80.72   78.58   76.44   74.56   73.22   71.87   70.53   69.20   67.87   66.55
  43         UI   65.22   63.72   62.16   60.59   59.02   58.00   57.04   56.07   55.10   54.09
  44         UI   53.08   52.07   51.05   50.01   48.97   47.93   47.02   46.24   45.45   44.67
  45         UI   43.88   43.08   42.28   41.48   40.76   40.05   39.34   38.64   37.91   37.19
  46         UI   36.47   35.80   35.31   34.81   34.31   33.77   33.18   32.60   32.01   31.50
  47         UI   31.03   30.57   30.10   29.62   29.14   28.66   28.18   27.74   27.30   26.87
  48         UI   26.45   26.09   25.72   25.36   25.02   24.71   24.39   24.07   23.72   23.34
  49         UI   22.96   22.59   22.27   21.97   21.67   21.37   21.10   20.83   20.56   20.29
  50         UI   20.01   19.74   19.47   19.23   19.04   18.84   18.65   18.38   18.08   17.78
  51         UI   17.48   17.29   17.12   16.96   16.79   16.52   16.25   15.98   15.74   15.62
  52         UI   15.50   15.38   15.22   15.01   14.80   14.58   14.45   14.36   14.27   14.18
  53         UI   14.04   13.89   13.74   13.59   13.48   13.37   13.27   13.16   13.02   12.89
  54         UI   12.75   12.61   12.48   12.34   12.21   12.08   11.96   11.84   11.72   11.62
  55         UI   11.53   11.44   11.35   11.23   11.11   10.99   10.87   10.77   10.66   10.56
  56         UI   10.46   10.39   10.31   10.24   10.14   10.04    9.93    9.83    9.72    9.62
  57         UI    9.51    9.40    9.34    9.28    9.22    9.15    9.05    8.94    8.84    8.75
  58         UI    8.69    8.63    8.57    8.48    8.38    8.27    8.17    8.11    8.06    8.02
  59         UI    7.97    7.87    7.76    7.66    7.56    7.50    7.44    7.38    7.31    7.24
  60         UI    7.16    7.09    7.03    7.00    6.97    6.94    6.87    6.78    6.69    6.60
  61         UI    6.54    6.48    6.42    6.36    6.30    6.23    6.17    6.11    6.05    5.99
  62         UI    5.93    5.88    5.84    5.79    5.75    5.70    5.65    5.61    5.56    5.51
  63         UI    5.45    5.39    5.33    5.28    5.24    5.19    5.15    5.10    5.06    5.01
  64         UI    4.96    4.92    4.87    4.83    4.78    4.74    4.69    4.65    4.60    4.56
  65         UI    4.51    4.47    4.42    4.38    4.33    4.29    4.26    4.23    4.20    4.16
  66         UI    4.10    4.04    3.98    3.94    3.90    3.87    3.84    3.80    3.76    3.71
  67         UI    3.67    3.64    3.61    3.58    3.55    3.52    3.49    3.46    3.43    3.40
  68         UI    3.37    3.34    3.31    3.27    3.24    3.21    3.18    3.15    3.12    3.09
```

```
 69          UI    3.06    3.03    3.00    2.97    2.94    2.91    2.88    2.86    2.84    2.83
1                                          HEC-1L INPUT                                                PAGE 4

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 70          UI    2.81    2.80    2.78    2.77    2.75    2.73    2.70    2.67    2.64    2.62
 71          UI    2.61    2.59    2.57    2.54    2.51    2.48    2.45    2.42    2.39    2.36
 72          UI    2.34    2.33    2.31    2.30    2.28    2.27    2.25    2.24    2.21    2.18
 73          UI    2.14    2.12    2.10    2.09    2.07    2.05    2.02    1.99    1.96    1.94
 74          UI    1.92    1.91    1.89    1.88    1.86    1.85    1.83    1.82    1.80    1.79
 75          UI    1.77    1.76    1.74    1.73    1.71    1.70    1.68    1.67    1.65    1.64
 76          UI    1.62    1.61    1.59    1.58    1.56    1.55    1.53    1.52    1.50    1.49
 77          UI    1.47    1.46    1.44    1.43    1.41    1.40    1.38    1.38    1.38    1.38
 78          UI    1.38    1.36    1.35    1.33    1.32    1.30    1.29    1.27    1.26    1.24
 79          UI    1.23    1.21    1.20    1.20    1.20    1.20
 80          ZW    C=FLOW F=010YR-10DY A=GREENBRI
             *

 81          KK  E1
             *  JXMIN    Time interval for input data
 82          IN      60
 83          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  2.959
             *   multiplier from table 4-4: 0.9808
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min          0.2500    0.2500    0.2452
             * 10 min         0.3600    0.3600    0.3531
             * 15 min         0.4300    0.4300    0.4217
             * 30 min         0.5700    0.5700    0.5591
             * 1 hour         0.7700    0.7700    0.7552
             * 2 hours        1.0400    1.0400    1.0196
             * 3 hours        1.2300    1.2300    1.2177
             * 6 hours        1.6500    1.6500    1.6335
             * 12 hours       2.2500    2.2500    2.2284
             * 24 hours       2.9800    2.9800    2.9800
             * 36 hours       3.5400    3.5400    3.5046
             * 2 days         3.9500    3.9500    3.9500
             * 3 days         4.6500    4.6500    4.6500
             * 5 days         5.7600    5.7600    5.7024
             * 10 days        7.5400    7.5400    7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
 84          PB      0
 85          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
 86          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 87          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 88          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
 89          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
 90          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 91          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 92          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 93          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 94          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
 95          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
1                                          HEC-1L INPUT                                                PAGE 5

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 96          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
 97          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
 98          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
 99          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
100          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
101          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
102          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
103          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
104          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
105          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
106          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
107          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
108          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA    subbasin area (sq mi)
109          BA  0.7000
             *  STRTL   CNSTL   RTIMP
110          LU    0.20   0.070   2.000
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  90.9 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 91.39346
             *   Volume of runoff (Step 4) V=   18.822222
111          UI    1.73    3.46    5.19    6.92    8.98   11.47   13.95   16.44   18.93   21.51
112          UI   24.11   26.70   29.30   31.97   34.80   37.64   40.48   43.32   45.65   47.79
113          UI   49.93   52.06   54.47   58.36   62.25   66.15   70.04   73.48   76.59   79.70
114          UI   82.81   85.93   89.79   93.66   97.53  101.39  105.33  109.36  113.39  117.42
```

```
115     UI  121.45  125.86  130.32  134.78  139.24  143.72  148.24  152.75  157.27  161.78
116     UI  166.93  172.32  177.70  183.08  188.53  194.31  200.10  205.89  211.67  217.15
117     UI  222.43  227.70  232.97  238.15  239.42  240.69  241.96  243.23  244.24  244.95
118     UI  245.65  246.35  247.06  246.51  245.81  245.11  244.40  243.52  242.25  240.98
119     UI  239.71  238.44  234.99  230.80  226.61  222.42  218.20  213.87  209.55  205.22
120     UI  200.89  196.54  192.15  187.77  183.39  179.03  175.19  171.35  167.51  163.67
121     UI  160.50  158.10  155.69  153.28  150.88  148.49  146.11  143.73  141.36  138.83
122     UI  136.02  133.21  130.40  127.58  125.59  123.86  122.13  120.40  118.65  116.84
123     UI  115.03  113.22  111.41  109.56  107.70  105.83  103.97  102.12  100.72   99.31
124     UI   97.90   96.50   95.08   93.65   92.21   90.78   89.35   88.06   86.79   85.52
125     UI   84.25   82.97   81.67   80.37   79.07   77.78   76.79   75.90   75.01   74.11
126     UI   73.19   72.13   71.08   70.02   68.97   68.05   67.21   66.37   65.54   64.70
127     UI   63.83   62.97   62.10   61.24   60.41   59.63   58.84   58.06   57.27   56.61
128     UI   55.96   55.32   54.67   54.05   53.48   52.91   52.34   51.77   51.12   50.45
129     UI   49.77   49.09   48.45   47.91   47.37   46.82   46.28   45.78   45.29   44.80
130     UI   44.32   43.83   43.34   42.86   42.37   41.88   41.47   41.11   40.76   40.41
131     UI   40.06   39.53   38.99   38.45   37.91   37.46   37.16   36.86   36.56   36.27
132     UI   35.82   35.33   34.85   34.36   33.93   33.72   33.50   33.28   33.07   32.74
133     UI   32.37   31.99   31.61   31.25   31.09   30.92   30.76   30.60   30.38   30.11
134     UI   29.84   29.57   29.30   29.11   28.92   28.73   28.54   28.33   28.09   27.84
135     UI   27.60   27.36   27.11   26.87   26.63   26.38   26.15   25.93   25.71   25.50
136     UI   25.28   25.10   24.94   24.78   24.61   24.45   24.23   24.01   23.80   23.58
137     UI   23.38   23.19   23.00   22.81   22.62   22.48   22.35   22.21   22.08   21.92
138     UI   21.73   21.54   21.35   21.16   20.98   20.79   20.60   20.41   20.24   20.13
1                                      HEC-1L INPUT                                         PAGE  6

LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

139     UI   20.02   19.91   19.81   19.64   19.45   19.26   19.07   18.89   18.79   18.68
140     UI   18.57   18.46   18.31   18.12   17.93   17.74   17.55   17.47   17.39   17.31
141     UI   17.22   17.10   16.91   16.72   16.53   16.34   16.22   16.11   16.00   15.90
142     UI   15.78   15.65   15.51   15.38   15.24   15.16   15.11   15.05   15.00   14.93
143     UI   14.77   14.61   14.45   14.28   14.15   14.04   13.93   13.83   13.72   13.61
144     UI   13.50   13.39   13.29   13.18   13.07   12.96   12.85   12.74   12.66   12.58
145     UI   12.50   12.42   12.33   12.25   12.17   12.09   12.01   11.91   11.80   11.69
146     UI   11.59   11.48   11.40   11.32   11.24   11.16   11.08   10.99   10.91   10.83
147     UI   10.75   10.67   10.59   10.51   10.43   10.35   10.26   10.18   10.10   10.02
148     UI    9.94    9.86    9.78    9.70    9.62    9.53    9.45    9.37    9.29    9.23
149     UI    9.17    9.12    9.07    9.00    8.90    8.79    8.68    8.57    8.49    8.44
150     UI    8.39    8.33    8.28    8.20    8.12    8.04    7.95    7.88    7.83    7.78
151     UI    7.72    7.67    7.61    7.56    7.51    7.45    7.40    7.34    7.29    7.24
152     UI    7.18    7.13    7.07    7.02    6.97    6.91    6.86    6.80    6.75    6.69
153     UI    6.64    6.59    6.53    6.48    6.42    6.37    6.32    6.26    6.21    6.17
154     UI    6.14    6.11    6.09    6.06    6.03    6.00    5.98    5.95    5.91    5.86
155     UI    5.81    5.75    5.70    5.66    5.64    5.61    5.58    5.55    5.50    5.44
156     UI    5.39    5.33    5.28    5.23    5.17    5.12    5.07    5.04    5.01    4.98
157     UI    4.96    4.93    4.90    4.88    4.85    4.82    4.77    4.72    4.66    4.61
158     UI    4.56    4.54    4.51    4.48    4.46    4.41    4.35    4.30    4.25    4.20
159     UI    4.17    4.14    4.12    4.09    4.06    4.03    4.01    3.98    3.95    3.93
160     UI    3.90    3.87    3.84    3.82    3.79    3.76    3.74    3.71    3.68    3.66
161     UI    3.63    3.60    3.57    3.55    3.52    3.49    3.47    3.44    3.41    3.39
162     UI    3.36    3.33    3.30    3.28    3.25    3.22    3.20    3.17    3.14    3.11
163     UI    3.09    3.06    3.03    3.01    2.98    2.97    2.97    2.97    2.97    2.97
164     UI    2.94    2.91    2.89    2.86    2.83    2.81    2.78    2.75    2.72    2.70
165     UI    2.67    2.64    2.62    2.59    2.59    2.59    2.59    2.59
166     ZW    C=FLOW F=010YR-10DY A=GREENBRI
        *

167     KK  E4
        *  JXMIN    Time interval for input data
168     IN       60
169     KM    Part of future Metro Air Park
        *
        * Design storm construction details
        *
        * Regional multiplier (zone 2) applied:  1.000
        * Areal adjustment using area:  2.959
        *   multiplier from table 4-4: 0.9808
        *
        * Adjusted depths for each duration from table 4-1: frequency:  10
        * Duration----Regional------Elev-----Areal (adjustments)
        * 5 min           0.2500     0.2500     0.2452
        * 10 min          0.3600     0.3600     0.3531
        * 15 min          0.4300     0.4300     0.4217
        * 30 min          0.5700     0.5700     0.5591
        * 1 hour          0.7700     0.7700     0.7552
        * 2 hours         1.0400     1.0400     1.0196
        * 3 hours         1.2300     1.2300     1.2177
        * 6 hours         1.6500     1.6500     1.6335
        * 12 hours        2.2500     2.2500     2.2284
        * 24 hours        2.9800     2.9800     2.9800
        * 36 hours        3.5400     3.5400     3.5046
        * 2 days          3.9500     3.9500     3.9500
        * 3 days          4.6500     4.6500     4.6500
        * 5 days          5.7600     5.7600     5.7024
        * 10 days         7.5400     7.5400     7.4646
        * Storm duration:  10, length:  240 ordinates
        * Distrubution using table 4-8 of total rainfall:  7.4646
1                                      HEC-1L INPUT                                         PAGE  7

LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

170     PB        0
171     PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
172     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
173      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
174      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
175      PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
176      PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
177      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
178      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
179      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
180      PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
181      PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
182      PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
183      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
184      PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
185      PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
186      PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
187      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
188      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
189      PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
190      PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
191      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
192      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
193      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
194      PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
         *
         * Precipitation losses computation (Chapter 5)
         *   Computing RTIMP (percent impervious) from land use and table 5-2
         *   Computing CNSTL (infiltration rate) from soil type and table 5-2
         *  TAREA    subbasin area (sq mi)
195      BA  1.1484
         *  STRTL   CNSTL   RTIMP
196      LU    0.20   0.070   2.000
         *
         * Runoff hydrograph computation (Chapter 6)
         *   Using basin lag: 170.4 minutes
         *   Using unit duration (Step 2): 1. min
         *   Lag Time + Unit Duration / 2 (Step 3):170.92508
         *   Volume of runoff (Step 4) V=    30.880209
197      UI    0.81    1.62    2.44    3.25    4.06    4.87    5.68    6.49    7.47    8.63
198      UI    9.80   10.97   12.13   13.30   14.47   15.64   16.80   18.02   19.23   20.45
199      UI   21.67   22.89   24.10   25.32   26.54   27.80   29.13   30.46   31.79   33.12
200      UI   34.46   35.79   37.12   38.45   39.52   40.52   41.52   42.52   43.52   44.53
201      UI   45.53   46.53   47.75   49.58   51.41   53.23   55.06   56.89   58.71   60.54
202      UI   62.36   63.93   65.38   66.84   68.30   69.76   71.22   72.68   74.14   75.66
203      UI   77.47   79.28   81.10   82.91   84.73   86.54   88.35   90.17   92.03   93.92
204      UI   95.81   97.70   99.59  101.48  103.37  105.26  107.17  109.26  111.35  113.44
205      UI  115.54  117.63  119.72  121.81  123.91  126.01  128.13  130.25  132.37  134.49
206      UI  136.61  138.72  140.84  142.96  145.48  148.00  150.53  153.05  155.58  158.10
207      UI  160.62  163.15  165.76  168.47  171.19  173.90  176.61  179.33  182.04  184.76
208      UI  187.47  189.97  192.44  194.92  197.39  199.86  202.34  204.81  207.28  209.10
209      UI  209.69  210.29  210.88  211.48  212.08  212.67  213.27  213.86  214.25  214.58
210      UI  214.91  215.24  215.56  215.89  216.22  216.55  216.71  216.38  216.05  215.72
211      UI  215.39  215.06  214.73  214.40  214.07  213.55  212.96  212.36  211.77  211.17
212      UI  210.57  209.98  209.38  208.56  206.59  204.62  202.66  200.69  198.73  196.76
```



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LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

213      UI  194.79  192.83  190.82  188.79  186.76  184.73  182.70  180.68  178.65  176.62
214      UI  174.59  172.53  170.48  168.42  166.37  164.31  162.26  160.20  158.15  156.23
215      UI  154.43  152.62  150.82  149.02  147.22  145.42  143.62  141.82  140.68  139.55
216      UI  138.42  137.29  136.16  135.03  133.90  132.78  131.65  130.54  129.42  128.30
217      UI  127.19  126.07  124.95  123.84  122.72  121.43  120.11  118.79  117.47  116.15
218      UI  114.83  113.51  112.19  111.05  110.24  109.42  108.61  107.80  106.99  106.18
219      UI  105.36  104.55  103.71  102.86  102.01  101.16  100.31   99.46   98.61   97.76
220      UI   96.91   96.03   95.16   94.28   93.41   92.53   91.65   90.78   89.90   89.18
221      UI   88.52   87.86   87.20   86.54   85.88   85.22   84.56   83.90   83.23   82.56
222      UI   81.89   81.21   80.54   79.87   79.20   78.52   77.90   77.30   76.71   76.11
223      UI   75.51   74.92   74.32   73.73   73.13   72.52   71.91   71.30   70.69   70.09
224      UI   69.48   68.87   68.26   67.75   67.33   66.91   66.49   66.07   65.66   65.24
225      UI   64.82   64.40   63.91   63.41   62.92   62.42   61.93   61.43   60.94   60.44
226      UI   59.99   59.60   59.21   58.81   58.42   58.03   57.63   57.24   56.85   56.44
227      UI   56.04   55.63   55.23   54.82   54.41   54.01   53.60   53.21   52.84   52.47
228      UI   52.11   51.74   51.37   51.00   50.63   50.27   49.95   49.64   49.34   49.04
229      UI   48.73   48.43   48.12   47.82   47.52   47.26   46.99   46.72   46.46   46.19
230      UI   45.92   45.66   45.39   45.09   44.77   44.46   44.14   43.82   43.50   43.19
231      UI   42.87   42.56   42.31   42.06   41.80   41.55   41.29   41.04   40.79   40.53
232      UI   40.30   40.07   39.84   39.61   39.38   39.15   38.93   38.70   38.47   38.24
233      UI   38.01   37.78   37.56   37.33   37.10   36.87   36.64   36.45   36.28   36.12
234      UI   35.95   35.79   35.62   35.46   35.29   35.13   34.88   34.62   34.37   34.12
235      UI   33.86   33.61   33.35   33.10   32.89   32.76   32.62   32.48   32.34   32.20
236      UI   32.06   31.92   31.78   31.56   31.33   31.11   30.88   30.65   30.42   30.19
237      UI   29.96   29.78   29.68   29.57   29.47   29.37   29.27   29.17   29.07   28.96
238      UI   28.80   28.63   28.45   28.27   28.09   27.92   27.74   27.56   27.41   27.33
239      UI   27.25   27.18   27.10   27.03   26.95   26.87   26.80   26.69   26.56   26.43
240      UI   26.31   26.18   26.05   25.93   25.80   25.68   25.59   25.50   25.41   25.32
241      UI   25.23   25.15   25.06   24.97   24.86   24.75   24.64   24.52   24.41   24.29
242      UI   24.18   24.06   23.95   23.84   23.72   23.61   23.49   23.38   23.27   23.15
243      UI   23.04   22.93   22.83   22.73   22.63   22.52   22.42   22.32   22.22   22.12
244      UI   22.04   21.96   21.89   21.81   21.74   21.66   21.58   21.51   21.42   21.32
245      UI.  21.22   21.12   21.02   20.91   20.81   20.71   20.61   20.52   20.43   20.34
246      UI   20.25   20.16   20.08   19.99   19.90   19.82   19.75   19.69   19.63   19.56
247      UI   19.50   19.44   19.37   19.31   19.23   19.14   19.05   18.96   18.87   18.78
248      UI   18.69   18.61   18.52   18.43   18.34   18.25   18.16   18.07   17.98   17.89
249      UI   17.81   17.74   17.69   17.64   17.59   17.54   17.49   17.44   17.39   17.33
250      UI   17.24   17.15   17.07   16.98   16.89   16.80   16.71   16.62   16.56   16.50
251      UI   16.45   16.40   16.35   16.30   16.25   16.20   16.15   16.06   15.97   15.88
```

```
252        UI   15.79   15.70   15.62   15.53   15.44   15.37   15.34   15.30   15.26   15.22
253        UI   15.18   15.15   15.11   15.07   14.98   14.89   14.81   14.72   14.63   14.54
254        UI   14.45   14.36   14.29   14.24   14.19   14.14   14.09   14.03   13.98   13.93
255        UI   13.88   13.82   13.76   13.69   13.63   13.57   13.50   13.44   13.38   13.33
256        UI   13.30   13.27   13.25   13.22   13.20   13.17   13.15   13.12   13.06   12.98
257        UI   12.91   12.83   12.75   12.68   12.60   12.53   12.45   12.40   12.35   12.30
258        UI   12.25   12.20   12.15   12.10   12.05   12.00   11.95   11.90   11.85   11.80
259        UI   11.74   11.69   11.64   11.59   11.54   11.49   11.44   11.39   11.34   11.29
260        UI   11.24   11.19   11.14   11.11   11.07   11.03   10.99   10.95   10.91   10.88
261        UI   10.84   10.80   10.76   10.72   10.69   10.65   10.61   10.57   10.53   10.49
262        UI   10.44   10.39   10.34   10.29   10.24   10.19   10.13   10.08   10.05   10.01
263        UI    9.97    9.93    9.89    9.86    9.82    9.78    9.74    9.70    9.66    9.63
264        UI    9.59    9.55    9.51    9.47    9.44    9.40    9.36    9.32    9.28    9.25
265        UI    9.21    9.17    9.13    9.09    9.06    9.02    8.98    8.94    8.90    8.87
266        UI    8.83    8.79    8.75    8.71    8.68    8.64    8.60    8.56    8.52    8.49
267        UI    8.45    8.41    8.37    8.33    8.30    8.26    8.22    8.18    8.14    8.11
1                                   HEC-1L INPUT                                                    PAGE  9

LINE       ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

268        UI    8.09    8.06    8.04    8.01    7.99    7.96    7.94    7.91    7.86    7.81
269        UI    7.76    7.70    7.65    7.60    7.55    7.50    7.47    7.44    7.41    7.39
270        UI    7.36    7.34    7.31    7.29    7.26    7.22    7.19    7.15    7.11    7.07
271        UI    7.03    7.00    6.96    6.93    6.90    6.87    6.85    6.82    6.80    6.77
272        UI    6.75    6.72    6.70    6.67    6.65    6.62    6.60    6.57    6.54    6.52
273        UI    6.49    6.47    6.44    6.42    6.39    6.37    6.34    6.32    6.29    6.27
274        UI    6.24    6.22    6.19    6.16    6.14    6.11    6.09    6.06    6.04    6.01
275        UI    5.99    5.96    5.94    5.91    5.89    5.86    5.83    5.81    5.78    5.76
276        UI    5.73    5.71    5.68    5.66    5.63    5.61    5.58    5.56    5.53    5.50
277        UI    5.48    5.45    5.43    5.41    5.40    5.39    5.37    5.36    5.35    5.34
278        UI    5.32    5.31    5.30    5.28    5.27    5.26    5.25    5.23    5.22    5.21
279        UI    5.19    5.16    5.14    5.11    5.09    5.06    5.04    5.01    4.99    4.97
280        UI    4.96    4.95    4.94    4.92    4.91    4.90    4.88    4.87    4.84    4.82
281        UI    4.79    4.76    4.74    4.71    4.69    4.66    4.64    4.61    4.59    4.56
282        UI    4.54    4.51    4.49    4.46    4.44    4.43    4.41    4.40    4.39    4.38
283        UI    4.36    4.35    4.34    4.33    4.31    4.30    4.29    4.27    4.26    4.25
284        UI    4.24    4.22    4.20    4.17    4.14    4.12    4.09    4.07    4.04    4.02
285        UI    4.00    3.99    3.98    3.96    3.95    3.94    3.93    3.91    3.90    3.87
286        UI    3.85    3.82    3.80    3.77    3.75    3.72    3.69    3.68    3.66    3.65
287        UI    3.64    3.63    3.61    3.60    3.59    3.58    3.56    3.55    3.54    3.53
288        UI    3.51    3.50    3.49    3.47    3.46    3.45    3.44    3.42    3.41    3.40
289        UI    3.39    3.37    3.36    3.35    3.33    3.32    3.31    3.30    3.28    3.27
290        UI    3.26    3.25    3.23    3.22    3.21    3.20    3.18    3.17    3.16    3.14
291        UI    3.13    3.12    3.11    3.09    3.08    3.07    3.06    3.04    3.03    3.02
292        UI    3.01    2.99    2.98    2.97    2.95    2.94    2.93    2.92    2.90    2.89
293        UI    2.88    2.87    2.85    2.84    2.83    2.81    2.80    2.79    2.78    2.76
294        UI    2.75    2.74    2.73    2.71    2.70    2.69    2.68    2.66    2.65    2.64
295        UI    2.62    2.61    2.60    2.60    2.60    2.60    2.60    2.60    2.60    2.60
296        UI    2.60    2.59    2.58    2.57    2.56    2.54    2.53    2.52    2.50    2.49
297        UI    2.48    2.47    2.45    2.44    2.43    2.42    2.40    2.39    2.38    2.37
298        UI    2.35    2.34    2.33    2.31    2.30    2.29    2.28    2.28    2.28    2.28
299        UI    2.28    2.28    2.28    2.28    2.28
300        ZW   C=FLOW F=010YR-10DY A=GREENBRI
           *

301        KK   E5
           *  JXMIN   Time interval for input data
302        IN      60
303        KM   E5
           *
           * Design storm construction details
           *
           * Regional multiplier (zone 2) applied:  1.000
           * Areal adjustment using area:  2.959
           *   multiplier from table 4-4: 0.9808
           *
           * Adjusted depths for each duration from table 4-1: frequency:  10
           * Duration----Regional------Elev-----Areal (adjustments)
           * 5 min          0.2500     0.2500     0.2452
           * 10 min         0.3600     0.3600     0.3531
           * 15 min         0.4300     0.4300     0.4217
           * 30 min         0.5700     0.5700     0.5591
           * 1 hour         0.7700     0.7700     0.7552
           * 2 hours        1.0400     1.0400     1.0196
           * 3 hours        1.2300     1.2300     1.2177
           * 6 hours        1.6500     1.6500     1.6335
           * 12 hours       2.2500     2.2500     2.2284
           * 24 hours       2.9800     2.9800     2.9800
           * 36 hours       3.5400     3.5400     3.5046
           * 2 days         3.9500     3.9500     3.9500
           * 3 days         4.6500     4.6500     4.6500
           * 5 days         5.7600     5.7600     5.7024
           * 10 days        7.5400     7.5400     7.4646
           * Storm duration:  10, length:  240 ordinates
           * Distrubution using table 4-8 of total rainfall:  7.4646
1                                   HEC-1L INPUT                                                    PAGE 10

LINE       ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

304        PB       0
305        PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
306        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
307        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
308        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
309        PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
```

```
310      PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
311      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
312      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
313      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
314      PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
315      PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
316      PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
317      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
318      PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
319      PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
320      PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
321      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
322      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
323      PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
324      PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
325      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
326      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
327      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
328      PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
         *
         * Precipitation losses computation (Chapter 5)
         *   Computing RTIMP (percent impervious) from land use and table 5-2
         *   Computing CNSTL (infiltration rate) from soil type and table 5-2
         *  TAREA   subbasin area (sq mi)
329      BA  0.8406
         *  STRTL   CNSTL   RTIMP
330      LU    0.20   0.070   2.000
         *
         * Runoff hydrograph computation (Chapter 6)
         *   Using basin lag:  78.2 minutes
         *   Using unit duration (Step 2): 1. min
         *   Lag Time + Unit Duration / 2 (Step 3): 78.67958
         *   Volume of runoff (Step 4) V=   22.603472
331      UI    2.80    5.61    8.41   11.30   15.33   19.36   23.39   27.45   31.65   35.86
332      UI   40.06   44.35   48.95   53.55   58.15   62.45   65.91   69.37   72.83   77.24
333      UI   83.55   89.86   96.17  101.97  107.01  112.05  117.09  122.69  128.96  135.22
334      UI  141.49  147.90  154.42  160.95  167.48  174.43  181.66  188.89  196.11  203.40
335      UI  210.72  218.04  225.35  233.69  242.41  251.13  259.85  269.09  278.46  287.84
336      UI  297.22  305.88  314.42  322.97  331.51  334.06  336.12  338.18  340.24  341.39
337      UI  342.53  343.67  344.68  343.54  342.40  341.26  340.01  337.95  335.89  333.83
338      UI  330.88  324.09  317.30  310.51  303.66  296.65  289.64  282.63  275.59  268.49
339      UI  261.39  254.29  247.53  241.31  235.09  228.87  223.70  219.80  215.90  212.00
340      UI  208.12  204.27  200.41  196.55  192.29  187.73  183.17  178.62  175.20  172.40
341      UI  169.59  166.79  163.89  160.95  158.02  155.08  152.08  149.06  146.03  143.01
342      UI  140.62  138.34  136.06  133.78  131.46  129.14  126.82  124.50  122.43  120.37
343      UI  118.31  116.25  114.15  112.05  109.94  107.91  106.47  105.02  103.58  102.08
344      UI  100.37   98.67   96.96   95.33   93.98   92.62   91.26   89.89   88.48   87.08
345      UI   85.68   84.33   83.06   81.79   80.52   79.34   78.29   77.24   76.19   75.20
346      UI   74.28   73.36   72.44   71.42   70.33   69.23   68.14   67.18   66.30   65.43
1                                   HEC-1L INPUT                                          PAGE 11

LINE     ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

347      UI   64.55   63.74   62.95   62.16   61.37   60.58   59.79   59.00   58.22   57.61
348      UI   57.04   56.47   55.90   55.06   54.18   53.30   52.43   51.93   51.45   50.97
349      UI   50.48   49.69   48.90   48.11   47.37   47.02   46.66   46.31   45.92   45.31
350      UI   44.69   44.08   43.55   43.29   43.02   42.76   42.44   42.01   41.57   41.13
351      UI   40.74   40.43   40.13   39.82   39.47   39.08   38.69   38.29   37.90   37.50
352      UI   37.11   36.71   36.34   35.99   35.64   35.29   35.00   34.73   34.47   34.21
353      UI   33.89   33.53   33.18   32.83   32.52   32.21   31.90   31.60   31.36   31.14
354      UI   30.92   30.71   30.41   30.10   29.79   29.49   29.18   28.87   28.57   28.26
355      UI   28.09   27.91   27.74   27.55   27.24   26.94   26.63   26.34   26.17   25.99
356      UI   25.82   25.61   25.31   25.00   24.69   24.44   24.31   24.18   24.04   23.85
357      UI   23.54   23.24   22.93   22.68   22.50   22.33   22.15   21.96   21.74   21.52
358      UI   21.30   21.15   21.07   20.98   20.89   20.69   20.43   20.17   19.90   19.70
359      UI   19.53   19.35   19.18   19.00   18.83   18.65   18.48   18.30   18.12   17.95
360      UI   17.77   17.64   17.51   17.37   17.24   17.11   16.98   16.85   16.72   16.54
361      UI   16.37   16.19   16.02   15.89   15.76   15.63   15.49   15.36   15.23   15.10
362      UI   14.97   14.84   14.71   14.57   14.44   14.31   14.18   14.05   13.92   13.78
363      UI   13.65   13.52   13.39   13.26   13.13   13.00   12.89   12.80   12.71   12.62
364      UI   12.49   12.31   12.14   11.96   11.84   11.75   11.66   11.58   11.46   11.33
365      UI   11.20   11.07   10.97   10.88   10.79   10.70   10.62   10.53   10.44   10.35
366      UI   10.27   10.18   10.09   10.00    9.91    9.83    9.74    9.65    9.56    9.48
367      UI    9.39    9.30    9.21    9.13    9.04    8.95    8.86    8.78    8.69    8.61
368      UI    8.57    8.52    8.48    8.43    8.39    8.35    8.30    8.24    8.16    8.07
369      UI    7.98    7.91    7.87    7.82    7.78    7.72    7.63    7.54    7.45    7.36
370      UI    7.28    7.19    7.10    7.04    7.00    6.95    6.91    6.87    6.82    6.78
371      UI    6.73    6.66    6.57    6.48    6.40    6.34    6.30    6.26    6.21    6.13
372      UI    6.04    5.95    5.87    5.82    5.78    5.73    5.69    5.64    5.60    5.56
373      UI    5.51    5.47    5.43    5.38    5.34    5.29    5.25    5.21    5.16    5.12
374      UI    5.07    5.03    4.99    4.94    4.90    4.86    4.81    4.77    4.72    4.68
375      UI    4.64    4.59    4.55    4.51    4.46    4.42    4.37    4.33    4.29    4.24
376      UI    4.20    4.15    4.14    4.14    4.14    4.14    4.11    4.06    4.02    3.98
377      UI    3.93    3.89    3.85    3.80    3.76    3.71    3.67    3.63    3.62    3.62
378      UI    3.62    3.62
379      ZW   C=FLOW F=010YR-10DY A=GREENBRI
         *

380      KK  ISCROS
381      KM
382      HC       3
383      ZW   C=FLOW
384      ZZ
1*****************************************                              **************************************
 *                                       *                              *                                    *
```

```
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *
*             JULY  1998                *
*           VERSION 4.1(L)              *
*                                       *
*  RUN DATE   13JUL05  TIME  10:17:29   *
*                                       *
*****************************************
```

```
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*     DAVIS, CALIFORNIA 95616           *
*          (916) 756-1104               *
*                                       *
*****************************************
```

```
                    10010 & 1010 &10024&1024

  3 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT           HYDROGRAPH TIME DATA
                       NMIN          1  MINUTES IN COMPUTATION INTERVAL
                      IDATE    31DEC99  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ      15592  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     11JAN 0  ENDING DATE
                     NDTIME       1951  ENDING TIME
                      ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL    0.02 HOURS
                     TOTAL TIME BASE  259.85 HOURS

        ENGLISH UNITS
              DRAINAGE AREA          SQUARE MILES
              PRECIPITATION DEPTH    INCHES
              LENGTH, ELEVATION      FEET
              FLOW                   CUBIC FEET PER SECOND
              STORAGE VOLUME         ACRE-FEET
              SURFACE AREA           ACRES
              TEMPERATURE            DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  4 KK        *     E2     *
              *            *
              **************

  5 IN          TIME DATA FOR INPUT TIME SERIES
                     JXMIN          60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

             SUBBASIN RUNOFF DATA

 32 BA          SUBBASIN CHARACTERISTICS
                      TAREA,      0.27  SUBBASIN AREA

                PRECIPITATION DATA

  7 PB                STORM       7.46  BASIN TOTAL PRECIPITATION

 33 LU          UNIFORM LOSS RATE
                      STRTL       0.20  INITIAL LOSS
                      CNSTL       0.07  UNIFORM LOSS RATE
                      RTIMP       2.00  PERCENT IMPERVIOUS AREA

 32 UI          INPUT UNITGRAPH, 456 ORDINATES,  VOLUME = 1.00
```

1.0	1.9	2.9	3.9	5.3	6.7	8.1	9.5	11.0	12.4
13.9	15.4	17.0	18.5	20.1	21.4	22.6	23.8	25.0	27.1
29.3	31.5	33.5	35.3	37.0	38.8	40.6	42.8	45.0	47.1
49.3	51.6	53.8	56.0	58.5	61.0	63.5	65.9	68.5	71.0
73.5	76.1	79.1	82.1	85.1	88.2	91.4	94.6	97.8	100.9
103.8	106.8	109.7	111.0	111.7	112.4	113.1	113.5	113.9	114.3
114.6	114.2	113.8	113.4	112.9	112.2	111.5	110.8	109.2	106.9
104.6	102.2	99.8	97.4	95.0	92.6	90.2	87.7	85.3	82.9
80.7	78.6	76.4	74.6	73.2	71.9	70.5	69.2	67.9	66.6
65.2	63.7	62.2	60.6	59.0	58.0	57.0	56.1	55.1	54.1
53.1	52.1	51.0	50.0	49.0	47.9	47.0	46.2	45.5	44.7
43.9	43.1	42.3	41.5	40.8	40.0	39.3	38.6	37.9	37.2
36.5	35.8	35.3	34.8	34.3	33.8	33.2	32.6	32.0	31.5
31.0	30.6	30.1	29.6	29.1	28.7	28.2	27.7	27.3	26.9
26.5	26.1	25.7	25.4	25.0	24.7	24.4	24.1	23.7	23.3
23.0	22.6	22.3	22.0	21.7	21.4	21.1	20.8	20.6	20.3
20.0	19.7	19.5	19.2	19.0	18.8	18.6	18.4	18.1	17.8
17.5	17.3	17.1	17.0	16.8	16.5	16.3	16.0	15.7	15.6
15.5	15.4	15.2	15.0	14.8	14.6	14.4	14.4	14.3	14.2
14.0	13.9	13.7	13.6	13.5	13.4	13.3	13.2	13.0	12.9
12.8	12.6	12.5	12.3	12.2	12.1	12.0	11.8	11.7	11.6
11.5	11.4	11.4	11.2	11.1	11.0	10.9	10.8	10.7	10.6
10.5	10.4	10.3	10.2	10.1	10.0	9.9	9.8	9.7	9.6

9.5	9.4	9.3	9.3	9.2	9.1	9.1	8.9	8.8	8.8
8.7	8.6	8.6	8.5	8.4	8.3	8.2	8.1	8.1	8.0
8.0	7.9	7.8	7.7	7.6	7.5	7.4	7.4	7.3	7.2
7.2	7.1	7.0	7.0	7.0	6.9	6.9	6.8	6.7	6.6
6.5	6.5	6.4	6.4	6.3	6.2	6.2	6.1	6.1	6.0
5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.6	5.6	5.5
5.4	5.4	5.3	5.3	5.2	5.2	5.2	5.1	5.1	5.0
5.0	4.9	4.9	4.8	4.8	4.7	4.7	4.7	4.6	4.6
4.5	4.5	4.4	4.4	4.3	4.3	4.3	4.2	4.2	4.2
4.1	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.7
3.7	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4
3.4	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.1	3.1
3.1	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8
2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.6	2.6
2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.4	2.4	2.4
2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2
2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.9
1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6
1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5
1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2
1.2	1.2	1.2	1.2	1.2	1.2				

***

*** *** *** *** ***

HYDROGRAPH AT STATION E2

TOTAL RAINFALL = 7.46, TOTAL LOSS = 4.55, TOTAL EXCESS = 2.92

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	259.85-HR
+ (CFS)	(HR)					
		(CFS)				
+ 52.	153.58		28.	11.	5.	2.
		(INCHES)	0.949	1.484	1.969	2.916
		(AC-FT)	14.	21.	28.	42.

CUMULATIVE AREA = 0.27 SQ MI

*** ***

```
          **************
          *            *
 81 KK    *     E1     *
          *            *
          **************


 82 IN        TIME DATA FOR INPUT TIME SERIES
                   JXMIN          60  TIME INTERVAL IN MINUTES
                   JXDATE    31DEC99  STARTING DATE
                   JXTIME       2400  STARTING TIME

            SUBBASIN RUNOFF DATA

109 BA        SUBBASIN CHARACTERISTICS
                   TAREA,       0.70  SUBBASIN AREA

              PRECIPITATION DATA

 84 PB             STORM        7.46  BASIN TOTAL PRECIPITATION

110 LU        UNIFORM LOSS RATE
                   STRTL        0.20  INITIAL LOSS
                   CNSTL        0.07  UNIFORM LOSS RATE
                   RTIMP        2.00  PERCENT IMPERVIOUS AREA

109 UI        INPUT UNITGRAPH, 548 ORDINATES,  VOLUME = 1.00
```

1.7	3.5	5.2	6.9	9.0	11.5	13.9	16.4	18.9	21.5
24.1	26.7	29.3	32.0	34.8	37.6	40.5	43.3	45.7	47.8
49.9	52.1	54.5	58.4	62.3	66.2	70.0	73.5	76.6	79.7
82.8	85.9	89.8	93.7	97.5	101.4	105.3	109.4	113.4	117.4
121.4	125.9	130.3	134.8	139.2	143.7	148.2	152.8	157.3	161.8
166.9	172.3	177.7	183.1	188.5	194.3	200.1	205.9	211.7	217.1
222.4	227.7	233.0	238.1	239.4	240.7	242.0	243.2	244.2	244.9
245.6	246.4	247.1	246.5	245.8	245.1	244.4	243.5	242.3	241.0
239.7	238.4	235.0	230.8	226.6	222.4	218.2	213.9	209.6	205.2
200.9	196.5	192.1	187.8	183.4	179.0	175.2	171.4	167.5	163.7
160.5	158.1	155.7	153.3	150.9	148.5	146.1	143.7	141.4	138.8
136.0	133.2	130.4	127.6	125.6	123.9	122.1	120.4	118.7	116.8
115.0	113.2	111.4	109.6	107.7	105.8	104.0	102.1	100.7	99.3
97.9	96.5	95.1	93.7	92.2	90.8	89.3	88.1	86.8	85.5
84.3	83.0	81.7	80.4	79.1	77.8	76.8	75.9	75.0	74.1
73.2	72.1	71.1	70.0	69.0	68.1	67.2	66.4	65.5	64.7
63.8	63.0	62.1	61.2	60.4	59.6	58.8	58.1	57.3	56.6
56.0	55.3	54.7	54.0	53.5	52.9	52.3	51.8	51.1	50.5
49.8	49.1	48.5	47.9	47.4	46.8	46.3	45.8	45.3	44.8
44.3	43.8	43.3	42.9	42.4	41.9	41.5	41.1	40.8	40.4

40.1	39.5	39.0	38.5	37.9	37.5	37.2	36.9	36.6	36.3
35.8	35.3	34.8	34.4	33.9	33.7	33.5	33.3	33.1	32.7
32.4	32.0	31.6	31.3	31.1	30.9	30.8	30.6	30.4	30.1
29.8	29.6	29.3	29.1	28.9	28.7	28.5	28.3	28.1	27.8
27.6	27.4	27.1	26.9	26.6	26.4	26.1	25.9	25.7	25.5
25.3	25.1	24.9	24.8	24.6	24.5	24.2	24.0	23.8	23.6
23.4	23.2	23.0	22.8	22.6	22.5	22.4	22.2	22.1	21.9
21.7	21.5	21.4	21.2	21.0	20.8	20.6	20.4	20.2	20.1
20.0	19.9	19.8	19.6	19.5	19.3	19.1	18.9	18.8	18.7
18.6	18.5	18.3	18.1	17.9	17.7	17.5	17.5	17.4	17.3
17.2	17.1	16.9	16.7	16.5	16.3	16.2	16.1	16.0	15.9
15.8	15.6	15.5	15.4	15.2	15.2	15.1	15.1	15.0	14.9
14.8	14.6	14.4	14.3	14.1	14.0	13.9	13.8	13.7	13.6
13.5	13.4	13.3	13.2	13.1	13.0	12.9	12.7	12.7	12.6
12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.8	11.7
11.6	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.8
10.8	10.7	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.0
9.9	9.9	9.8	9.7	9.6	9.5	9.4	9.4	9.3	9.2
9.2	9.1	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4
8.4	8.3	8.3	8.2	8.1	8.0	7.9	7.9	7.8	7.8
7.7	7.7	7.6	7.6	7.5	7.4	7.4	7.3	7.3	7.2
7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.7
6.6	6.6	6.5	6.5	6.4	6.4	6.3	6.3	6.2	6.2
6.1	6.1	6.1	6.1	6.0	6.0	6.0	5.9	5.9	5.9
5.8	5.8	5.7	5.7	5.6	5.6	5.6	5.6	5.5	5.4
5.4	5.3	5.3	5.2	5.2	5.1	5.1	5.0	5.0	5.0
5.0	4.9	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6
4.6	4.5	4.5	4.5	4.5	4.4	4.3	4.3	4.3	4.2
4.2	4.1	4.1	4.1	4.1	4.0	4.0	4.0	4.0	3.9
3.9	3.9	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7
3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4	3.4
3.4	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.1	3.1
3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.7	2.7
2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6		

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HYDROGRAPH AT STATION E1

TOTAL RAINFALL = 7.46, TOTAL LOSS = 4.55, TOTAL EXCESS = 2.92

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	259.85-HR
+ (CFS)	(HR)					
		(CFS)				
+ 127.	153.78		70.	28.	12.	5.
		(INCHES)	0.929	1.483	1.969	2.916
		(AC-FT)	35.	55.	74.	109.

CUMULATIVE AREA = 0.70 SQ MI

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              **************
              *            *
167 KK        *     E4     *
              *            *
              **************
                    Part of future Metro Air Park

168 IN           TIME DATA FOR INPUT TIME SERIES
                      JXMIN           60  TIME INTERVAL IN MINUTES
                      JXDATE     31DEC99  STARTING DATE
                      JXTIME        2400  STARTING TIME

               SUBBASIN RUNOFF DATA

195 BA           SUBBASIN CHARACTERISTICS
                      TAREA,        1.15  SUBBASIN AREA

                 PRECIPITATION DATA

170 PB                STORM         7.46  BASIN TOTAL PRECIPITATION

196 LU           UNIFORM LOSS RATE
                      STRTL         0.20  INITIAL LOSS
                      CNSTL         0.07  UNIFORM LOSS RATE
                      RTIMP         2.00  PERCENT IMPERVIOUS AREA

195 UI           INPUT UNITGRAPH,1025 ORDINATES,   VOLUME = 1.00
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0.8	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.5	8.6
9.8	11.0	12.1	13.3	14.5	15.6	16.8	18.0	19.2	20.5
21.7	22.9	24.1	25.3	26.5	27.8	29.1	30.5	31.8	33.1
34.5	35.8	37.1	38.5	39.5	40.5	41.5	42.5	43.5	44.5
45.5	46.5	47.8	49.6	51.4	53.2	55.1	56.9	58.7	60.5
62.4	63.9	65.4	66.8	68.3	69.8	71.2	72.7	74.1	75.7
77.5	79.3	81.1	82.9	84.7	86.5	88.3	90.2	92.0	93.9

95.8	97.7	99.6	101.5	103.4	105.3	107.2	109.3	111.3	113.4
115.5	117.6	119.7	121.8	123.9	126.0	128.1	130.3	132.4	134.5
136.6	138.7	140.8	143.0	145.5	148.0	150.5	153.1	155.6	158.1
160.6	163.1	165.8	168.5	171.2	173.9	176.6	179.3	182.0	184.8
187.5	190.0	192.4	194.9	197.4	199.9	202.3	204.8	207.3	209.1
209.7	210.3	210.9	211.5	212.1	212.7	213.3	213.9	214.3	214.6
214.9	215.2	215.6	215.9	216.2	216.6	216.7	216.4	216.1	215.7
215.4	215.1	214.7	214.4	214.1	213.6	213.0	212.4	211.8	211.2
210.6	210.0	209.4	208.6	206.6	204.6	202.7	200.7	198.7	196.8
194.8	192.8	190.8	188.8	186.8	184.7	182.7	180.7	178.6	176.6
174.6	172.5	170.5	168.4	166.4	164.3	162.3	160.2	158.1	156.2
154.4	152.6	150.8	149.0	147.2	145.4	143.6	141.8	140.7	139.6
138.4	137.3	136.2	135.0	133.9	132.8	131.6	130.5	129.4	128.3
127.2	126.1	124.9	123.8	122.7	121.4	120.1	118.8	117.5	116.2
114.8	113.5	112.2	111.1	110.2	109.4	108.6	107.8	107.0	106.2
105.4	104.6	103.7	102.9	102.0	101.2	100.3	99.5	98.6	97.8
96.9	96.0	95.2	94.3	93.4	92.5	91.7	90.8	89.9	89.2
88.5	87.9	87.2	86.5	85.9	85.2	84.6	83.9	83.2	82.6
81.9	81.2	80.5	79.9	79.2	78.5	77.9	77.3	76.7	76.1
75.5	74.9	74.3	73.7	73.1	72.5	71.9	71.3	70.7	70.1
69.5	68.9	68.3	67.8	67.3	66.9	66.5	66.1	65.7	65.2
64.8	64.4	63.9	63.4	62.9	62.4	61.9	61.4	60.9	60.4
60.0	59.6	59.2	58.8	58.4	58.0	57.6	57.2	56.8	56.4
56.0	55.6	55.2	54.8	54.4	54.0	53.6	53.2	52.8	52.5
52.1	51.7	51.4	51.0	50.6	50.3	50.0	49.6	49.3	49.0
48.7	48.4	48.1	47.8	47.5	47.3	47.0	46.7	46.5	46.2
45.9	45.7	45.4	45.1	44.8	44.5	44.1	43.8	43.5	43.2
42.9	42.6	42.3	42.1	41.8	41.5	41.3	41.0	40.8	40.5
40.3	40.1	39.8	39.6	39.4	39.2	38.9	38.7	38.5	38.2
38.0	37.8	37.6	37.3	37.1	36.9	36.6	36.5	36.3	36.1
36.0	35.8	35.6	35.5	35.3	35.1	34.9	34.6	34.4	34.1
33.9	33.6	33.3	33.1	32.9	32.8	32.6	32.5	32.3	32.2
32.1	31.9	31.8	31.6	31.3	31.1	30.9	30.6	30.4	30.2
30.0	29.8	29.7	29.6	29.5	29.4	29.3	29.2	29.1	29.0
28.8	28.6	28.5	28.3	28.1	27.9	27.7	27.6	27.4	27.3
27.3	27.2	27.1	27.0	27.0	26.9	26.8	26.7	26.6	26.4
26.3	26.2	26.0	25.9	25.8	25.7	25.6	25.5	25.4	25.3
25.2	25.1	25.1	25.0	24.9	24.8	24.6	24.5	24.4	24.3
24.2	24.1	24.0	23.8	23.7	23.6	23.5	23.4	23.3	23.1
23.0	22.9	22.8	22.7	22.6	22.5	22.4	22.3	22.2	22.1
22.0	22.0	21.9	21.8	21.7	21.7	21.6	21.5	21.4	21.3
21.2	21.1	21.0	20.9	20.8	20.7	20.6	20.5	20.4	20.3
20.3	20.2	20.1	20.0	19.9	19.8	19.8	19.7	19.6	19.6
19.5	19.4	19.4	19.3	19.2	19.1	19.0	19.0	18.9	18.8
18.7	18.6	18.5	18.4	18.3	18.3	18.2	18.1	18.0	17.9
17.8	17.7	17.7	17.6	17.6	17.5	17.5	17.4	17.4	17.3
17.2	17.1	17.1	17.0	16.9	16.8	16.7	16.6	16.6	16.5
16.5	16.4	16.4	16.3	16.3	16.2	16.1	16.1	16.0	15.9
15.8	15.7	15.6	15.5	15.4	15.4	15.3	15.3	15.3	15.2
15.2	15.1	15.1	15.1	15.0	14.9	14.8	14.7	14.6	14.5
14.4	14.4	14.3	14.2	14.2	14.1	14.1	14.0	14.0	13.9
13.9	13.8	13.8	13.7	13.6	13.6	13.5	13.4	13.4	13.3
13.3	13.3	13.3	13.2	13.2	13.2	13.1	13.1	13.1	13.0
12.9	12.8	12.8	12.7	12.6	12.5	12.4	12.4	12.4	12.3
12.3	12.2	12.1	12.1	12.1	12.0	11.9	11.9	11.9	11.8
11.7	11.7	11.6	11.6	11.5	11.5	11.4	11.4	11.3	11.3
11.2	11.2	11.1	11.1	11.1	11.0	11.0	10.9	10.9	10.9
10.8	10.8	10.8	10.7	10.7	10.6	10.6	10.6	10.5	10.5
10.4	10.4	10.3	10.3	10.2	10.2	10.1	10.1	10.1	10.0
10.0	9.9	9.9	9.9	9.8	9.8	9.7	9.7	9.7	9.6
9.6	9.6	9.5	9.5	9.4	9.4	9.4	9.3	9.3	9.3
9.2	9.2	9.1	9.1	9.1	9.0	9.0	8.9	8.9	8.9
8.8	8.8	8.8	8.7	8.7	8.6	8.6	8.6	8.5	8.5
8.4	8.4	8.4	8.3	8.3	8.3	8.2	8.2	8.1	8.1
8.1	8.1	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.8
7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.4
7.4	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.1	7.1
7.0	7.0	7.0	6.9	6.9	6.9	6.8	6.8	6.8	6.8
6.8	6.7	6.7	6.7	6.7	6.6	6.6	6.6	6.5	6.5
6.5	6.5	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3
6.2	6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.0	6.0
6.0	6.0	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.8
5.7	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.5	5.5
5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.3	5.3
5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2
5.2	5.2	5.1	5.1	5.1	5.1	5.0	5.0	5.0	5.0
5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8
4.8	4.8	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.6
4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4
4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.0	4.0
4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9
3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.7
3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.5
3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4
3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3
3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1
3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0
3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9
2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6
2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4
2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3

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                2.3        2.3        2.3        2.3        2.3
                                                             ***

   ***              ***              ***              ***              ***

                    HYDROGRAPH AT STATION   E4

   TOTAL RAINFALL =    7.46, TOTAL LOSS =    4.55, TOTAL EXCESS =     2.92

 PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR    259.85-HR
+  (CFS)        (HR)
                           (CFS)
+    158.     154.75                   103.          45.         20.           8.
                         (INCHES)     0.837        1.456       1.968        2.916
                          (AC-FT)       51.          89.        121.         179.

                      CUMULATIVE AREA =    1.15 SQ MI
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               **************
               *            *
  301 KK       *    E5      *
               *            *
               **************
                          E5

  302 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN          60  TIME INTERVAL IN MINUTES
                       JXDATE    31DEC99  STARTING DATE
                       JXTIME       2400  STARTING TIME

                SUBBASIN RUNOFF DATA

  329 BA          SUBBASIN CHARACTERISTICS
                       TAREA,        0.84  SUBBASIN AREA

                  PRECIPITATION DATA

  304 PB               STORM         7.46  BASIN TOTAL PRECIPITATION


  330 LU          UNIFORM LOSS RATE
                       STRTL         0.20  INITIAL LOSS
                       CNSTL         0.07  UNIFORM LOSS RATE
                       RTIMP         2.00  PERCENT IMPERVIOUS AREA

  329 UI          INPUT UNITGRAPH, 472 ORDINATES,  VOLUME = 1.00
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2.8	5.6	8.4	11.3	15.3	19.4	23.4	27.5	31.6	35.9
40.1	44.3	49.0	53.5	58.2	62.5	65.9	69.4	72.8	77.2
83.6	89.9	96.2	102.0	107.0	112.1	117.1	122.7	129.0	135.2
141.5	147.9	154.4	160.9	167.5	174.4	181.7	188.9	196.1	203.4
210.7	218.0	225.4	233.7	242.4	251.1	259.9	269.1	278.5	287.8
297.2	305.9	314.4	323.0	331.5	334.1	336.1	338.2	340.2	341.4
342.5	343.7	344.7	343.5	342.4	341.3	340.0	338.0	335.9	333.8
330.9	324.1	317.3	310.5	303.7	296.6	289.6	282.6	275.6	268.5
261.4	254.3	247.5	241.3	235.1	228.9	223.7	219.8	215.9	212.0
208.1	204.3	200.4	196.6	192.3	187.7	183.2	178.6	175.2	172.4
169.6	166.8	163.9	160.9	158.0	155.1	152.1	149.1	146.0	143.0
140.6	138.3	136.1	133.8	131.5	129.1	126.8	124.5	122.4	120.4
118.3	116.3	114.2	112.1	109.9	107.9	106.5	105.0	103.6	102.1
100.4	98.7	97.0	95.3	94.0	92.6	91.3	89.9	88.5	87.1
85.7	84.3	83.1	81.8	80.5	79.3	78.3	77.2	76.2	75.2
74.3	73.4	72.4	71.4	70.3	69.2	68.1	67.2	66.3	65.4
64.6	63.7	63.0	62.2	61.4	60.6	59.8	59.0	58.2	57.6
57.0	56.5	55.9	55.1	54.2	53.3	52.4	51.9	51.5	51.0
50.5	49.7	48.9	48.1	47.4	47.0	46.7	46.3	45.9	45.3
44.7	44.1	43.5	43.3	43.0	42.8	42.4	42.0	41.6	41.1
40.7	40.4	40.1	39.8	39.5	39.1	38.7	38.3	37.9	37.5
37.1	36.7	36.3	36.0	35.6	35.3	35.0	34.7	34.5	34.2
33.9	33.5	33.2	32.8	32.5	32.2	31.9	31.6	31.4	31.1
30.9	30.7	30.4	30.1	29.8	29.5	29.2	28.9	28.6	28.3
28.1	27.9	27.7	27.5	27.2	26.9	26.6	26.3	26.2	26.0
25.8	25.6	25.3	25.0	24.7	24.4	24.3	24.2	24.0	23.9
23.5	23.2	22.9	22.7	22.5	22.3	22.1	22.0	21.7	21.5
21.3	21.1	21.1	21.0	20.9	20.7	20.4	20.2	19.9	19.7
19.5	19.4	19.2	19.0	18.8	18.6	18.5	18.3	18.1	18.0
17.8	17.6	17.5	17.4	17.2	17.1	17.0	16.9	16.7	16.5
16.4	16.2	16.0	15.9	15.8	15.6	15.5	15.4	15.2	15.1
15.0	14.8	14.7	14.6	14.4	14.3	14.2	14.1	13.9	13.8
13.6	13.5	13.4	13.3	13.1	13.0	12.9	12.8	12.7	12.6
12.5	12.3	12.1	12.0	11.8	11.8	11.7	11.6	11.5	11.3
11.2	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.4	10.4
10.3	10.2	10.1	10.0	9.9	9.8	9.7	9.6	9.6	9.5
9.4	9.3	9.2	9.1	9.0	8.9	8.9	8.8	8.7	8.6
8.6	8.5	8.5	8.4	8.4	8.4	8.3	8.2	8.2	8.1
8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.5	7.4	7.4
7.3	7.2	7.1	7.0	7.0	6.9	6.9	6.9	6.8	6.8
6.7	6.7	6.6	6.5	6.4	6.3	6.3	6.3	6.2	6.1

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                    6.0     5.9     5.9     5.8     5.8     5.7     5.7     5.6     5.6     5.6
                    5.5     5.5     5.4     5.4     5.3     5.3     5.3     5.2     5.2     5.1
                    5.1     5.0     5.0     4.9     4.9     4.9     4.8     4.8     4.7     4.7
                    4.6     4.6     4.6     4.5     4.5     4.4     4.4     4.3     4.3     4.2
                    4.2     4.2     4.1     4.1     4.1     4.1     4.1     4.1     4.0     4.0
                    3.9     3.9     3.8     3.8     3.8     3.7     3.7     3.6     3.6     3.6
                    3.6     3.6
                                                         ***

     ***              ***            ***            ***            ***

                       HYDROGRAPH AT STATION   E5

     TOTAL RAINFALL =    7.46, TOTAL LOSS =    4.55, TOTAL EXCESS =    2.92

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     259.85-HR
+   (CFS)        (HR)
                            (CFS)
+     161.      153.62                  85.         34.         15.          6.
                          (INCHES)    0.945       1.484       1.969       2.916
                           (AC-FT)      42.         67.         88.        131.

                         CUMULATIVE AREA =     0.84 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                **************
                *            *
  380 KK        *   I5CROS   *
                *            *
                **************

  382 HC              HYDROGRAPH COMBINATION
                           ICOMP            3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                         ***

     ***              ***            ***            ***            ***

                       HYDROGRAPH AT STATION   I5CROS

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     259.85-HR
+   (CFS)        (HR)
                            (CFS)
+     415.      153.85                 255.        106.         47.         19.
                          (INCHES)    0.883       1.466       1.968       2.916
                           (AC-FT)     127.        210.        282.        418.

                         CUMULATIVE AREA =     2.69 SQ MI

1
                                                RUNOFF SUMMARY
                                          FLOW IN CUBIC FEET PER SECOND
                                        TIME IN HOURS,  AREA IN SQUARE MILES

                                        PEAK    TIME OF       AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
              OPERATION       STATION    FLOW      PEAK                                              AREA      STAGE    MAX STAGE
+                                                            6-HOUR      24-HOUR       72-HOUR

              HYDROGRAPH AT
+                              E2          52.   153.58        28.          11.            5.       0.27

              HYDROGRAPH AT
+                              E1         127.   153.78        70.          28.           12.       0.70

              HYDROGRAPH AT
+                              E4         158.   154.75       103.          45.           20.       1.15

              HYDROGRAPH AT
+                              E5         161.   153.62        85.          34.           15.       0.84

              3 COMBINED AT
+                              I5CROS     415.   153.85       255.         106.           47.       2.69


*** NORMAL END OF HEC-1L ***
```

7. APPENDIX B –

Ultimate Conditions SacCalc Model

```
INPUT  FILENAME ====>J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\SACCALC\Developed\sc.dat
 OUTPUT FILENAME ===>J:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\SACCALC\Developed\sc.hecout
 DSS FILENAME ===>hcalc.dss
1****************************************                              ****************************************
 *                                       *                              *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                              *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JULY   1998              *                              *   HYDROLOGIC ENGINEERING CENTER      *
 *           VERSION 4.1(L)              *                              *          609 SECOND STREET           *
 *                                       *                              *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   12JUL05  TIME  19:20:27   *                              *          (916) 756-1104              *
 *                                       *                              *                                      *
 ****************************************                              ****************************************


                              X     X  XXXXXXX   XXXXX           X    X
                              X     X  X        X     X         XX    X
                              X     X  X        X                X    X
                              XXXXXXX  XXXX     X        XXXXX   X    X
                              X     X  X        X                X    X
                              X     X  X        X     X          X    X
                              X     X  XXXXXXX   XXXXX          XXX  XXXX


        Special version of HEC-1 with Extra-large array
        Modified by David Ford Consulting Engineers (2000)
         Program dimensions:
         Number of hydrograph ordinates: 20000
         Unit hydrograph ordinates: 3000


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL    LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                             HEC-1L INPUT                                          PAGE  1

         LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                   * SacCalc, developed by David Ford Consulting Engineers
                   * File generated 07/12/2005 19:20:26
                   *
           1       ID   10010 & 1010 &10024&1024
                   * Lag computation for station A
                   *   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
                   *   Basin "n" composition (based on Table 7-1)
                   *             Developed                     Undeveloped
                   *          n   adj n   fract             n   adj n   fract
                   *   ---------------------------------------------------------
                   *      0.030  0.0300  0.0000         0.067  0.0670  0.0000
                   *      0.031  0.0310  0.3757         0.070  0.0700  0.0000
                   *      0.032  0.0320  0.0000         0.071  0.0710  0.0000
                   *      0.033  0.0330  0.0000         0.072  0.0720  0.0000
                   *      0.034  0.0340  0.0000         0.073  0.0730  0.0000
                   *      0.035  0.0350  0.1751         0.074  0.0740  0.0000
                   *      0.037  0.0370  0.0000         0.076  0.0760  0.0000
                   *      0.040  0.0400  0.1337         0.080  0.0800  0.1350
                   *      0.042  0.0420  0.0000         0.084  0.0840  0.0000
                   *      0.046  0.0460  0.0000         0.088  0.0880  0.0000
                   *      0.050  0.0500  0.0000         0.090  0.0900  0.0000
                   *      0.053  0.0530  0.0000         0.093  0.0930  0.0000
                   *      0.056  0.0560  0.0000         0.096  0.0960  0.0000
                   *      0.060  0.0600  0.0000         0.100  0.1000  0.0000
                   *      0.065  0.0650  0.0414         0.110  0.1100  0.0535
                   *      0.070  0.0700  0.0856         0.115  0.1150  0.0000
                   *      0.075  0.0750  0.0000         0.120  0.1200  0.0000
                   *      0.080  0.0800  0.0000         0.150  0.1500  0.0000
                   *   ---------------------------------------------------------
                   *   Equation (7-1) with L=  0.6705, Lc=  0.2765, S=   13.200, n=0.0485
                   *   Resulting lag:   28.3 minutes
                   * Lag computation for station B
                   *   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
                   *   Basin "n" composition (based on Table 7-1)
                   *             Developed                     Undeveloped
                   *          n   adj n   fract             n   adj n   fract
                   *   ---------------------------------------------------------
                   *      0.030  0.0300  0.0000         0.067  0.0670  0.0000
                   *      0.031  0.0310  0.0000         0.070  0.0700  0.0000
                   *      0.032  0.0320  0.0000         0.071  0.0710  0.0000
                   *      0.033  0.0330  0.0000         0.072  0.0720  0.0000
                   *      0.034  0.0340  0.0000         0.073  0.0730  0.0000
```

```
*      0.035  0.0350  0.7942        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0289        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.1480        0.110  0.1100  0.0000
*      0.070  0.0700  0.0144        0.115  0.1150  0.0144
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.3504, Lc=  0.1186, S=   13.200, n=0.0412
*   Resulting lag:    14.7 minutes
* Lag computation for station C
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                      Undeveloped
*          n   adj n   fract             n   adj n   fract
*   ---------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.6675        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0914        0.080  0.0800  0.1015
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.1041        0.110  0.1100  0.0000
*      0.070  0.0700  0.0178        0.115  0.1150  0.0178
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.4485, Lc=  0.1420, S=   13.200, n=0.0452
*   Resulting lag:    18.6 minutes
* Lag computation for station D
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                      Undeveloped
*          n   adj n   fract             n   adj n   fract
*   ---------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.3054        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.4966        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.1443        0.110  0.1100  0.0000
*      0.070  0.0700  0.0201        0.115  0.1150  0.0336
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.4555, Lc=  0.1290, S=   13.200, n=0.0452
*   Resulting lag:    18.1 minutes
* Lag computation for station E
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                      Undeveloped
*          n   adj n   fract             n   adj n   fract
*   ---------------------------------------------------
*      0.030  0.0300  0.2282        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.3983        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.2075        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.1660        0.110  0.1100  0.0000
*      0.070  0.0700  0.0000        0.115  0.1150  0.0000
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ---------------------------------------------------
```

```
*   Equation (7-1) with L=  0.3797, Lc=  0.1150, S=   10.560, n=0.0399
*   Resulting lag:    15.0 minutes
* Lag computation for station F
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                     Undeveloped
*         n   adj n   fract            n   adj n   fract
*   ----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.9898        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.0051        0.115  0.1150  0.0051
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ----------------------------------------------------
*   Equation (7-1) with L=  0.3589, Lc=  0.1383, S=   10.560, n=0.0405
*   Resulting lag:    15.9 minutes
* Lag computation for station G
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                     Undeveloped
*         n   adj n   fract            n   adj n   fract
*   ----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.7583        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.1730        0.110  0.1100  0.0000
*      0.070  0.0700  0.0433        0.115  0.1150  0.0254
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ----------------------------------------------------
*   Equation (7-1) with L=  0.3930, Lc=  0.1231, S=   13.200, n=0.0475
*   Resulting lag:    17.8 minutes
* Lag computation for station H
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                     Undeveloped
*         n   adj n   fract            n   adj n   fract
*   ----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.1213        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.6798        0.080  0.0800  0.0846
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.0578        0.115  0.1150  0.0564
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   ----------------------------------------------------
*   Equation (7-1) with L=  0.6178, Lc=  0.2131, S=   10.560, n=0.0487
*   Resulting lag:    26.4 minutes
* Lag computation for station I
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                     Undeveloped
*         n   adj n   fract            n   adj n   fract
*   ----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.1959        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0591        0.074  0.0740  0.0000
```

```
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.5083        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.2089        0.110  0.1100  0.0000
*      0.070  0.0700  0.0092        0.115  0.1150  0.0185
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -----------------------------------------------------
*   Equation (7-1) with L=  0.6780, Lc=  0.3822, S=   10.560, n=0.0452
*   Resulting lag:   30.6 minutes
* Lag computation for station J
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*             Developed                      Undeveloped
*         n   adj n   fract               n   adj n   fract
*   -----------------------------------------------------
*      0.030  0.0300  0.1145        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.6964        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.1164        0.080  0.0800  0.0545
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.0091        0.115  0.1150  0.0091
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -----------------------------------------------------
*   Equation (7-1) with L=  0.5758, Lc=  0.2036, S=   10.560, n=0.0371
*   Resulting lag:   19.3 minutes
* Lag computation for station K
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*             Developed                      Undeveloped
*         n   adj n   fract               n   adj n   fract
*   -----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  0.6104        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0248        0.080  0.0800  0.0521
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.2481        0.110  0.1100  0.0000
*      0.070  0.0700  0.0397        0.115  0.1150  0.0248
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -----------------------------------------------------
*   Equation (7-1) with L=  0.4909, Lc=  0.2286, S=   10.560, n=0.0483
*   Resulting lag:   24.8 minutes
* Lag computation for station L
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*             Developed                      Undeveloped
*         n   adj n   fract               n   adj n   fract
*   -----------------------------------------------------
*      0.030  0.0300  0.0000        0.067  0.0670  0.0000
*      0.031  0.0310  0.0000        0.070  0.0700  0.0000
*      0.032  0.0320  0.0000        0.071  0.0710  0.0000
*      0.033  0.0330  0.0000        0.072  0.0720  0.0000
*      0.034  0.0340  0.0000        0.073  0.0730  0.0000
*      0.035  0.0350  1.0000        0.074  0.0740  0.0000
*      0.037  0.0370  0.0000        0.076  0.0760  0.0000
*      0.040  0.0400  0.0000        0.080  0.0800  0.0000
*      0.042  0.0420  0.0000        0.084  0.0840  0.0000
*      0.046  0.0460  0.0000        0.088  0.0880  0.0000
*      0.050  0.0500  0.0000        0.090  0.0900  0.0000
*      0.053  0.0530  0.0000        0.093  0.0930  0.0000
*      0.056  0.0560  0.0000        0.096  0.0960  0.0000
*      0.060  0.0600  0.0000        0.100  0.1000  0.0000
*      0.065  0.0650  0.0000        0.110  0.1100  0.0000
*      0.070  0.0700  0.0000        0.115  0.1150  0.0000
*      0.075  0.0750  0.0000        0.120  0.1200  0.0000
*      0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -----------------------------------------------------
*   Equation (7-1) with L=  0.2784, Lc=  0.0848, S=   10.560, n=0.0350
```

```
*   Resulting lag:   10.8 minutes
* Lag computation for station M
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                   Undeveloped
*         n   adj n   fract           n   adj n   fract
*   -------------------------------------------------------
*       0.030  0.0300  1.0000        0.067  0.0670  0.0000
*       0.031  0.0310  0.0000        0.070  0.0700  0.0000
*       0.032  0.0320  0.0000        0.071  0.0710  0.0000
*       0.033  0.0330  0.0000        0.072  0.0720  0.0000
*       0.034  0.0340  0.0000        0.073  0.0730  0.0000
*       0.035  0.0350  0.0000        0.074  0.0740  0.0000
*       0.037  0.0370  0.0000        0.076  0.0760  0.0000
*       0.040  0.0400  0.0000        0.080  0.0800  0.0000
*       0.042  0.0420  0.0000        0.084  0.0840  0.0000
*       0.046  0.0460  0.0000        0.088  0.0880  0.0000
*       0.050  0.0500  0.0000        0.090  0.0900  0.0000
*       0.053  0.0530  0.0000        0.093  0.0930  0.0000
*       0.056  0.0560  0.0000        0.096  0.0960  0.0000
*       0.060  0.0600  0.0000        0.100  0.1000  0.0000
*       0.065  0.0650  0.0000        0.110  0.1100  0.0000
*       0.070  0.0700  0.0000        0.115  0.1150  0.0000
*       0.075  0.0750  0.0000        0.120  0.1200  0.0000
*       0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -------------------------------------------------------
*   Equation (7-1) with L=  0.8854, Lc=  0.4290, S=    4.752, n=0.0300
*   Resulting lag:   26.3 minutes
* Lag computation for station N
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                   Undeveloped
*         n   adj n   fract           n   adj n   fract
*   -------------------------------------------------------
*       0.030  0.0300  0.0000        0.067  0.0670  0.0000
*       0.031  0.0310  0.0000        0.070  0.0700  0.0000
*       0.032  0.0320  0.0000        0.071  0.0710  0.0000
*       0.033  0.0330  0.0000        0.072  0.0720  0.0000
*       0.034  0.0340  0.0000        0.073  0.0730  0.0000
*       0.035  0.0350  0.2500        0.074  0.0740  0.0000
*       0.037  0.0370  0.0000        0.076  0.0760  0.0000
*       0.040  0.0400  0.4917        0.080  0.0800  0.0000
*       0.042  0.0420  0.0000        0.084  0.0840  0.0000
*       0.046  0.0460  0.0000        0.088  0.0880  0.0000
*       0.050  0.0500  0.0000        0.090  0.0900  0.0000
*       0.053  0.0530  0.0000        0.093  0.0930  0.0000
*       0.056  0.0560  0.0000        0.096  0.0960  0.0000
*       0.060  0.0600  0.0000        0.100  0.1000  0.0000
*       0.065  0.0650  0.1708        0.110  0.1100  0.0000
*       0.070  0.0700  0.0875        0.115  0.1150  0.0000
*       0.075  0.0750  0.0000        0.120  0.1200  0.0000
*       0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -------------------------------------------------------
*   Equation (7-1) with L=  0.4350, Lc=  0.1388, S=   10.560, n=0.0456
*   Resulting lag:   19.1 minutes
* Lag computation for station O
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                   Undeveloped
*         n   adj n   fract           n   adj n   fract
*   -------------------------------------------------------
*       0.030  0.0300  0.0000        0.067  0.0670  0.0000
*       0.031  0.0310  0.0000        0.070  0.0700  0.0000
*       0.032  0.0320  0.0000        0.071  0.0710  0.0000
*       0.033  0.0330  0.0000        0.072  0.0720  0.0000
*       0.034  0.0340  0.0000        0.073  0.0730  0.0000
*       0.035  0.0350  0.0000        0.074  0.0740  0.0000
*       0.037  0.0370  0.0000        0.076  0.0760  0.0000
*       0.040  0.0400  1.0000        0.080  0.0800  0.0000
*       0.042  0.0420  0.0000        0.084  0.0840  0.0000
*       0.046  0.0460  0.0000        0.088  0.0880  0.0000
*       0.050  0.0500  0.0000        0.090  0.0900  0.0000
*       0.053  0.0530  0.0000        0.093  0.0930  0.0000
*       0.056  0.0560  0.0000        0.096  0.0960  0.0000
*       0.060  0.0600  0.0000        0.100  0.1000  0.0000
*       0.065  0.0650  0.0000        0.110  0.1100  0.0000
*       0.070  0.0700  0.0000        0.115  0.1150  0.0000
*       0.075  0.0750  0.0000        0.120  0.1200  0.0000
*       0.080  0.0800  0.0000        0.150  0.1500  0.0000
*   -------------------------------------------------------
*   Equation (7-1) with L=  0.2949, Lc=  0.1515, S=   10.560, n=0.0400
*   Resulting lag:   15.2 minutes
* Lag computation for station P
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                   Undeveloped
*         n   adj n   fract           n   adj n   fract
*   -------------------------------------------------------
*       0.030  0.0300  0.0000        0.067  0.0670  0.0000
*       0.031  0.0310  0.0000        0.070  0.0700  0.0000
*       0.032  0.0320  0.0000        0.071  0.0710  0.0000
*       0.033  0.0330  0.0000        0.072  0.0720  0.0000
*       0.034  0.0340  0.0000        0.073  0.0730  0.0000
*       0.035  0.0350  0.7945        0.074  0.0740  0.0000
*       0.037  0.0370  0.0000        0.076  0.0760  0.0000
```

```
*       0.040  0.0400  0.0000         0.080  0.0800  0.0000
*       0.042  0.0420  0.0000         0.084  0.0840  0.0000
*       0.046  0.0460  0.0000         0.088  0.0880  0.0000
*       0.050  0.0500  0.0000         0.090  0.0900  0.0000
*       0.053  0.0530  0.0000         0.093  0.0930  0.0000
*       0.056  0.0560  0.0000         0.096  0.0960  0.0000
*       0.060  0.0600  0.0000         0.100  0.1000  0.0000
*       0.065  0.0650  0.1187         0.110  0.1100  0.0000
*       0.070  0.0700  0.0868         0.115  0.1150  0.0000
*       0.075  0.0750  0.0000         0.120  0.1200  0.0000
*       0.080  0.0800  0.0000         0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.3576, Lc=  0.1437, S=   10.560, n=0.0416
*   Resulting lag:   16.5 minutes
* Lag computation for station OFF-N
*   Lag frequency factor of 1.0 (Table 7-6) for frequency  10 years will be appl
*   Basin "n" composition (based on Table 7-1)
*              Developed                    Undeveloped
*          n   adj n   fract            n   adj n   fract
*   ---------------------------------------------------
*       0.030  0.0300  0.0000         0.067  0.0670  0.0000
*       0.031  0.0310  0.0000         0.070  0.0700  0.0000
*       0.032  0.0320  0.0000         0.071  0.0710  0.0000
*       0.033  0.0330  0.0000         0.072  0.0720  0.0000
*       0.034  0.0340  0.0000         0.073  0.0730  0.0000
*       0.035  0.0350  0.0000         0.074  0.0740  0.0000
*       0.037  0.0370  0.0000         0.076  0.0760  0.0000
*       0.040  0.0400  0.0000         0.080  0.0800  0.0000
*       0.042  0.0420  0.0000         0.084  0.0840  0.0000
*       0.046  0.0460  0.0000         0.088  0.0880  0.0000
*       0.050  0.0500  0.0000         0.090  0.0900  0.0000
*       0.053  0.0530  0.0000         0.093  0.0930  0.0000
*       0.056  0.0560  0.0000         0.096  0.0960  0.0000
*       0.060  0.0600  0.0000         0.100  0.1000  0.0000
*       0.065  0.0650  0.0000         0.110  0.1100  0.0000
*       0.070  0.0700  0.5000         0.115  0.1150  0.5000
*       0.075  0.0750  0.0000         0.120  0.1200  0.0000
*       0.080  0.0800  0.0000         0.150  0.1500  0.0000
*   ---------------------------------------------------
*   Equation (7-1) with L=  0.9470, Lc=  0.3788, S=    5.280, n=0.0925
*   Resulting lag:   78.2 minutes
* End of lag computations
*
*   NMIN  JXDATE  JXTIME       NQ
1                              HEC-1L INPUT                                              PAGE  2

LINE      ID.......1.......2.......3.......4.......5........6.......7.......8.......9......10

   2      IT       1 31DEC99    2400   14947
          *   IPRT    IPLT
   3      IO       3       0
          *

   4      KK  A
          *  JXMIN    Time interval for input data
   5      IN      60
   6      KM
          *
          * Design storm construction details
          *
          * Regional multiplier (zone 2) applied:  1.000
          * Areal adjustment using area:  1.813
          *   multiplier from table 4-4: 1.0000
          *
          * Adjusted depths for each duration from table 4-1: frequency:  10
          * Duration----Regional------Elev-----Areal (adjustments)
          * 5 min          0.2500     0.2500    0.2500
          * 10 min         0.3600     0.3600    0.3600
          * 15 min         0.4300     0.4300    0.4300
          * 30 min         0.5700     0.5700    0.5700
          * 1 hour         0.7700     0.7700    0.7700
          * 2 hours        1.0400     1.0400    1.0315
          * 3 hours        1.2300     1.2300    1.2200
          * 6 hours        1.6500     1.6500    1.6366
          * 12 hours       2.2500     2.2500    2.2500
          * 24 hours       2.9800     2.9800    2.9800
          * 36 hours       3.5400     3.5400    3.5046
          * 2 days         3.9500     3.9500    3.9500
          * 3 days         4.6500     4.6500    4.6500
          * 5 days         5.7600     5.7600    5.7024
          * 10 days        7.5400     7.5400    7.4646
          * Storm duration:  10, length:  240 ordinates
          * Distrubution using table 4-8 of total rainfall:  7.4646
   7      PB       0
   8      PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
   9      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  10      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  11      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
  12      PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
  13      PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  14      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  15      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  16      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  17      PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
  18      PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
```

```
19          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
20          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
21          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
22          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
23          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
24          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
25          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
26          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

27          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
28          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
29          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
30          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
31          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
            *
            * Precipitation losses computation (Chapter 5)
            *   Computing RTIMP (percent impervious) from land use and table 5-2
            *   Computing CNSTL (infiltration rate) from soil type and table 5-2
            * TAREA   subbasin area (sq mi)
32          BA  0.1169
            * STRTL   CNSTL   RTIMP
33          LU    0.20   0.061  60.151
            *
            * Runoff hydrograph computation (Chapter 6)
            *   Using basin lag:  28.3 minutes
            *   Using unit duration (Step 2): 1. min
            *   Lag Time + Unit Duration / 2 (Step 3): 28.83720
            *   Volume of runoff (Step 4) V=     3.142639
34          UI    2.90    6.51   10.71   15.06   19.69   24.18   27.76   33.67   39.74   44.96
35          UI   51.33   57.94   64.71   72.19   79.73   87.50   96.53  106.03  115.51  124.36
36          UI  127.74  129.51  130.69  129.68  128.03  125.67  118.64  111.48  104.21   96.86
37          UI   90.17   84.40   80.36   76.37   72.09   67.37   64.39   61.41   58.37   55.24
38          UI   52.59   50.23   47.82   45.62   43.48   41.30   39.71   38.10   36.33   34.92
39          UI   33.49   32.05   30.73   29.57   28.51   27.55   26.46   25.40   24.49   23.67
40          UI   22.85   22.04   21.45   20.68   19.82   19.32   18.61   17.90   17.53   16.96
41          UI   16.45   16.18   15.74   15.35   15.03   14.62   14.21   13.81   13.45   13.15
42          UI   12.85   12.49   12.17   11.88   11.65   11.34   11.03   10.72   10.53   10.27
43          UI    9.97    9.79    9.51    9.25    9.11    8.82    8.56    8.38    8.15    8.00
44          UI    7.89    7.62    7.41    7.22    7.04    6.86    6.69    6.56    6.42    6.27
45          UI    6.09    5.95    5.81    5.68    5.54    5.40    5.27    5.13    5.00    4.87
46          UI    4.78    4.61    4.47    4.38    4.24    4.13    4.04    3.95    3.86    3.77
47          UI    3.68    3.59    3.50    3.41    3.32    3.25    3.20    3.16    3.09    3.00
48          UI    2.96    2.88    2.79    2.70    2.64    2.60    2.55    2.47    2.40    2.35
49          UI    2.26    2.20    2.15    2.11    2.06    2.01    1.97    1.92    1.88    1.83
50          UI    1.79    1.74    1.70    1.65    1.61    1.57    1.57    1.54    1.49    1.44
51          UI    1.40    1.37    1.37
52          ZW    C=FLOW F=010YR-10DY A=GREENBRI
            *

53          KK  B
            * JXMIN    Time interval for input data
54          IN      60
55          KM
            *
            * Design storm construction details
            *
            * Regional multiplier (zone 2) applied:  1.000
            * Areal adjustment using area:  1.813
            *   multiplier from table 4-4: 1.0000
            *
            * Adjusted depths for each duration from table 4-1: frequency:  10
            * Duration----Regional------Elev-----Areal (adjustments)
            * 5 min           0.2500     0.2500     0.2500
            * 10 min          0.3600     0.3600     0.3600
            * 15 min          0.4300     0.4300     0.4300
            * 30 min          0.5700     0.5700     0.5700
            * 1 hour          0.7700     0.7700     0.7700
            * 2 hours         1.0400     1.0400     1.0315
            * 3 hours         1.2300     1.2300     1.2200
            * 6 hours         1.6500     1.6500     1.6366
            * 12 hours        2.2500     2.2500     2.2500
            * 24 hours        2.9800     2.9800     2.9800
            * 36 hours        3.5400     3.5400     3.5046
            * 2 days          3.9500     3.9500     3.9500
            * 3 days          4.6500     4.6500     4.6500
            * 5 days          5.7600     5.7600     5.7024
            * 10 days         7.5400     7.5400     7.4646
            * Storm duration:  10, length:  240 ordinates
            * Distrubution using table 4-8 of total rainfall:  7.4646
```



```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

56          PB       0
57          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
58          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
59          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
60          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
61          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
62          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
63          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
64          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
 65          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 66          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
 67          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
 68          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
 69          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
 70          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
 71          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
 72          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
 73          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 74          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 75          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
 76          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
 77          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 78          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 79          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
 80          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
 81          BA  0.0433
             *  STRTL   CNSTL   RTIMP
 82          LU    0.20   0.062  57.838
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  14.7 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 15.21310
             *   Volume of runoff (Step 4) V=     1.163785
 83          UI   4.266   9.933  16.116  21.721  29.648  37.728  46.837  56.841  68.140  80.809
 84          UI  89.443  91.531  90.410  85.565  76.047  66.329  58.610  53.270  47.241  43.300
 85          UI  39.201  35.757  32.628  29.766  27.467  25.216  23.323  21.504  20.029  18.681
 86          UI  17.346  16.237  15.239  14.230  13.438  12.502  11.842  11.349  10.791  10.315
 87          UI   9.772   9.304   8.893   8.449   8.119   7.696   7.383   7.004   6.705   6.417
 88          UI   6.050   5.792   5.583   5.281   5.039   4.797   4.599   4.406   4.191   4.010
 89          UI   3.829   3.648   3.467   3.325   3.125   2.970   2.838   2.718   2.597   2.476
 90          UI   2.355   2.265   2.205   2.098   2.010   1.890   1.825   1.740   1.659   1.553
 91          UI   1.492   1.432   1.372   1.311   1.251   1.191   1.130   1.102   1.055   0.995
 92          UI   0.964
 93          ZW   C=FLOW F=010YR-10DY A=GREENBRI
             *
```

1   HEC-1L INPUT   PAGE 5

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LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

 94          KK  C
             *  JXMIN    Time interval for input data
 95          IN      60
 96          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  1.813
             *   multiplier from table 4-4: 1.0000
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min          0.2500    0.2500    0.2500
             * 10 min         0.3600    0.3600    0.3600
             * 15 min         0.4300    0.4300    0.4300
             * 30 min         0.5700    0.5700    0.5700
             * 1 hour         0.7700    0.7700    0.7700
             * 2 hours        1.0400    1.0400    1.0315
             * 3 hours        1.2300    1.2300    1.2200
             * 6 hours        1.6500    1.6500    1.6366
             * 12 hours       2.2500    2.2500    2.2500
             * 24 hours       2.9800    2.9800    2.9800
             * 36 hours       3.5400    3.5400    3.5046
             * 2 days         3.9500    3.9500    3.9500
             * 3 days         4.6500    4.6500    4.6500
             * 5 days         5.7600    5.7600    5.7024
             * 10 days        7.5400    7.5400    7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
 97          PB       0
 98          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
 99          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
100          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
101          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
102          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
103          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
104          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
105          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
106          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
107          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
108          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
109          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
110          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
111          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
112          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
113          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
114          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
115          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
116          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
117          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
118          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
119          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
120          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
1                                     HEC-1L INPUT                                                  PAGE  6

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

121          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
122          BA  0.0616
             *  STRTL   CNSTL   RTIMP
123          LU    0.20   0.063  56.962
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  18.6 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 19.06322
             *   Volume of runoff (Step 4) V=     1.655347
124          UI    3.57    8.62   13.94   19.41   24.56   31.99   38.77   46.71   55.23   64.30
125          UI   74.33   85.66   96.73  102.08  103.85  103.14  100.80   93.26   84.54   75.69
126          UI   68.00   63.14   58.22   52.91   49.38   45.68   42.20   39.34   36.58   33.98
127          UI   31.77   29.78   27.91   26.18   24.55   23.16   21.98   20.65   19.52   18.53
128          UI   17.55   16.81   15.77   15.11   14.24   13.72   13.08   12.68   12.20   11.77
129          UI   11.28   10.81   10.44   10.04    9.64    9.34    8.98    8.60    8.36    7.99
130          UI    7.76    7.39    7.21    6.85    6.62    6.38    6.21    5.92    5.70    5.48
131          UI    5.29    5.13    4.93    4.75    4.58    4.42    4.25    4.09    3.93    3.81
132          UI    3.60    3.49    3.33    3.22    3.11    3.00    2.89    2.78    2.67    2.58
133          UI    2.53    2.45    2.37    2.28    2.17    2.10    2.04    1.95    1.88    1.78
134          UI    1.72    1.67    1.61    1.56    1.50    1.45    1.39    1.34    1.28    1.25
135          UI    1.23    1.17    1.12    1.09
136          ZW    C=FLOW F=010YR-10DY A=GREENBRI
             *

137          KK  D
             *  JXMIN     Time interval for input data
138          IN      60
139          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  1.813
             *   multiplier from table 4-4: 1.0000
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min          0.2500     0.2500     0.2500
             * 10 min         0.3600     0.3600     0.3600
             * 15 min         0.4300     0.4300     0.4300
             * 30 min         0.5700     0.5700     0.5700
             * 1 hour         0.7700     0.7700     0.7700
             * 2 hours        1.0400     1.0400     1.0315
             * 3 hours        1.2300     1.2300     1.2200
             * 6 hours        1.6500     1.6500     1.6366
             * 12 hours       2.2500     2.2500     2.2500
             * 24 hours       2.9800     2.9800     2.9800
             * 36 hours       3.5400     3.5400     3.5046
             * 2 days         3.9500     3.9500     3.9500
             * 3 days         4.6500     4.6500     4.6500
             * 5 days         5.7600     5.7600     5.7024
             * 10 days        7.5400     7.5400     7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
1                                     HEC-1L INPUT                                                  PAGE  7

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

140          PB       0
141          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
142          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
143          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
144          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
145          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
146          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
147          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
148          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
149          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
150          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
151          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
152          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
153          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
154          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
155          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
156          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
157          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
158          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
159          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
160          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
```

```
161          PI  0.0000  0.0000  0.0000  3.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
162          PI  0.0000  0.0000  0.0000  3.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
163          PI  0.0000  0.0000  0.0000  3.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
164          PI  0.0149  0.0373  0.0523  3.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
165          BA  0.0466
             *  STRTL   CNSTL   RTIMP
166          LU    0.20   0.067  47.037
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  18.1 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 18.57796
             *   Volume of runoff (Step 4) V=     1.252014
167          UI   2.873   6.902  11.165  15.414  19.858  25.588  31.201  37.574  44.506  51.751
168          UI  60.110  69.329  77.880  79.895  80.715  79.393  76.031  69.207  62.206  55.583
169          UI  50.704  46.857  42.534  39.361  36.464  33.468  31.195  28.922  26.867  24.958
170          UI  23.431  21.878  20.508  19.188  18.063  17.110  16.061  15.156  14.365  13.594
171          UI  12.989  12.197  11.635  11.001  10.545  10.104   9.746   9.392   9.027   8.635
172          UI   8.280   8.011   7.667   7.373   7.138   6.833   6.573   6.345   6.103   5.857
173          UI   5.661   5.409   5.204   4.994   4.895   4.642   4.468   4.293   4.131   4.000
174          UI   3.852   3.698   3.568   3.437   3.307   3.176   3.046   2.954   2.786   2.694
175          UI   2.572   2.485   2.398   2.311   2.223   2.136   2.049   1.992   1.948   1.869
176          UI   1.821   1.735   1.653   1.610   1.555   1.482   1.421   1.355   1.311   1.267
177          UI   1.224   1.180   1.137   1.093   1.050   1.006   0.970   0.960   0.916   0.873
178          UI   0.849
179          ZW   C=FLOW F=010YR-10DY A=GREENBRI
             *
1                                        HEC-1L INPUT                                        PAGE  8

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


180          KK  E
             *  JXMIN    Time interval for input data
181          IN      60
182          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  1.813
             *    multiplier from table 4-4: 1.0000
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min           0.2500      0.2500     0.2500
             * 10 min          0.3600      0.3600     0.3600
             * 15 min          0.4300      0.4300     0.4300
             * 30 min          0.5700      0.5700     0.5700
             * 1 hour          0.7700      0.7700     0.7700
             * 2 hours         1.0400      1.0400     1.0315
             * 3 hours         1.2300      1.2300     1.2200
             * 6 hours         1.6500      1.6500     1.6366
             * 12 hours        2.2500      2.2500     2.2500
             * 24 hours        2.9800      2.9800     2.9800
             * 36 hours        3.5400      3.5400     3.5046
             * 2 days          3.9500      3.9500     3.9500
             * 3 days          4.6500      4.6500     4.6500
             * 5 days          5.7600      5.7600     5.7024
             * 10 days         7.5400      7.5400     7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
183          PB       0
184          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
185          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
186          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
187          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
188          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
189          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
190          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
191          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
192          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
193          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
194          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
195          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
196          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
197          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
198          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
199          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
200          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
201          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
202          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
203          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
204          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
205          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
206          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
1                                        HEC-1L INPUT                                        PAGE  9

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10
```

```
207          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
208          BA  0.0377
             *  STRTL   CNSTL   RTIMP
209          LU    0.20   0.059  60.768
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  15.0 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 15.50161
             *   Volume of runoff (Step 4) V=     1.012535
210          UI   3.555   8.297  13.458  17.994  24.763  31.391  38.884  47.252  56.463  67.056
211          UI  75.874  77.854  77.595  75.140  67.234  59.093  51.633  47.003  42.232  38.233
212          UI  34.861  31.628  28.972  26.519  24.243  22.447  20.736  19.140  17.755  16.624
213          UI  15.406  14.416  13.506  12.766  11.847  11.168  10.546   9.909   9.556   9.122
214          UI   8.697   8.250   7.883   7.519   7.160   6.880   6.526   6.282   5.962   5.700
215          UI   5.471   5.159   4.942   4.768   4.516   4.311   4.109   3.939   3.783   3.596
216          UI   3.445   3.293   3.141   2.990   2.872   2.692   2.574   2.451   2.350   2.249
217          UI   2.147   2.046   1.952   1.902   1.821   1.759   1.658   1.582   1.531   1.442
218          UI   1.371   1.301   1.251   1.200   1.150   1.099   1.048   0.998   0.947   0.936
219          UI   0.885   0.835   0.823
220          ZW   C=FLOW P=010YR-10DY A=GREENBRI
             *

221          KK  DUMMY1
222          KM
223          HC       5
224          ZW   C=FLOW
             *

225          KK  F
             *  JXMIN    Time interval for input data
226          IN      60
227          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  1.813
             *   multiplier from table 4-4: 1.0000
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min          0.2500     0.2500     0.2500
             * 10 min         0.3600     0.3600     0.3600
             * 15 min         0.4300     0.4300     0.4300
             * 30 min         0.5700     0.5700     0.5700
             * 1 hour         0.7700     0.7700     0.7700
             * 2 hours        1.0400     1.0400     1.0315
             * 3 hours        1.2300     1.2300     1.2200
             * 6 hours        1.6500     1.6500     1.6366
             * 12 hours       2.2500     2.2500     2.2500
             * 24 hours       2.9800     2.9800     2.9800
             * 36 hours       3.5400     3.5400     3.5046
             * 2 days         3.9500     3.9500     3.9500
             * 3 days         4.6500     4.6500     4.6500
             * 5 days         5.7600     5.7600     5.7024
             * 10 days        7.5400     7.5400     7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
```



```
LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

228          PB       0
229          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
230          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
231          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
232          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
233          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
234          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
235          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
236          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
237          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
238          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
239          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
240          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
241          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
242          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
243          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
244          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
245          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
246          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
247          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
248          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
249          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
250          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
251          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
252          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
```

```
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
 253          BA  0.0458
              *  STRTL   CNSTL   RTIMP
 254          LU    0.20   0.070  49.509
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  15.9 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 16.40914
              *   Volume of runoff (Step 4) V=    1.231007
 255          UI   3.787   8.913  14.446  19.182  26.594  33.298  41.287  50.002  59.141  70.142
 256          UI  81.534  88.062  89.842  88.719  84.767  76.150  67.308  59.265  54.244  49.145
 257          UI  44.512  40.890  37.147  34.283  31.502  28.893  26.873  24.804  23.088  21.408
 258          UI  19.994  18.812  17.490  16.433  15.445  14.655  13.636  12.933  12.186  11.543
 259          UI  11.125  10.608  10.187   9.693   9.237   8.888   8.462   8.124   7.784   7.400
 260          UI   7.151   6.819   6.518   6.281   5.935   5.704   5.494   5.259   5.012   4.793
 261          UI   4.589   4.425   4.225   4.050   3.886   3.721   3.557   3.392   3.268   3.077
 262          UI   2.943   2.813   2.703   2.593   2.484   2.374   2.264   2.202   2.135   2.048
 263          UI   1.960   1.850   1.793   1.721   1.638   1.547   1.484   1.429   1.374   1.319
 264          UI   1.264   1.209   1.154   1.100   1.080   1.035   0.980   0.945
 265          ZW   C=FLOW F=010YR-10DY A=GREENBRI
              *
```



```
 266          KK  G
              *  JXMIN    Time interval for input data
 267          IN      60
 268          KM
              *
              * Design storm construction details
              *
              * Regional multiplier (zone 2) applied:  1.000
              * Areal adjustment using area:  1.813
              *   multiplier from table 4-4: 1.0000
              *
              * Adjusted depths for each duration from table 4-1: frequency:  10
              * Duration----Regional------Elev-----Areal (adjustments)
              * 5 min           0.2500    0.2500    0.2500
              * 10 min          0.3600    0.3600    0.3600
              * 15 min          0.4300    0.4300    0.4300
              * 30 min          0.5700    0.5700    0.5700
              * 1 hour          0.7700    0.7700    0.7700
              * 2 hours         1.0400    1.0400    1.0315
              * 3 hours         1.2300    1.2300    1.2200
              * 6 hours         1.6500    1.6500    1.6366
              * 12 hours        2.2500    2.2500    2.2500
              * 24 hours        2.9800    2.9800    2.9800
              * 36 hours        3.5400    3.5400    3.5046
              * 2 days          3.9500    3.9500    3.9500
              * 3 days          4.6500    4.6500    4.6500
              * 5 days          5.7600    5.7600    5.7024
              * 10 days         7.5400    7.5400    7.4646
              * Storm duration:  10, length:  240 ordinates
              * Distrubution using table 4-8 of total rainfall:  7.4646
 269          PB       0
 270          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
 271          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 272          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 273          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
 274          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
 275          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 276          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 277          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 278          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 279          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
 280          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
 281          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
 282          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
 283          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
 284          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
 285          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
 286          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 287          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 288          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
 289          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
 290          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 291          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 292          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
```



```
 293          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
              *
              * Precipitation losses computation (Chapter 5)
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
 294          BA  0.0614
              *  STRTL   CNSTL   RTIMP
```

```
295           LU    0.20   0.070  38.916
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  17.8 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 18.33008
              *   Volume of runoff (Step 4) V=     1.651146
296           UI    3.91    9.38   15.17   20.85   27.11   34.74   42.49   51.16   60.66   70.49
297           UI   82.07   94.59  104.62  107.08  107.58  105.53   99.55   90.24   80.72   72.06
298           UI   66.30   61.10   55.18   51.37   47.39   43.66   40.57   37.62   34.82   32.58
299           UI   30.37   28.46   26.58   24.90   23.51   22.21   20.84   19.71   18.65   17.76
300           UI   16.72   15.94   14.94   14.42   13.64   13.25   12.70   12.25   11.72   11.22
301           UI   10.82   10.38    9.96    9.64    9.24    8.84    8.57    8.21    7.91    7.60
302           UI    7.30    6.99    6.72    6.56    6.24    6.00    5.76    5.54    5.36    5.16
303           UI    4.95    4.77    4.60    4.42    4.24    4.07    3.94    3.72    3.59    3.43
304           UI    3.31    3.19    3.07    2.96    2.84    2.72    2.65    2.59    2.48    2.41
305           UI    2.29    2.20    2.14    2.05    1.96    1.87    1.79    1.73    1.67    1.62
306           UI    1.56    1.50    1.44    1.38    1.32    1.30    1.26    1.20    1.14
307           ZW   C=FLOW F=010YR-10DY A=GREENBRI
              *

308           KK  H
              *  JXMIN    Time interval for input data
309           IN       60
310           KM
              *
              * Design storm construction details
              *
              * Regional multiplier (zone 2) applied:  1.000
              * Areal adjustment using area:  1.813
              *   multiplier from table 4-4: 1.0000
              *
              * Adjusted depths for each duration from table 4-1: frequency:  10
              * Duration----Regional------Elev-----Areal (adjustments)
              * 5 min          0.2500     0.2500     0.2500
              * 10 min         0.3600     0.3600     0.3600
              * 15 min         0.4300     0.4300     0.4300
              * 30 min         0.5700     0.5700     0.5700
              * 1 hour         0.7700     0.7700     0.7700
              * 2 hours        1.0400     1.0400     1.0315
              * 3 hours        1.2300     1.2300     1.2200
              * 6 hours        1.6500     1.6500     1.6366
              * 12 hours       2.2500     2.2500     2.2500
              * 24 hours       2.9800     2.9800     2.9800
              * 36 hours       3.5400     3.5400     3.5046
              * 2 days         3.9500     3.9500     3.9500
              * 3 days         4.6500     4.6500     4.6500
              * 5 days         5.7600     5.7600     5.7024
              * 10 days        7.5400     7.5400     7.4646
              * Storm duration:  10, length:  240 ordinates
              * Distrubution using table 4-8 of total rainfall:  7.4646
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

311           PB       0
312           PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
313           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
314           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
315           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
316           PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
317           PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
318           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
319           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
320           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
321           PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
322           PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
323           PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
324           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
325           PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
326           PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
327           PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
328           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
329           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
330           PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
331           PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
332           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
333           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
334           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
335           PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
              *
              * Precipitation losses computation (Chapter 5)
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
336           BA  0.1108
              *  STRTL   CNSTL   RTIMP
337           LU    0.20   0.069  46.942
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  26.4 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 26.89606
              *   Volume of runoff (Step 4) V=     2.978785
338           UI    3.16    7.23   11.84   16.58   21.76   26.15   30.94   38.05   43.83   50.33
```

```
339        UI   57.46   64.83   72.90   81.11   89.69   99.52  109.99  120.08  128.45  130.77
340        UI  132.24  132.28  130.85  128.53  121.97  114.20  106.29   98.28   91.03   85.10
341        UI   80.70   76.35   71.43   67.04   63.88   60.57   57.19   54.07   51.50   48.88
342        UI   46.45   44.12   41.74   40.09   38.27   36.46   34.92   33.35   31.85   30.48
343        UI   29.29   28.24   27.09   25.91   24.92   24.02   23.13   22.28   21.64   20.71
344        UI   19.94   19.35   18.46   17.96   17.43   16.78   16.48   16.04   15.61   15.25
345        UI   14.81   14.36   13.94   13.55   13.25   12.88   12.51   12.16   11.91   11.60
346        UI   11.26   10.91   10.71   10.42   10.11    9.91    9.58    9.35    9.15    8.81
347        UI    8.59    8.37    8.15    8.05    7.78    7.54    7.34    7.14    6.95    6.77
348        UI    6.62    6.48    6.29    6.11    5.96    5.82    5.67    5.52    5.37    5.22
349        UI    5.08    4.95    4.84    4.65    4.52    4.40    4.25    4.15    4.06    3.96
350        UI    3.86    3.76    3.66    3.56    3.46    3.36    3.29    3.24    3.19    3.10
351        UI    3.03    2.97    2.87    2.77    2.70    2.65    2.60    2.51    2.43    2.38
352        UI    2.28    2.22    2.17    2.12    2.07    2.02    1.97    1.92    1.87    1.82
353        UI    1.78    1.73    1.68    1.63    1.59    1.59    1.55    1.50    1.45    1.40
```



```
LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

354        UI    1.40
355        ZW   C=FLOW F=010YR-10DY A=GREENBRI
           *

356        KK  I
           *  JXMIN    Time interval fcr input data
357        IN      60
358        KM
           *
           * Design storm construction details
           *
           * Regional multiplier (zone 2) applied:  1.000
           * Areal adjustment using area:  1.813
           *   multiplier from table 4-4: 1.0000
           *
           * Adjusted depths for each duration from table 4-1: frequency:  10
           * Duration----Regional------Elev-----Areal (adjustments)
           * 5 min           0.2500     0.2500     0.2500
           * 10 min          0.3600     0.3600     0.3600
           * 15 min          0.4300     0.4300     0.4300
           * 30 min          0.5700     0.5700     0.5700
           * 1 hour          0.7700     0.7700     0.7700
           * 2 hours         1.0400     1.0400     1.0315
           * 3 hours         1.2300     1.2300     1.2200
           * 6 hours         1.6500     1.6500     1.6366
           * 12 hours        2.2500     2.2500     2.2500
           * 24 hours        2.9800     2.9800     2.9800
           * 36 hours        3.5400     3.5400     3.5046
           * 2 days          3.9500     3.9500     3.9500
           * 3 days          4.6500     4.6500     4.6500
           * 5 days          5.7600     5.7600     5.7024
           * 10 days         7.5400     7.5400     7.4646
           * Storm duration:  10, length:  240 ordinates
           * Distrubution using table 4-8 of total rainfall:  7.4646
359        PB        0
360        PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
361        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
362        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
363        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
364        PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
365        PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
366        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
367        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
368        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
369        PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
370        PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
371        PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
372        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
373        PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
374        PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
375        PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
376        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
377        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
378        PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
379        PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
```



```
LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

380        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
381        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
382        PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
383        PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
           *
           * Precipitation losses computation (Chapter 5)
           *   Computing RTIMP (percent impervious) from land use and table 5-2
           *   Computing CNSTL (infiltration rate) from soil type and table 5-2
           *  TAREA    subbasin area (sq mi)
384        BA  0.0845
           *  STRTL   CNSTL   RTIMP
385        LU    0.20   0.066  46.331
           *
           * Runoff hydrograph computation (Chapter 6)
           *   Using basin lag:  30.6 minutes
           *   Using unit duration (Step 2): 1. min
           *   Lag Time + Unit Duration / 2 (Step 3): 31.11960
```

```
            *   Volume of runoff (Step 4) V=    2.272951
386         UI   1.803   3.955   6.546   9.238  12.026  14.983  17.372  20.000  24.055  27.569
387         UI  30.893  34.920  39.041  43.238  47.883  52.555  57.259  62.759  68.502  74.530
388         UI  80.144  84.734  86.058  86.991  87.571  86.838  85.782  84.458  80.116  75.689
389         UI  71.182  66.627  62.247  58.247  55.395  52.894  50.416  47.642  44.826  43.023
390         UI  41.175  39.288  37.345  35.609  34.144  32.655  31.216  29.892  28.547  27.283
391         UI  26.354  25.314  24.238  23.365  22.476  21.575  20.757  20.000  19.325  18.722
392         UI  18.095  17.391  16.794  16.242  15.735  15.228  14.735  14.368  13.896  13.333
393         UI  13.018  12.625  12.118  11.856  11.577  11.183  10.959  10.768  10.486  10.259
394         UI  10.057   9.803   9.550   9.296   9.070   8.869   8.700   8.482   8.266   8.068
395         UI   7.914   7.762   7.565   7.367   7.177   7.065   6.907   6.710   6.595   6.447
396         UI   6.250   6.150   6.031   5.834   5.700   5.582   5.441   5.354   5.289   5.120
397         UI   4.981   4.868   4.755   4.643   4.530   4.441   4.357   4.272   4.167   4.060
398         UI   3.975   3.891   3.806   3.722   3.637   3.553   3.468   3.384   3.299   3.239
399         UI   3.166   3.053   2.982   2.920   2.836   2.769   2.713   2.657   2.600   2.544
400         UI   2.488   2.431   2.375   2.319   2.262   2.206   2.170   2.142   2.114   2.068
401         UI   2.014   1.986   1.943   1.887   1.830   1.785   1.757   1.729   1.693   1.636
402         UI   1.601   1.568   1.511   1.472   1.444   1.416   1.388   1.360   1.332   1.303
403         UI   1.275   1.247   1.219   1.191   1.163   1.135   1.106   1.078   1.052   1.052
404         UI   1.038   1.009   0.981   0.953   0.925   0.920
405         ZW    C=FLOW F=010YR-10DY A=GREENBRI
            *

406         KK  J
            *  JXMIN    Time interval for input data
407         IN       60
408         KM
            *
            * Design storm construction details
            *
            * Regional multiplier (zone 2) applied:  1.000
            * Areal adjustment using area:  1.813
            *   multiplier from table 4-4: 1.0000
            *
            * Adjusted depths for each duration from table 4-1: frequency:  10
            * Duration----Regional------Elev-----Areal (adjustments)
            * 5 min          0.2500    0.2500    0.2500
            * 10 min         0.3600    0.3600    0.3600
            * 15 min         0.4300    0.4300    0.4300
            * 30 min         0.5700    0.5700    0.5700
            * 1 hour         0.7700    0.7700    0.7700
            * 2 hours        1.0400    1.0400    1.0315
            * 3 hours        1.2300    1.2300    1.2200
            * 6 hours        1.6500    1.6500    1.6366
            * 12 hours       2.2500    2.2500    2.2500
            * 24 hours       2.9800    2.9800    2.9800
            * 36 hours       3.5400    3.5400    3.5046
            * 2 days         3.9500    3.9500    3.9500
            * 3 days         4.6500    4.6500    4.6500
            * 5 days         5.7600    5.7600    5.7024
            * 10 days        7.5400    7.5400    7.4646
            * Storm duration:  10, length:  240 ordinates
            * Distrubution using table 4-8 of total rainfall:  7.4646
                                        HEC-1L INPUT                                          PAGE 16
1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

409         PB       0
410         PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
411         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
412         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
413         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
414         PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
415         PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
416         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
417         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
418         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
419         PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
420         PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
421         PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
422         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
423         PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
424         PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
425         PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
426         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
427         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
428         PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
429         PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
430         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
431         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
432         PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
433         PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
            *
            * Precipitation losses computation (Chapter 5)
            *   Computing RTIMP (percent impervious) from land use and table 5-2
            *   Computing CNSTL (infiltration rate) from soil type and table 5-2
            *  TAREA   subbasin area (sq mi)
434         BA  0.0859
            *  STRTL   CNSTL   RTIMP
435         LU    0.20   0.056  75.173
            *
            * Runoff hydrograph computation (Chapter 6)
            *   Using basin lag:  19.3 minutes
            *   Using unit duration (Step 2): 1. min
            *   Lag Time + Unit Duration / 2 (Step 3): 19.84462
```

```
              *   Volume of runoff (Step 4) V=      2.310764
436           UI    4.52   11.00   17.78   25.11   30.86   40.90   49.10   59.20   69.77   81.40
437           UI   93.35  107.46  122.39  134.99  138.13  139.50  137.48  133.10  122.14  110.85
438           UI   99.67   90.31   84.06   77.65   70.88   66.33   61.58   56.98   53.31   49.67
439           UI   46.35   43.23   40.80   38.20   36.00   33.80   31.86   30.23   28.67   27.02
440           UI   25.66   24.39   23.24   22.16   20.97   20.02   19.01   18.29   17.52   16.98
441           UI   16.36   15.81   15.18   14.58   14.07   13.59   13.06   12.63   12.21   11.72
442           UI   11.32   10.94   10.55   10.16    9.81    9.46    9.08    8.76    8.52    8.22
443           UI    7.88    7.60    7.32    7.07    6.86    6.61    6.37    6.16    5.95    5.74
444           UI    5.53    5.31    5.15    4.92    4.73    4.54    4.38    4.24    4.09    3.95
445           UI    3.81    3.67    3.53    3.44    3.37    3.25    3.16    3.04    2.90    2.81
446           UI    2.74    2.61    2.53    2.40    2.32    2.25    2.18    2.11    2.04    1.97
447           UI    1.90    1.83    1.75    1.68    1.68    1.61    1.54    1.47    1.47
448           ZW    C=FLOW F=010YR-10DY A=GREENBRI
              *
1                                          HEC-1L INPUT                                        PAGE 17

LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


449           KK  OFF-N
              *  JXMIN    Time interval for input data
450           IN      60
451           KM    E5
              *
              * Design storm construction details
              *
              * Regional multiplier (zone 2) applied:  1.000
              * Areal adjustment using area:  1.813
              *   multiplier from table 4-4: 1.0000
              *
              * Adjusted depths for each duration from table 4-1: frequency:  10
              * Duration----Regional------Elev-----Areal (adjustments)
              * 5 min           0.2500     0.2500     0.2500
              * 10 min          0.3600     0.3600     0.3600
              * 15 min          0.4300     0.4300     0.4300
              * 30 min          0.5700     0.5700     0.5700
              * 1 hour          0.7700     0.7700     0.7700
              * 2 hours         1.0400     1.0400     1.0315
              * 3 hours         1.2300     1.2300     1.2200
              * 6 hours         1.6500     1.6500     1.6366
              * 12 hours        2.2500     2.2500     2.2500
              * 24 hours        2.9800     2.9800     2.9800
              * 36 hours        3.5400     3.5400     3.5046
              * 2 days          3.9500     3.9500     3.9500
              * 3 days          4.6500     4.6500     4.6500
              * 5 days          5.7600     5.7600     5.7024
              * 10 days         7.5400     7.5400     7.4646
              * Storm duration:  10, length:  240 ordinates
              * Distrubution using table 4-8 of total rainfall:  7.4646
452           PB       0
453           PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
454           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
455           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
456           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
457           PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
458           PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
459           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
460           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
461           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
462           PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
463           PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
464           PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
465           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
466           PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
467           PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
468           PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
469           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
470           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
471           PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
472           PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
473           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
474           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
475           PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
1                                          HEC-1L INPUT                                        PAGE 18

LINE          ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

476           PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
              *
              * Precipitation losses computation (Chapter 5)
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
477           BA  0.8438
              *  STRTL   CNSTL   RTIMP
478           LU    0.20    0.070    2.000
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  78.2 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 78.67958
              *   Volume of runoff (Step 4) V=    22.687500
479           UI    2.81    5.63    8.44   11.34   15.39   19.43   23.48   27.55   31.77   35.99
480           UI   40.21   44.51   49.13   53.75   58.37   62.68   66.16   69.63   73.11   77.52
```

```
481   UI   83.86   90.19   96.52  102.35  107.41  112.47  117.52  123.15  129.44  135.73
482   UI  142.02  148.44  155.00  161.55  168.10  175.07  182.33  189.59  196.84  204.16
483   UI  211.50  218.85  226.19  234.56  243.31  252.06  260.81  270.09  279.50  288.91
484   UI  298.32  307.02  315.59  324.17  332.74  335.30  337.37  339.44  341.51  342.66
485   UI  343.80  344.94  345.96  344.82  343.67  342.53  341.27  339.21  337.14  335.07
486   UI  332.11  325.29  318.48  311.66  304.79  297.75  290.71  283.68  276.61  269.49
487   UI  262.36  255.24  248.45  242.21  235.96  229.72  224.53  220.61  216.70  212.79
488   UI  208.89  205.02  201.15  197.28  193.00  188.43  183.86  179.28  175.85  173.04
489   UI  170.22  167.41  164.50  161.55  158.61  155.66  152.64  149.61  146.57  143.54
490   UI  141.14  138.85  136.57  134.28  131.95  129.62  127.29  124.96  122.89  120.82
491   UI  118.75  116.68  114.57  112.46  110.35  108.31  106.86  105.41  103.96  102.46
492   UI  100.75   99.03   97.32   95.69   94.32   92.96   91.60   90.22   88.81   87.41
493   UI   86.00   84.64   83.37   82.09   80.82   79.64   78.58   77.53   76.47   75.48
494   UI   74.56   73.64   72.71   71.69   70.59   69.49   68.39   67.43   66.55   65.67
495   UI   64.79   63.97   63.18   62.39   61.60   60.81   60.02   59.22   58.43   57.83
496   UI   57.25   56.68   56.11   55.26   54.38   53.50   52.62   52.13   51.64   51.16
497   UI   50.66   49.87   49.08   48.29   47.54   47.19   46.84   46.49   46.09   45.47
498   UI   44.86   44.24   43.71   43.45   43.18   42.92   42.60   42.16   41.72   41.28
499   UI   40.89   40.58   40.28   39.97   39.62   39.23   38.83   38.43   38.04   37.64
500   UI   37.25   36.85   36.48   36.13   35.78   35.42   35.13   34.86   34.60   34.34
501   UI   34.01   33.66   33.31   32.96   32.64   32.33   32.02   31.71   31.48   31.26
502   UI   31.04   30.82   30.52   30.21   29.90   29.60   29.29   28.98   28.67   28.37
503   UI   28.19   28.02   27.84   27.65   27.35   27.04   26.73   26.44   26.27   26.09
504   UI   25.92   25.71   25.40   25.09   24.79   24.53   24.40   24.27   24.13   23.94
505   UI   23.63   23.32   23.02   22.76   22.59   22.41   22.24   22.04   21.82   21.60
506   UI   21.38   21.23   21.14   21.06   20.97   20.77   20.51   20.24   19.98   19.78
507   UI   19.60   19.42   19.25   19.07   18.90   18.72   18.54   18.37   18.19   18.02
508   UI   17.84   17.70   17.57   17.44   17.31   17.18   17.04   16.91   16.78   16.60
509   UI   16.43   16.25   16.08   15.95   15.82   15.68   15.55   15.42   15.29   15.16
510   UI   15.02   14.89   14.76   14.63   14.50   14.36   14.23   14.10   13.97   13.84
511   UI   13.70   13.57   13.44   13.31   13.18   13.04   12.93   12.85   12.76   12.67
512   UI   12.53   12.36   12.18   12.01   11.88   11.80   11.71   11.62   11.50   11.37
513   UI   11.24   11.11   11.01   10.92   10.83   10.74   10.66   10.57   10.48   10.39
514   UI   10.30   10.22   10.13   10.04    9.95    9.86    9.78    9.69    9.60    9.51
515   UI    9.42    9.34    9.25    9.16    9.07    8.98    8.90    8.81    8.72    8.64
516   UI    8.60    8.55    8.51    8.47    8.42    8.38    8.33    8.27    8.19    8.10
517   UI    8.01    7.94    7.90    7.85    7.81    7.74    7.66    7.57    7.48    7.39
518   UI    7.30    7.22    7.13    7.07    7.02    6.98    6.94    6.89    6.85    6.80
```



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LINE  ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

519   UI    6.76    6.68    6.59    6.51    6.42    6.37    6.32    6.28    6.23    6.15
520   UI    6.06    5.98    5.89    5.84    5.80    5.75    5.71    5.67    5.62    5.58
521   UI    5.53    5.49    5.45    5.40    5.36    5.31    5.27    5.23    5.18    5.14
522   UI    5.09    5.05    5.01    4.96    4.92    4.87    4.83    4.79    4.74    4.70
523   UI    4.65    4.61    4.57    4.52    4.48    4.43    4.39    4.35    4.30    4.26
524   UI    4.21    4.17    4.15    4.15    4.15    4.15    4.12    4.08    4.04    3.99
525   UI    3.95    3.90    3.86    3.82    3.77    3.73    3.68    3.64    3.63    3.63
526   UI    3.63    3.63
527   ZW    C=FLOW F=010YR-10DY A=GREENBRI
      *

528   KK  DUMMY2
529   KM
530   HC       6
531   ZW    C=FLOW
      *

532   KK  K
      *  JXMIN    Time interval for input data
533   IN      60
534   KM
      *
      * Design storm construction details
      *
      * Regional multiplier (zone 2) applied:  1.000
      * Areal adjustment using area:  1.813
      *   multiplier from table 4-4: 1.0000
      *
      * Adjusted depths for each duration from table 4-1: frequency:  10
      * Duration----Regional------Elev-----Areal (adjustments)
      * 5 min          0.2500     0.2500     0.2500
      * 10 min         0.3600     0.3600     0.3600
      * 15 min         0.4300     0.4300     0.4300
      * 30 min         0.5700     0.5700     0.5700
      * 1 hour         0.7700     0.7700     0.7700
      * 2 hours        1.0400     1.0400     1.0315
      * 3 hours        1.2300     1.2300     1.2200
      * 6 hours        1.6500     1.6500     1.6366
      * 12 hours       2.2500     2.2500     2.2500
      * 24 hours       2.9800     2.9800     2.9800
      * 36 hours       3.5400     3.5400     3.5046
      * 2 days         3.9500     3.9500     3.9500
      * 3 days         4.6500     4.6500     4.6500
      * 5 days         5.7600     5.7600     5.7024
      * 10 days        7.5400     7.5400     7.4646
      * Storm duration:  10, length:  240 ordinates
      * Distrubution using table 4-8 of total rainfall:  7.4646
535   PB       0
536   PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
537   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
538   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
539   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
540   PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
```

```
541          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
542          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
                                           HEC-1L INPUT                                              PAGE 20
1

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

543          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
544          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
545          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
546          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
547          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
548          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
549          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
550          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
551          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
552          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
553          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
554          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
555          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
556          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
557          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
558          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
559          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
             *
             * Precipitation losses computation (Chapter 5)
             *   Computing RTIMP (percent impervious) from land use and table 5-2
             *   Computing CNSTL (infiltration rate) from soil type and table 5-2
             *  TAREA   subbasin area (sq mi)
560          BA  0.0630
             *  STRTL   CNSTL   RTIMP
561          LU    0.20   0.064  47.945
             *
             * Runoff hydrograph computation (Chapter 6)
             *   Using basin lag:  24.8 minutes
             *   Using unit duration (Step 2): 1. min
             *   Lag Time + Unit Duration / 2 (Step 3): 25.30746
             *   Volume of runoff (Step 4) V=    1.693160
562          UI   2.030   4.713   7.691  10.795  14.126  16.683  20.577  24.770  28.545  33.081
563          UI  37.785  42.822  48.078  53.458  59.771  66.472  72.929  77.779  79.257  80.081
564          UI  79.662  78.512  76.256  71.339  66.270  61.150  56.282  52.049  49.226  46.431
565          UI  43.319  40.484  38.444  36.318  34.140  32.258  30.599  28.925  27.434  25.918
566          UI  24.637  23.544  22.307  21.318  20.312  19.339  18.448  17.686  17.012  16.264
567          UI  15.532  14.905  14.334  13.763  13.285  12.801  12.183  11.834  11.309  10.905
568          UI  10.602  10.157   9.966   9.683   9.410   9.175   8.890   8.604   8.340   8.112
569          UI   7.913   7.659   7.433   7.250   7.069   6.847   6.625   6.480   6.301   6.106
570          UI   5.978   5.756   5.629   5.472   5.271   5.144   4.987   4.894   4.777   4.596
571          UI   4.469   4.342   4.216   4.100   4.005   3.910   3.788   3.679   3.584   3.489
572          UI   3.394   3.299   3.203   3.108   3.013   2.949   2.840   2.742   2.673   2.577
573          UI   2.511   2.448   2.384   2.321   2.257   2.194   2.131   2.067   2.005   1.974
574          UI   1.942   1.894   1.838   1.807   1.743   1.680   1.631   1.599   1.568   1.506
575          UI   1.464   1.420   1.361   1.329   1.297   1.265   1.234   1.202   1.170   1.138
576          UI   1.107   1.075   1.043   1.012   0.980   0.963   0.957   0.925   0.893   0.861
577          UI   0.843
578          ZW   C=FLOW F=010YR-10DY A=GREENBRI
             *
                                           HEC-1L INPUT                                              PAGE 21
1

LINE         ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


579          KK  L
             *  JXMIN   Time interval for input data
580          IN      60
581          KM
             *
             * Design storm construction details
             *
             * Regional multiplier (zone 2) applied:  1.000
             * Areal adjustment using area:  1.813
             *   multiplier from table 4-4: 1.0000
             *
             * Adjusted depths for each duration from table 4-1: frequency:  10
             * Duration----Regional------Elev-----Areal (adjustments)
             * 5 min          0.2500      0.2500     0.2500
             * 10 min         0.3600      0.3600     0.3600
             * 15 min         0.4300      0.4300     0.4300
             * 30 min         0.5700      0.5700     0.5700
             * 1 hour         0.7700      0.7700     0.7700
             * 2 hours        1.0400      1.0400     1.0315
             * 3 hours        1.2300      1.2300     1.2200
             * 6 hours        1.6500      1.6500     1.6366
             * 12 hours       2.2500      2.2500     2.2500
             * 24 hours       2.9800      2.9800     2.9800
             * 36 hours       3.5400      3.5400     3.5046
             * 2 days         3.9500      3.9500     3.9500
             * 3 days         4.6500      4.6500     4.6500
             * 5 days         5.7600      5.7600     5.7024
             * 10 days        7.5400      7.5400     7.4646
             * Storm duration:  10, length:  240 ordinates
             * Distrubution using table 4-8 of total rainfall:  7.4646
582          PB      0
583          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
584          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
585          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
586          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
```

```
587      PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
588      PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
589      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
590      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
591      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
592      PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
593      PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
594      PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
595      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
596      PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
597      PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
598      PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
599      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
600      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
601      PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
602      PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
603      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
604      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
605      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
```



```
LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

606      PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
         *
         * Precipitation losses computation (Chapter 5)
         *    Computing RTIMP (percent impervious) from land use and table 5-2
         *    Computing CNSTL (infiltration rate) from soil type and table 5-2
         *  TAREA    subbasin area (sq mi)
607      BA  0.0330
         *  STRTL   CNSTL   RTIMP
608      LU     0.20   0.060  70.000
         *
         * Runoff hydrograph computation (Chapter 6)
         *    Using basin lag:  10.8 minutes
         *    Using unit duration (Step 2): 1. min
         *    Lag Time + Unit Duration / 2 (Step 3): 11.25192
         *    Volume of runoff (Step 4) V=     0.886493
609      UI   6.407  14.667  22.873  33.597  45.864  59.705  76.233  91.581  94.540  91.593
610      UI  79.589  66.331  57.178  49.115  43.425  38.013  33.648  29.652  26.656  23.939
611      UI  21.516  19.636  17.744  16.220  14.903  13.668  12.625  11.742  11.022  10.309
612      UI   9.615   9.027   8.495   7.940   7.493   7.046   6.604   6.137   5.784   5.418
613      UI   5.081   4.776   4.504   4.225   3.973   3.721   3.494   3.232   3.016   2.848
614      UI   2.680   2.512   2.354   2.270   2.139   1.982   1.876   1.745   1.619   1.529
615      UI   1.445   1.361   1.277   1.193   1.135   1.072   0.993
616      ZW   C=FLOW F=010YR-10DY A=GREENBRI
         *

617      KK  M
         *  JXMIN    Time interval for input data
618      IN      60
619      KM
         *
         * Design storm construction details
         *
         * Regional multiplier (zone 2) applied:  1.000
         * Areal adjustment using area:  1.813
         *   multiplier from table 4-4: 1.0000
         *
         * Adjusted depths for each duration from table 4-1: frequency:  10
         * Duration----Regional------Elev-----Areal (adjustments)
         * 5 min           0.2500     0.2500     0.2500
         * 10 min          0.3600     0.3600     0.3600
         * 15 min          0.4300     0.4300     0.4300
         * 30 min          0.5700     0.5700     0.5700
         * 1 hour          0.7700     0.7700     0.7700
         * 2 hours         1.0400     1.0400     1.0315
         * 3 hours         1.2300     1.2300     1.2200
         * 6 hours         1.6500     1.6500     1.6366
         * 12 hours        2.2500     2.2500     2.2500
         * 24 hours        2.9800     2.9800     2.9800
         * 36 hours        3.5400     3.5400     3.5046
         * 2 days          3.9500     3.9500     3.9500
         * 3 days          4.6500     4.6500     4.6500
         * 5 days          5.7600     5.7600     5.7024
         * 10 days         7.5400     7.5400     7.4646
         * Storm duration:  10, length:  240 ordinates
         * Distrubution using table 4-8 of total rainfall:  7.4646
```



```
LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

620      PB       0
621      PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
622      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
623      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
624      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
625      PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
626      PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
627      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
628      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
629      PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
630      PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
631      PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
632      PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
633   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
634   PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
635   PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
636   PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
637   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
638   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
639   PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
640   PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
641   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
642   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
643   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
644   PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
      *
      * Precipitation losses computation (Chapter 5)
      *   Computing RTIMP (percent impervious) from land use and table 5-2
      *   Computing CNSTL (infiltration rate) from soil type and table 5-2
      *  TAREA   subbasin area (sq mi)
645   BA  0.0666
      *  STRTL   CNSTL   RTIMP
646   LU    0.20   0.040  95.000
      *
      * Runoff hydrograph computation (Chapter 6)
      *   Using basin lag:  26.3 minutes
      *   Using unit duration (Step 2): 1. min
      *   Lag Time + Unit Duration / 2 (Step 3): 26.79198
      *   Volume of runoff (Step 4) V=      1.789792
647   UI    1.915   4.383   7.174  10.047  13.183  15.826  18.777  23.086  26.559  30.522
648   UI   34.851  39.310  44.219  49.193  54.442  60.397  66.766  72.836  77.583  78.990
649   UI   79.827  79.723  78.803  77.397  73.123  68.404  63.604  58.757  54.429  51.019
650   UI   48.362  45.729  42.689  40.188  38.257  36.253  34.198  32.383  30.823  29.237
651   UI   27.797  26.377  25.000  24.013  22.883  21.825  20.894  19.936  19.048  18.246
652   UI   17.536  16.908  16.189  15.503  14.909  14.371  13.832  13.353  12.952  12.354
653   UI   11.949  11.540  11.013  10.774  10.409  10.076   9.894   9.595   9.357   9.127
654   UI    8.858   8.588   8.339   8.119   7.939   7.701   7.481   7.290   7.140   6.933
655   UI    6.723   6.539   6.420   6.215   6.060   5.917   5.707   5.609   5.449   5.261
656   UI    5.142   4.995   4.896   4.809   4.629   4.503   4.383   4.264   4.144   4.050
657   UI    3.961   3.865   3.745   3.651   3.561   3.472   3.382   3.292   3.202   3.113
658   UI    3.023   2.957   2.869   2.758   2.698   2.614   2.538   2.478   2.418   2.358
659   UI    2.299   2.239   2.179   2.119   2.059   2.002   1.972   1.942   1.900   1.842
660   UI    1.812   1.761   1.701   1.642   1.612   1.582   1.542   1.482   1.452   1.402
661   UI    1.353   1.323   1.293   1.263   1.233   1.203   1.173   1.143   1.113   1.083
662   UI    1.053   1.023   0.993   0.964   0.962   0.944   0.914   0.884   0.854   0.842
                                      HEC-1L INPUT                                           PAGE 24
1

LINE  ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10

663   ZW   C=FLOW F=010YR-10DY A=GREENBRI
      *

664   KK  N
      *  JXMIN    Time interval for input data
665   IN      60
666   KM
      *
      * Design storm construction details
      *
      * Regional multiplier (zone 2) applied:  1.000
      * Areal adjustment using area:  1.813
      *   multiplier from table 4-4: 1.0000
      *
      * Adjusted depths for each duration from table 4-1: frequency:  10
      * Duration----Regional------Elev-----Areal (adjustments)
      * 5 min          0.2500     0.2500    0.2500
      * 10 min         0.3600     0.3600    0.3600
      * 15 min         0.4300     0.4300    0.4300
      * 30 min         0.5700     0.5700    0.5700
      * 1 hour         0.7700     0.7700    0.7700
      * 2 hours        1.0400     1.0400    1.0315
      * 3 hours        1.2300     1.2300    1.2200
      * 6 hours        1.6500     1.6500    1.6366
      * 12 hours       2.2500     2.2500    2.2500
      * 24 hours       2.9800     2.9800    2.9800
      * 36 hours       3.5400     3.5400    3.5046
      * 2 days         3.9500     3.9500    3.9500
      * 3 days         4.6500     4.6500    4.6500
      * 5 days         5.7600     5.7600    5.7024
      * 10 days        7.5400     7.5400    7.4646
      * Storm duration:  10, length:  240 ordinates
      * Distrubution using table 4-8 of total rainfall:  7.4646
667   PB      0
668   PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
669   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
670   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
671   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
672   PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
673   PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
674   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
675   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
676   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
677   PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
678   PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
679   PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
680   PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
681   PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
682   PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
```

```
 683          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
 684          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 685          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 686          PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
 687          PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
 688          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
1                                     HEC-1L INPUT                                                     PAGE 25

LINE          ID.......1.......2.......3.......4.......5........6.......7.......8.......9......10

 689          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 690          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
 691          PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
              *
              * Precipitation losses computation (Chapter 5)
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
 692          BA  0.0375
              *  STRTL   CNSTL   RTIMP
 693          LU    0.20    0.068  43.112
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  19.1 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 19.61394
              *   Volume of runoff (Step 4) V=     1.008333
 694          UI   2.030   4.928   7.964  11.204  13.886  18.309  22.045  26.572  31.346  36.548
 695          UI  42.014  48.382  54.963  59.839  61.126  61.438  60.404  57.745  52.812  47.756
 696          UI  42.915  39.157  36.372  33.371  30.707  28.647  26.506  24.625  22.972  21.414
 697          UI  19.917  18.699  17.541  16.479  15.483  14.542  13.742  13.057  12.301  11.637
 698          UI  11.057  10.491  10.056   9.460   9.076   8.535   8.254   7.828   7.625   7.315
 699          UI   7.093   6.810   6.529   6.281   6.087   5.839   5.626   5.460   5.240   5.036
 700          UI   4.892   4.692   4.544   4.356   4.227   4.035   3.899   3.773   3.666   3.501
 701          UI   3.375   3.249   3.137   3.042   2.933   2.823   2.728   2.634   2.540   2.445
 702          UI   2.351   2.276   2.174   2.088   2.004   1.931   1.868   1.806   1.743   1.680
 703          UI   1.617   1.554   1.517   1.485   1.427   1.391   1.332   1.269   1.235   1.204
 704          UI   1.142   1.110   1.048   1.016   0.985   0.954   0.922   0.891   0.859   0.828
 705          UI   0.796   0.765   0.740   0.733   0.701   0.670   0.648
 706          ZW    C=FLOW F=010YR-10DY A=GREENBRI
              *

 707          KK  O
              *  JXMIN    Time interval for input data
 708          IN      60
 709          KM
              *
              * Design storm construction details
              *
              * Regional multiplier (zone 2) applied:  1.000
              * Areal adjustment using area:  1.813
              *   multiplier from table 4-4: 1.0000
              *
              * Adjusted depths for each duration from table 4-1: frequency:  10
              * Duration----Regional------Elev-----Areal (adjustments)
              * 5 min          0.2500     0.2500    0.2500
              * 10 min         0.3600     0.3600    0.3600
              * 15 min         0.4300     0.4300    0.4300
              * 30 min         0.5700     0.5700    0.5700
              * 1 hour         0.7700     0.7700    0.7700
              * 2 hours        1.0400     1.0400    1.0315
              * 3 hours        1.2300     1.2300    1.2200
              * 6 hours        1.6500     1.6500    1.6366
              * 12 hours       2.2500     2.2500    2.2500
              * 24 hours       2.9800     2.9800    2.9800
              * 36 hours       3.5400     3.5400    3.5046
              * 2 days         3.9500     3.9500    3.9500
              * 3 days         4.6500     4.6500    4.6500
              * 5 days         5.7600     5.7600    5.7024
              * 10 days        7.5400     7.5400    7.4646
              * Storm duration:  10, length:  240 ordinates
              * Distrubution using table 4-8 of total rainfall:  7.4646
1                                     HEC-1L INPUT                                                     PAGE 26

LINE          ID.......1.......2.......3.......4.......5........6.......7.......8.......9......10

 710          PB       0
 711          PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
 712          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 713          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 714          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
 715          PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
 716          PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 717          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 718          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 719          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 720          PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
 721          PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
 722          PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
 723          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
 724          PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
 725          PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
 726          PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
 727          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
 728          PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
729     PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
730     PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
731     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
732     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
733     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
734     PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
        *
        * Precipitation losses computation (Chapter 5)
        *   Computing RTIMP (percent impervious) from land use and table 5-2
        *   Computing CNSTL (infiltration rate) from soil type and table 5-2
        *  TAREA   subbasin area (sq mi)
735     BA  0.0402
        *  STRTL   CNSTL   RTIMP
736     LU     0.20   0.070  50.000
        *
        * Runoff hydrograph computation (Chapter 6)
        *   Using basin lag:  15.2 minutes
        *   Using unit duration (Step 2): 1. min
        *   Lag Time + Unit Duration / 2 (Step 3): 15.66410
        *   Volume of runoff (Step 4) V=     1.079757
737     UI   3.700   8.650  14.029  18.671  25.815  32.653  40.437  49.127  58.596  69.581
738     UI  79.786  81.989  82.075  79.942  72.282  63.797  55.826  50.481  45.662  41.057
739     UI  37.576  34.011  31.250  28.611  26.091  24.250  22.347  20.679  19.122  17.893
740     UI  16.687  15.545  14.582  13.717  12.831  12.134  11.294  10.743  10.266   9.781
741     UI   9.383   8.907   8.469   8.130   7.726   7.417   7.070   6.735   6.454   6.189
742     UI   5.858   5.635   5.348   5.098   4.949   4.673   4.462   4.253   4.095   3.911
743     UI   3.737   3.578   3.420   3.261   3.103   2.975   2.809   2.669   2.556   2.450
744     UI   2.345   2.239   2.134   2.048   1.995   1.901   1.835   1.730   1.660   1.601
745     UI   1.513   1.431   1.366   1.313   1.260   1.207   1.155   1.102   1.049   0.996
746     UI   0.985   0.932   0.879
747     ZW    C=FLOW F=010YR-10DY A=GREENBRI
        *
                                       HEC-1L INPUT                                       PAGE 27
1

LINE    ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10


748     KK  P
        *  JXMIN    Time interval for input data
749     IN      60
750     KM
        *
        * Design storm construction details
        *
        * Regional multiplier (zone 2) applied:  1.000
        * Areal adjustment using area:  1.813
        *   multiplier from table 4-4: 1.0000
        *
        * Adjusted depths for each duration from table 4-1: frequency:  10
        * Duration----Regional------Elev-----Areal (adjustments)
        * 5 min          0.2500     0.2500     0.2500
        * 10 min         0.3600     0.3600     0.3600
        * 15 min         0.4300     0.4300     0.4300
        * 30 min         0.5700     0.5700     0.5700
        * 1 hour         0.7700     0.7700     0.7700
        * 2 hours        1.0400     1.0400     1.0315
        * 3 hours        1.2300     1.2300     1.2200
        * 6 hours        1.6500     1.6500     1.6366
        * 12 hours       2.2500     2.2500     2.2500
        * 24 hours       2.9800     2.9800     2.9800
        * 36 hours       3.5400     3.5400     3.5046
        * 2 days         3.9500     3.9500     3.9500
        * 3 days         4.6500     4.6500     4.6500
        * 5 days         5.7600     5.7600     5.7024
        * 10 days        7.5400     7.5400     7.4646
        * Storm duration:  10, length:  240 ordinates
        * Distrubution using table 4-8 of total rainfall:  7.4646
751     PB       0
752     PI  0.0224  0.0821  0.2015  0.1120  0.0373  0.0224  0.0075  0.0000  0.0000  0.0000
753     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
754     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
755     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224
756     PI  0.0373  0.0523  0.0672  0.0970  0.2239  0.1418  0.0746  0.0597  0.0448  0.0373
757     PI  0.0299  0.0224  0.0149  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
758     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
759     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
760     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
761     PI  0.0000  0.0000  0.0000  0.0075  0.0149  0.0224  0.0299  0.0373  0.0448  0.0523
762     PI  0.0672  0.1120  0.3956  0.1642  0.0746  0.0597  0.0448  0.0373  0.0299  0.0224
763     PI  0.0224  0.0149  0.0149  0.0075  0.0075  0.0000  0.0000  0.0000  0.0000  0.0000
764     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075  0.0075
765     PI  0.0149  0.0149  0.0149  0.0224  0.0373  0.0448  0.0523  0.0672  0.0746  0.0821
766     PI  0.0970  0.1045  0.1194  0.1269  0.1344  0.1418  0.1568  0.1120  0.0896  0.0672
767     PI  0.2314  0.2911  0.5001  0.2463  0.0373  0.0224  0.0149  0.0075  0.0075  0.0075
768     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
769     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
770     PI  0.0075  0.0149  0.0224  0.0299  0.0373  0.0523  0.0672  0.0970  0.2911  0.1493
771     PI  0.0746  0.0597  0.0523  0.0448  0.0373  0.0299  0.0224  0.0149  0.0075  0.0000
772     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
773     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
774     PI  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0075
                                       HEC-1L INPUT                                       PAGE 28
1

LINE    ID.......1.......2.......3.......4.......5,.......6.......7.......8.......9......10
```

```
775           PI  0.0149  0.0373  0.0523  0.0746  0.2165  0.1194  0.0597  0.0448  0.0299  0.0149
              *
              * Precipitation losses computation (Chapter 5)
              *   Computing RTIMP (percent impervious) from land use and table 5-2
              *   Computing CNSTL (infiltration rate) from soil type and table 5-2
              *  TAREA   subbasin area (sq mi)
776           BA  0.0342
              *  STRTL   CNSTL   RTIMP
777           LU    0.20   0.062  56.384
              *
              * Runoff hydrograph computation (Chapter 6)
              *   Using basin lag:  16.5 minutes
              *   Using unit duration (Step 2): 1. min
              *   Lag Time + Unit Duration / 2 (Step 3): 17.01644
              *   Volume of runoff (Step 4) V=     0.920104
778           UI   2.600   6.153   9.967  13.380  18.241  22.789  28.286  34.177  40.506  47.656
779           UI  55.696  62.676  64.278  64.502  63.082  58.468  52.398  46.323  41.479  38.101
780           UI  34.392  31.539  28.996  26.479  24.484  22.572  20.756  19.368  17.921  16.730
781           UI  15.552  14.546  13.707  12.781  12.021  11.335  10.728  10.081   9.564   8.918
782           UI   8.577   8.137   7.838   7.527   7.202   6.861   6.571   6.316   6.030   5.813
783           UI   5.561   5.305   5.124   4.903   4.688   4.527   4.284   4.125   3.968   3.824
784           UI   3.641   3.488   3.337   3.223   3.095   2.962   2.847   2.733   2.618   2.504
785           UI   2.404   2.287   2.187   2.079   2.002   1.925   1.849   1.773   1.697   1.621
786           UI   1.583   1.533   1.474   1.413   1.336   1.295   1.249   1.186   1.129   1.078
787           UI   1.040   1.001   0.963   0.925   0.887   0.849   0.811   0.779   0.767   0.729
788           UI   0.691   0.681
789           ZW   C=FLOW F=010YR-10DY A=GREENBRI
              *

790           KK   DUMMY3
791           KM
792           HC       6
793           ZW   C=FLOW
794           ZZ
1*****************************************                      ****************************************
*                                       *                      *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1L)  *                      *   U.S. ARMY CORPS OF ENGINEERS       *
*            JULY   1998                *                      *   HYDROLOGIC ENGINEERING CENTER      *
*         VERSION 4.1(L)                *                      *         609 SECOND STREET            *
*                                       *                      *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE   12JUL05  TIME  19:20:27   *                      *          (916) 756-1104              *
*                                       *                      *                                      *
*****************************************                      ****************************************


                      10010 & 1010 &10024&1024

  3 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                        NMIN           1  MINUTES IN COMPUTATION INTERVAL
                       IDATE     31DEC99  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ       14947  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE     11JAN 0  ENDING DATE
                      NDTIME        0906  ENDING TIME
                       ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL    0.02 HOURS
                       TOTAL TIME BASE  249.10 HOURS

       ENGLISH UNITS
            DRAINAGE AREA           SQUARE MILES
            PRECIPITATION DEPTH     INCHES
            LENGTH, ELEVATION       FEET
            FLOW                    CUBIC FEET PER SECOND
            STORAGE VOLUME          ACRE-FEET
            SURFACE AREA            ACRES
            TEMPERATURE             DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

         **************
         *            *
  4 KK   *     A      *
         *            *
         **************


  5 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN          60  TIME INTERVAL IN MINUTES
                     JXDATE     31DEC99  STARTING DATE
                     JXTIME        2400  STARTING TIME

            SUBBASIN RUNOFF DATA
```

32 BA SUBBASIN CHARACTERISTICS
TAREA, 0.12 SUBBASIN AREA

PRECIPITATION DATA

7 PB STORM 7.46 BASIN TOTAL PRECIPITATION

33 LU UNIFORM LOSS RATE
STRTL 0.20 INITIAL LOSS
CNSTL 0.06 UNIFORM LOSS RATE
RTIMP 60.15 PERCENT IMPERVIOUS AREA

32 UI INPUT UNITGRAPH, 173 ORDINATES, VOLUME = 1.00

2.9	6.5	10.7	15.1	19.7	24.2	27.8	33.7	39.7	45.0
51.3	57.9	64.7	72.2	79.7	87.5	96.5	106.0	115.5	124.4
127.7	129.5	130.7	129.7	128.0	125.7	118.6	111.5	104.2	96.9
90.2	84.4	80.4	76.4	72.1	67.4	64.4	61.4	58.4	55.2
52.6	50.2	47.8	45.6	43.5	41.3	39.7	38.1	36.3	34.9
33.5	32.0	30.7	29.6	28.5	27.5	26.5	25.4	24.5	23.7
22.9	22.0	21.5	20.7	19.8	19.3	18.6	17.9	17.5	17.0
16.5	16.2	15.7	15.4	15.0	14.6	14.2	13.8	13.4	13.1
12.9	12.5	12.2	11.9	11.6	11.3	11.0	10.7	10.5	10.3
10.0	9.8	9.5	9.3	9.1	8.8	8.6	8.4	8.1	8.0
7.9	7.6	7.4	7.2	7.0	6.9	6.7	6.6	6.4	6.3
6.1	5.9	5.8	5.7	5.5	5.4	5.3	5.1	5.0	4.9
4.8	4.6	4.5	4.4	4.2	4.1	4.0	4.0	3.9	3.8
3.7	3.6	3.5	3.4	3.3	3.3	3.2	3.2	3.1	3.0
3.0	2.9	2.8	2.7	2.6	2.6	2.5	2.5	2.4	2.3
2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8
1.8	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.4
1.4	1.4	1.4							

***

*** *** *** *** ***

HYDROGRAPH AT STATION A

TOTAL RAINFALL = 7.46, TOTAL LOSS = 1.72, TOTAL EXCESS = 5.74

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	249.10-HR
+ (CFS)	(HR)					
		(CFS)				
+ 33.	153.07		16.	7.	4.	2.
		(INCHES)	1.245	2.366	3.390	5.736
		(AC-FT)	8.	15.	21.	36.

CUMULATIVE AREA = 0.12 SQ MI

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              **************
              *            *
53 KK         *     B      *
              *            *
              **************
```

54 IN TIME DATA FOR INPUT TIME SERIES
JXMIN 60 TIME INTERVAL IN MINUTES
JXDATE 31DEC99 STARTING DATE
JXTIME 2400 STARTING TIME

SUBBASIN RUNOFF DATA

81 BA SUBBASIN CHARACTERISTICS
TAREA, 0.04 SUBBASIN AREA

PRECIPITATION DATA

56 PB STORM 7.46 BASIN TOTAL PRECIPITATION

82 LU UNIFORM LOSS RATE
STRTL 0.20 INITIAL LOSS
CNSTL 0.06 UNIFORM LOSS RATE
RTIMP 57.84 PERCENT IMPERVIOUS AREA

81 UI INPUT UNITGRAPH, 91 ORDINATES, VOLUME = 1.00

4.3	9.9	16.1	21.7	29.6	37.7	46.8	56.8	68.1	80.8
89.4	91.5	90.4	85.6	76.0	66.3	58.6	53.3	47.2	43.3
39.2	35.8	32.6	29.8	27.5	25.2	23.3	21.5	20.0	18.7
17.3	16.2	15.2	14.2	13.4	12.5	11.8	11.3	10.8	10.3
9.8	9.3	8.9	8.4	8.1	7.7	7.4	7.0	6.7	6.4
6.1	5.8	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0
3.8	3.6	3.5	3.3	3.1	3.0	2.8	2.7	2.6	2.5
2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.7	1.6
1.5	1.4	1.4	1.3	1.3	1.2	1.1	1.1	1.1	1.0
1.0									

```
                                                                          ***

      ***              ***              ***              ***              ***

                              HYDROGRAPH AT STATION    B

     TOTAL RAINFALL =    7.46, TOTAL LOSS =    1.84, TOTAL EXCESS =    5.63

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR    249.10-HR
 +   (CFS)       (HR)
                              (CFS)
 +      13.    153.00                      6.          3.          1.          1.
                            (INCHES)   1.251       2.328       3.329       5.617
                            (AC-FT)       3.          5.          8.         13.

                            CUMULATIVE AREA =     0.04 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   94 KK      *    C       *
              *            *
              **************


   95 IN           TIME DATA FOR INPUT TIME SERIES
                        JXMIN          60   TIME INTERVAL IN MINUTES
                        JXDATE    31DEC99   STARTING DATE
                        JXTIME       2400   STARTING TIME

                SUBBASIN RUNOFF DATA

  122 BA           SUBBASIN CHARACTERISTICS
                        TAREA,       0.06   SUBBASIN AREA

                   PRECIPITATION DATA

   97 PB                STORM        7.46   BASIN TOTAL PRECIPITATION


  123 LU           UNIFORM LOSS RATE
                        STRTL        0.20   INITIAL LOSS
                        CNSTL        0.06   UNIFORM LOSS RATE
                        RTIMP       56.96   PERCENT IMPERVIOUS AREA

  122 UI           INPUT UNITGRAPH, 114 ORDINATES,   VOLUME = 1.00
                        3.6        8.6       13.9       19.4       24.6       32.0       38.8       46.7       55.2       64.3
                       74.3       85.7       96.7      102.1      103.8      103.1      100.8       93.3       84.5       75.7
                       68.0       63.1       58.2       52.9       49.4       45.7       42.2       39.3       36.6       34.0
                       31.8       29.8       27.9       26.2       24.5       23.2       22.0       20.6       19.5       18.5
                       17.5       16.8       15.8       15.1       14.2       13.7       13.1       12.7       12.2       11.8
                       11.3       10.8       10.4       10.0        9.6        9.3        9.0        8.6        8.4        8.0
                        7.8        7.4        7.2        6.8        6.6        6.4        6.2        5.9        5.7        5.5
                        5.3        5.1        4.9        4.8        4.6        4.4        4.3        4.1        3.9        3.8
                        3.6        3.5        3.3        3.2        3.1        3.0        2.9        2.8        2.7        2.6
                        2.5        2.5        2.4        2.3        2.2        2.1        2.0        2.0        1.9        1.8
                        1.7        1.7        1.6        1.6        1.5        1.5        1.4        1.3        1.3        1.3
                        1.2        1.2        1.1        1.1
                                                                          ***

      ***              ***              ***              ***              ***

                              HYDROGRAPH AT STATION    C

     TOTAL RAINFALL =    7.46, TOTAL LOSS =    1.89, TOTAL EXCESS =    5.57

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR    249.10-HR
 +   (CFS)       (HR)
                              (CFS)
 +      18.    153.02                      8.          4.          2.          1.
                            (INCHES)   1.241       2.310       3.301       5.563
                            (AC-FT)       4.          8.         11.         18.

                            CUMULATIVE AREA =     0.06 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  137 KK      *    D       *
              *            *
              **************
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138 IN          TIME DATA FOR INPUT TIME SERIES
                     JXMIN         60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

              SUBBASIN RUNOFF DATA

165 BA          SUBBASIN CHARACTERISTICS
                     TAREA,        0.05  SUBBASIN AREA

                PRECIPITATION DATA

140 PB               STORM         7.46  BASIN TOTAL PRECIPITATION


166 LU          UNIFORM LOSS RATE
                     STRTL         0.20  INITIAL LOSS
                     CNSTL         0.07  UNIFORM LOSS RATE
                     RTIMP        47.04  PERCENT IMPERVIOUS AREA

165 UI          INPUT UNITGRAPH, 111 ORDINATES,  VOLUME = 1.00
                      2.9      6.9     11.2     15.4     19.9     25.6     31.2     37.6     44.5     51.8
                     60.1     69.3     77.9     79.9     80.7     79.4     76.0     69.2     62.2     55.6
                     50.7     46.9     42.5     39.4     36.5     33.5     31.2     28.9     26.9     25.0
                     23.4     21.9     20.5     19.2     18.1     17.1     16.1     15.2     14.4     13.6
                     13.0     12.2     11.6     11.0     10.5     10.1      9.7      9.4      9.0      8.6
                      8.3      8.0      7.7      7.4      7.1      6.8      6.6      6.3      6.1      5.9
                      5.7      5.4      5.2      5.0      4.9      4.6      4.5      4.3      4.1      4.0
                      3.9      3.7      3.6      3.4      3.3      3.2      3.0      3.0      2.8      2.7
                      2.6      2.5      2.4      2.3      2.2      2.1      2.0      2.0      1.9      1.9
                      1.8      1.7      1.7      1.6      1.6      1.5      1.4      1.4      1.3      1.3
                      1.2      1.2      1.1      1.1      1.0      1.0      1.0      1.0      0.9      0.9
                      0.8

                                                         ***

     ***           ***           ***           ***           ***

                      HYDROGRAPH AT STATION   D

   TOTAL RAINFALL =    7.46, TOTAL LOSS =   2.41, TOTAL EXCESS =   5.06

 PEAK FLOW      TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR        24-HR       72-HR    249.10-HR
+   (CFS)       (HR)
                         (CFS)
+      14.    153.02                   6.          3.          1.          1.
                       (INCHES)    1.192       2.145       3.040       5.052
                        (AC-FT)       3.          5.          8.         13.

                     CUMULATIVE AREA =    0.05 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
180 KK     *     E      *
           *            *
           **************


181 IN          TIME DATA FOR INPUT TIME SERIES
                     JXMIN         60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

              SUBBASIN RUNOFF DATA

208 BA          SUBBASIN CHARACTERISTICS
                     TAREA,        0.04  SUBBASIN AREA

                PRECIPITATION DATA

183 PB               STORM         7.46  BASIN TOTAL PRECIPITATION


209 LU          UNIFORM LOSS RATE
                     STRTL         0.20  INITIAL LOSS
                     CNSTL         0.06  UNIFORM LOSS RATE
                     RTIMP        60.77  PERCENT IMPERVIOUS AREA

208 UI          INPUT UNITGRAPH,  93 ORDINATES,  VOLUME = 1.00
                      3.6      8.3     13.5     18.0     24.8     31.4     38.9     47.3     56.5     67.1
                     75.9     77.9     77.6     75.1     67.2     59.1     51.6     47.0     42.2     38.2
                     34.9     31.6     29.0     26.5     24.2     22.4     20.7     19.1     17.8     16.6
                     15.4     14.4     13.5     12.8     11.8     11.2     10.5      9.9      9.6      9.1
                      8.7      8.3      7.9      7.5      7.2      6.9      6.5      6.3      6.0      5.7
                      5.5      5.2      4.9      4.8      4.5      4.3      4.1      3.9      3.8      3.6
                      3.4      3.3      3.1      3.0      2.9      2.7      2.6      2.5      2.3      2.2
```

```
                 2.1     2.0     2.0     1.9     1.8     1.8     1.7     1.6     1.5     1.4
                 1.4     1.3     1.3     1.2     1.1     1.1     1.0     1.0     0.9     0.9
                 0.9     0.8     0.8

                                                     ***

      ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION    E

   TOTAL RAINFALL =     7.46, TOTAL LOSS =    1.67, TOTAL EXCESS =    5.80

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR         24-HR       72-HR     249.10-HR
+   (CFS)       (HR)
                              (CFS)
+      11.    153.00                     5.            2.          1.           1.
                            (INCHES)   1.268        2.386       3.418        5.788
                             (AC-FT)      3.            5.          7.          12.

                         CUMULATIVE AREA =     0.04 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  221 KK    *   DUMMY1   *
            *            *
            **************

  223 HC        HYDROGRAPH COMBINATION
                    ICOMP             5   NUMBER OF HYDROGRAPHS TO COMBINE

                                                     ***

      ***          ***          ***          ***          ***

                    HYDROGRAPH AT STATION    DUMMY1

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR         24-HR       72-HR     249.10-HR
+   (CFS)       (HR)
                              (CFS)
+      89.    153.02                    41.           19.          9.           4.
                            (INCHES)   1.237        2.318       3.314        5.587
                             (AC-FT)     20.           38.         54.          91.

                         CUMULATIVE AREA =     0.31 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  225 KK    *     F      *
            *            *
            **************

  226 IN        TIME DATA FOR INPUT TIME SERIES
                    JXMIN            60   TIME INTERVAL IN MINUTES
                    JXDATE      31DEC99   STARTING DATE
                    JXTIME         2400   STARTING TIME

             SUBBASIN RUNOFF DATA

  253 BA        SUBBASIN CHARACTERISTICS
                    TAREA,         0.05   SUBBASIN AREA

                PRECIPITATION DATA

  228 PB            STORM          7.46   BASIN TOTAL PRECIPITATION


  254 LU        UNIFORM LOSS RATE
                    STRTL          0.20   INITIAL LOSS
                    CNSTL          0.07   UNIFORM LOSS RATE
                    RTIMP         49.51   PERCENT IMPERVIOUS AREA

  253 UI        INPUT UNITGRAPH,  98 ORDINATES,   VOLUME = 1.00
                 3.8     8.9    14.4    19.2    26.6    33.3    41.3    50.0    59.1    70.1
                81.5    88.1    89.8    88.7    84.8    76.2    67.3    59.3    54.2    49.1
                44.5    40.9    37.1    34.3    31.5    28.9    26.9    24.8    23.1    21.4
                20.0    18.8    17.5    16.4    15.4    14.7    13.6    12.9    12.2    11.5
                11.1    10.6    10.2     9.7     9.2     8.9     8.5     8.1     7.8     7.4
                 7.2     6.8     6.5     6.3     5.9     5.7     5.5     5.3     5.0     4.8
                 4.6     4.4     4.2     4.1     3.9     3.7     3.6     3.4     3.3     3.1
```

```
              2.9      2.8      2.7      2.6      2.5      2.4      2.3      2.2      2.1      2.0
              2.0      1.9      1.8      1.7      1.6      1.5      1.5      1.4      1.4      1.3
              1.3      1.2      1.2      1.1      1.1      1.0      1.0      0.9
                                                  ***

    ***           ***         ***         ***         ***

                HYDROGRAPH AT STATION   F

   TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.34, TOTAL EXCESS =    5.12

  PEAK FLOW    TIME                         MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     249.10-HR
 +  (CFS)      (HR)
                         (CFS)
 +     13.   153.00                 6.          3.          1.          1.
                       (INCHES)  1.197       2.155       3.066       5.114
                        (AC-FT)     3.          5.          7.         12.

                  CUMULATIVE AREA =    0.05 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
 266 KK      *    G       *
             *            *
             **************

 267 IN           TIME DATA FOR INPUT TIME SERIES
                      JXMIN          60  TIME INTERVAL IN MINUTES
                      JXDATE    31DEC99  STARTING DATE
                      JXTIME       2400  STARTING TIME

                SUBBASIN RUNOFF DATA

 294 BA           SUBBASIN CHARACTERISTICS
                      TAREA,       0.06  SUBBASIN AREA

                  PRECIPITATION DATA

 269 PB               STORM        7.46  BASIN TOTAL PRECIPITATION


 295 LU           UNIFORM LOSS RATE
                      STRTL        0.20  INITIAL LOSS
                      CNSTL        0.07  UNIFORM LOSS RATE
                      RTIMP       38.92  PERCENT IMPERVIOUS AREA

 294 UI           INPUT UNITGRAPH, 109 ORDINATES,  VOLUME = 1.00
                  3.9      9.4     15.2     20.9     27.1     34.7     42.5     51.2     60.7     70.5
                 82.1     94.6    104.6    107.1    107.6    105.5     99.6     90.2     80.7     72.1
                 66.3     61.1     55.2     51.4     47.4     43.7     40.6     37.6     34.8     32.6
                 30.4     28.5     26.6     24.9     23.5     22.2     20.8     19.7     18.6     17.8
                 16.7     15.9     14.9     14.4     13.6     13.3     12.7     12.3     11.7     11.2
                 10.8     10.4     10.0      9.6      9.2      8.8      8.6      8.2      7.9      7.6
                  7.3      7.0      6.7      6.6      6.2      6.0      5.8      5.5      5.4      5.2
                  4.9      4.8      4.6      4.4      4.2      4.1      3.9      3.7      3.6      3.4
                  3.3      3.2      3.1      3.0      2.8      2.7      2.7      2.6      2.5      2.4
                  2.3      2.2      2.1      2.0      2.0      1.9      1.8      1.7      1.7      1.6
                  1.6      1.5      1.4      1.4      1.3      1.3      1.3      1.2      1.1
                                                  ***

    ***           ***         ***         ***         ***

                HYDROGRAPH AT STATION   G

   TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.83, TOTAL EXCESS =    4.63

  PEAK FLOW    TIME                         MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     249.10-HR
 +  (CFS)      (HR)
                         (CFS)
 +     18.   153.02                 8.          3.          2.          1.
                       (INCHES)  1.152       2.007       2.822       4.625
                        (AC-FT)     4.          7.          9.         15.

                  CUMULATIVE AREA =    0.06 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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             *            *
 308 KK      *    H       *
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                *            *
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309 IN          TIME DATA FOR INPUT TIME SERIES
                     JXMIN          60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

              SUBBASIN RUNOFF DATA

336 BA          SUBBASIN CHARACTERISTICS
                     TAREA,       0.11  SUBBASIN AREA

                PRECIPITATION DATA

311 PB               STORM        7.46  BASIN TOTAL PRECIPITATION


337 LU          UNIFORM LOSS RATE
                     STRTL        0.20  INITIAL LOSS
                     CNSTL        0.07  UNIFORM LOSS RATE
                     RTIMP       46.94  PERCENT IMPERVIOUS AREA

336 UI          INPUT UNITGRAPH, 161 ORDINATES,  VOLUME = 1.00
                     3.2      7.2     11.8     16.6     21.8     26.1     30.9     38.0     43.8     50.3
                    57.5     64.8     72.9     81.1     89.7     99.5    110.0    120.1    128.4    130.8
                   132.2    132.3    130.9    128.5    122.0    114.2    106.3     98.3     91.0     85.1
                    80.7     76.3     71.4     67.0     63.9     60.6     57.2     54.1     51.5     48.9
                    46.5     44.1     41.7     40.1     38.3     36.5     34.9     33.3     31.9     30.5
                    29.3     28.2     27.1     25.9     24.9     24.0     23.1     22.3     21.6     20.7
                    19.9     19.4     18.5     18.0     17.4     16.8     16.5     16.0     15.6     15.3
                    14.8     14.4     13.9     13.6     13.3     12.9     12.5     12.2     11.9     11.6
                    11.3     10.9     10.7     10.4     10.1      9.9      9.6      9.4      9.1      8.8
                     8.6      8.4      8.1      8.1      7.8      7.5      7.3      7.1      6.9      6.8
                     6.6      6.5      6.3      6.1      6.0      5.8      5.7      5.5      5.4      5.2
                     5.1      4.9      4.8      4.7      4.5      4.4      4.3      4.2      4.1      4.0
                     3.9      3.8      3.7      3.6      3.5      3.4      3.3      3.2      3.2      3.1
                     3.0      3.0      2.9      2.8      2.7      2.7      2.6      2.5      2.4      2.4
                     2.3      2.2      2.2      2.1      2.1      2.0      2.0      1.9      1.9      1.8
                     1.8      1.7      1.7      1.6      1.6      1.6      1.5      1.5      1.5      1.4
                     1.4

                                                ***

      ***           ***           ***           ***           ***

                    HYDROGRAPH AT STATION    H

  TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.44, TOTAL EXCESS =    5.02

 PEAK FLOW      TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR       72-HR     249.10-HR
+  (CFS)        (HR)
                          (CFS)
+     31.     153.05                14.          6.          3.          1.
                        (INCHES)   1.177       2.128       3.019       5.015
                        (AC-FT)       7.         13.         18.         30.

                     CUMULATIVE AREA =    0.11 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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                *            *
356 KK          *     I      *
                *            *
                **************


357 IN          TIME DATA FOR INPUT TIME SERIES
                     JXMIN          60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

              SUBBASIN RUNOFF DATA

384 BA          SUBBASIN CHARACTERISTICS
                     TAREA,       0.08  SUBBASIN AREA

                PRECIPITATION DATA

359 PB               STORM        7.46  BASIN TOTAL PRECIPITATION

385 LU          UNIFORM LOSS RATE
                     STRTL        0.20  INITIAL LOSS
                     CNSTL        0.07  UNIFORM LOSS RATE
                     RTIMP       46.33  PERCENT IMPERVIOUS AREA

384 UI          INPUT UNITGRAPH, 186 ORDINATES,  VOLUME = 1.00
                     1.8      4.0      6.5      9.2     12.0     15.0     17.4     20.0     24.1     27.6
```

30.9	34.9	39.0	43.2	47.9	52.6	57.3	62.8	68.5	74.5
80.1	84.7	86.1	87.0	87.6	86.8	85.8	84.5	80.1	75.7
71.2	66.6	62.2	58.2	55.4	52.9	50.4	47.6	44.8	43.0
41.2	39.3	37.3	35.6	34.1	32.7	31.2	29.9	28.5	27.3
26.4	25.3	24.2	23.4	22.5	21.6	20.8	20.0	19.3	18.7
18.1	17.4	16.8	16.2	15.7	15.2	14.7	14.4	13.9	13.3
13.0	12.6	12.1	11.9	11.6	11.2	11.0	10.8	10.5	10.3
10.1	9.8	9.6	9.3	9.1	8.9	8.7	8.5	8.3	8.1
7.9	7.8	7.6	7.4	7.2	7.1	6.9	6.7	6.6	6.4
6.3	6.2	6.0	5.8	5.7	5.6	5.4	5.4	5.3	5.1
5.0	4.9	4.8	4.6	4.5	4.4	4.4	4.3	4.2	4.1
4.0	3.9	3.8	3.7	3.6	3.6	3.5	3.4	3.3	3.2
3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.7	2.6	2.5
2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1
2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.6
1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3
1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1
1.0	1.0	1.0	1.0	0.9	0.9				

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                 HYDROGRAPH AT STATION   I

   TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.42, TOTAL EXCESS =    5.05

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR    249.10-HR
+  (CFS)       (HR)
                           (CFS)
+      23.    153.08                 11.          5.          2.          1.
                         (INCHES)   1.178       2.146       3.038       5.043
                          (AC-FT)      5.         10.         14.         23.

                 CUMULATIVE AREA =     0.08 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  406 KK      *     J      *
              *            *
              **************

  407 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN          60  TIME INTERVAL IN MINUTES
                       JXDATE    31DEC99  STARTING DATE
                       JXTIME       2400  STARTING TIME

                 SUBBASIN RUNOFF DATA

  434 BA          SUBBASIN CHARACTERISTICS
                       TAREA,       0.09  SUBBASIN AREA

                  PRECIPITATION DATA

  409 PB               STORM        7.46  BASIN TOTAL PRECIPITATION

  435 LU          UNIFORM LOSS RATE
                       STRTL        0.20  INITIAL LOSS
                       CNSTL        0.06  UNIFORM LOSS RATE
                       RTIMP       75.17  PERCENT IMPERVIOUS AREA

  434 UI          INPUT UNITGRAPH, 119 ORDINATES,  VOLUME = 1.00
```

4.5	11.0	17.8	25.1	30.9	40.9	49.1	59.2	69.8	81.4
93.3	107.5	122.4	135.0	138.1	139.5	137.5	133.1	122.1	110.8
99.7	90.3	84.1	77.7	70.9	66.3	61.6	57.0	53.3	49.7
46.3	43.2	40.8	38.2	36.0	33.8	31.9	30.2	28.7	27.0
25.7	24.4	23.2	22.2	21.0	20.0	19.0	18.3	17.5	17.0
16.4	15.8	15.2	14.6	14.1	13.6	13.1	12.6	12.2	11.7
11.3	10.9	10.6	10.2	9.8	9.5	9.1	8.8	8.5	8.2
7.9	7.6	7.3	7.1	6.9	6.6	6.4	6.2	5.9	5.7
5.5	5.3	5.2	4.9	4.7	4.5	4.4	4.2	4.1	4.0
3.8	3.7	3.5	3.4	3.4	3.3	3.2	3.0	2.9	2.8
2.7	2.6	2.5	2.4	2.3	2.3	2.2	2.1	2.0	2.0
1.9	1.8	1.8	1.7	1.7	1.6	1.5	1.5	1.5	

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                 HYDROGRAPH AT STATION   J

   TOTAL RAINFALL =    7.46, TOTAL LOSS =    1.02, TOTAL EXCESS =    6.44

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR    249.10-HR
+  (CFS)       (HR)
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                                  (CFS)
+      26.    153.02                    12.           6.          3.          1.
                                (INCHES)  1.319       2.580       3.740       6.439
                                (AC-FT)     6.          12.         17.         29.

                                CUMULATIVE AREA =    0.09 SQ MI
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              **************
              *            *
 449 KK       *   OFF-N    *
              *            *
              **************
                       85

 450 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN         60  TIME INTERVAL IN MINUTES
                      JXDATE   31DEC99  STARTING DATE
                      JXTIME      2400  STARTING TIME

                 SUBBASIN RUNOFF DATA

 477 BA          SUBBASIN CHARACTERISTICS
                      TAREA,      0.84  SUBBASIN AREA

                 PRECIPITATION DATA

 452 PB               STORM       7.46  BASIN TOTAL PRECIPITATION


 478 LU          UNIFORM LOSS RATE
                      STRTL       0.20  INITIAL LOSS
                      CNSTL       0.07  UNIFORM LOSS RATE
                      RTIMP       2.00  PERCENT IMPERVIOUS AREA

 477 UI          INPUT UNITGRAPH, 472 ORDINATES,   VOLUME = 1.00
```

2.8	5.6	8.4	11.3	15.4	19.4	23.5	27.5	31.8	36.0
40.2	44.5	49.1	53.8	58.4	62.7	66.2	69.6	73.1	77.5
83.9	90.2	96.5	102.3	107.4	112.5	117.5	123.2	129.4	135.7
142.0	148.4	155.0	161.6	168.1	175.1	182.3	189.6	196.8	204.2
211.5	218.9	226.2	234.6	243.3	252.1	260.8	270.1	279.5	288.9
298.3	307.0	315.6	324.2	332.7	335.3	337.4	339.4	341.5	342.7
343.8	344.9	346.0	344.8	343.7	342.5	341.3	339.2	337.1	335.1
332.1	325.3	318.5	311.7	304.8	297.8	290.7	283.7	276.6	269.5
262.4	255.2	248.4	242.2	236.0	229.7	224.5	220.6	216.7	212.8
208.9	205.0	201.1	197.3	193.0	188.4	183.9	179.3	175.9	173.0
170.2	167.4	164.5	161.6	158.6	155.7	152.6	149.6	146.6	143.5
141.1	138.9	136.6	134.3	131.9	129.6	127.3	125.0	122.9	120.8
118.8	116.7	114.6	112.5	110.3	108.3	106.9	105.4	104.0	102.5
100.8	99.0	97.3	95.7	94.3	93.0	91.6	90.2	88.8	87.4
86.0	84.6	83.4	82.1	80.8	79.6	78.6	77.5	76.5	75.5
74.6	73.6	72.7	71.7	70.6	69.5	68.4	67.4	66.6	65.7
64.8	64.0	63.2	62.4	61.6	60.8	60.0	59.2	58.4	57.8
57.3	56.7	56.1	55.3	54.4	53.5	52.6	52.1	51.6	51.2
50.7	49.9	49.1	48.3	47.5	47.2	46.8	46.5	46.1	45.5
44.9	44.2	43.7	43.5	43.2	42.9	42.6	42.2	41.7	41.3
40.9	40.6	40.3	40.0	39.6	39.2	38.8	38.4	38.0	37.6
37.3	36.8	36.5	36.1	35.8	35.4	35.1	34.9	34.6	34.3
34.0	33.7	33.3	33.0	32.6	32.3	32.0	31.7	31.5	31.3
31.0	30.8	30.5	30.2	29.9	29.6	29.3	29.0	28.7	28.4
28.2	28.0	27.8	27.6	27.4	27.0	26.7	26.4	26.3	26.1
25.9	25.7	25.4	25.1	24.8	24.5	24.4	24.3	24.1	23.9
23.6	23.3	23.0	22.8	22.6	22.4	22.2	22.0	21.8	21.6
21.4	21.2	21.1	21.1	21.0	20.8	20.5	20.2	20.0	19.8
19.6	19.4	19.3	19.1	18.9	18.7	18.5	18.4	18.2	18.0
17.8	17.7	17.6	17.4	17.3	17.2	17.0	16.9	16.8	16.6
16.4	16.3	16.1	15.9	15.8	15.7	15.6	15.4	15.3	15.2
15.0	14.9	14.8	14.6	14.5	14.4	14.2	14.1	14.0	13.8
13.7	13.6	13.4	13.3	13.2	13.0	12.9	12.9	12.8	12.7
12.5	12.4	12.2	12.0	11.9	11.8	11.7	11.6	11.5	11.4
11.2	11.1	11.0	10.9	10.8	10.7	10.7	10.6	10.5	10.4
10.3	10.2	10.1	10.0	9.9	9.9	9.8	9.7	9.6	9.5
9.4	9.3	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.6
8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.1
8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.4
7.3	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8
6.8	6.7	6.6	6.5	6.4	6.4	6.3	6.3	6.2	6.2
6.1	6.0	5.9	5.8	5.8	5.8	5.7	5.7	5.6	5.6
5.5	5.5	5.4	5.4	5.4	5.3	5.3	5.2	5.2	5.1
5.1	5.1	5.0	5.0	4.9	4.9	4.8	4.8	4.7	4.7
4.7	4.6	4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.3
4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.0	4.0
4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.6	3.6	3.6
3.6	3.6								

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HYDROGRAPH AT STATION   OFF-N

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      TOTAL RAINFALL =     7.46, TOTAL LOSS =     4.55, TOTAL EXCESS =     2.92

    PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR     249.10-HR
 +    (CFS)        (HR)
                                (CFS)
 +      162.     153.62                    86.          34.          15.          6.
                              (INCHES)   0.945        1.484        1.969        2.916
                               (AC-FT)     43.          67.          89.        131.

                             CUMULATIVE AREA =     0.84 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

               **************
               *            *
   528 KK      *   DUMMY2   *
               *            *
               **************

   530 HC            HYDROGRAPH COMBINATION
                         ICOMP            6  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                        ***

       ***                ***              ***               ***               ***

                                 HYDROGRAPH AT STATION    DUMMY2

    PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR     249.10-HR
 +    (CFS)        (HR)
                                (CFS)
 +      252.     153.17                   134.          56.          26.         12.
                              (INCHES)   1.010        1.703        2.344        3.663
                               (AC-FT)     66.         112.         154.        241.

                             CUMULATIVE AREA =     1.23 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

               **************
               *            *
   532 KK      *     K      *
               *            *
               **************

   533 IN            TIME DATA FOR INPUT TIME SERIES
                         JXMIN           60  TIME INTERVAL IN MINUTES
                         JXDATE     31DEC99  STARTING DATE
                         JXTIME        2400  STARTING TIME

                  SUBBASIN RUNOFF DATA

   560 BA            SUBBASIN CHARACTERISTICS
                         TAREA,        0.06  SUBBASIN AREA

                     PRECIPITATION DATA

   535 PB                STORM         7.46  BASIN TOTAL PRECIPITATION

   561 LU            UNIFORM LOSS RATE
                         STRTL         0.20  INITIAL LOSS
                         CNSTL         0.06  UNIFORM LOSS RATE
                         RTIMP        47.94  PERCENT IMPERVIOUS AREA

   560 UI            INPUT UNITGRAPH, 151 ORDINATES,  VOLUME = 1.00
                          2.0       4.7       7.7      10.8      14.1      16.7      20.6      24.8      28.5      33.1
                         37.8      42.8      48.1      53.5      59.8      66.5      72.9      77.8      79.3      80.1
                         79.7      78.5      76.3      71.3      66.3      61.2      56.3      52.0      49.2      46.4
                         43.3      40.5      38.4      36.3      34.1      32.3      30.6      28.9      27.4      25.9
                         24.6      23.5      22.3      21.3      20.3      19.3      18.4      17.7      17.0      16.3
                         15.5      14.9      14.3      13.8      13.3      12.8      12.2      11.8      11.3      10.9
                         10.6      10.2      10.0       9.7       9.4       9.2       8.9       8.6       8.3       8.1
                          7.9       7.7       7.4       7.3       7.1       6.8       6.6       6.5       6.3       6.1
                          6.0       5.8       5.6       5.5       5.3       5.1       5.0       4.9       4.8       4.6
                          4.5       4.3       4.2       4.1       4.0       3.9       3.8       3.7       3.6       3.5
                          3.4       3.3       3.2       3.1       3.0       2.9       2.8       2.7       2.7       2.6
                          2.5       2.4       2.4       2.3       2.3       2.2       2.1       2.1       2.0       2.0
                          1.9       1.9       1.8       1.8       1.7       1.7       1.6       1.6       1.6       1.5
                          1.5       1.4       1.4       1.3       1.3       1.3       1.2       1.2       1.2       1.1
                          1.1       1.1       1.0       1.0       1.0       1.0       1.0       0.9       0.9       0.9
                          0.8
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                           HYDROGRAPH AT STATION   K

    TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.31, TOTAL EXCESS =    5.16

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR      72-HR    249.10-HR
+   (CFS)       (HR)
                             (CFS)
+       18.    153.05                     8.          4.         2.          1.
                           (INCHES)     1.196       2.184      3.094       5.149
                           (AC-FT)        4.          7.        10.         17.

                           CUMULATIVE AREA =     0.06 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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            *            *
  579 KK    *     L      *
            *            *
            **************

  580 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         60   TIME INTERVAL IN MINUTES
                       JXDATE   31DEC99   STARTING DATE
                       JXTIME      2400   STARTING TIME

                SUBBASIN RUNOFF DATA

  607 BA          SUBBASIN CHARACTERISTICS
                       TAREA,       0.03  SUBBASIN AREA

                  PRECIPITATION DATA

  582 PB               STORM        7.46  BASIN TOTAL PRECIPITATION

  608 LU          UNIFORM LOSS RATE
                       STRTL        0.20  INITIAL LOSS
                       CNSTL        0.06  UNIFORM LOSS RATE
                       RTIMP       70.00  PERCENT IMPERVIOUS AREA

  607 UI          INPUT UNITGRAPH,  67 ORDINATES,   VOLUME = 1.00
                      6.4      14.7      22.9      33.6      45.9      59.7      76.2      91.6      94.5      91.6
                     79.6      66.3      57.2      49.1      43.4      38.0      33.6      29.7      26.7      23.9
                     21.5      19.6      17.7      16.2      14.9      13.7      12.6      11.7      11.0      10.3
                      9.6       9.0       8.5       7.9       7.5       7.0       6.6       6.1       5.8       5.4
                      5.1       4.8       4.5       4.2       4.0       3.7       3.5       3.2       3.0       2.8
                      2.7       2.5       2.4       2.3       2.1       2.0       1.9       1.7       1.6       1.5
                      1.4       1.4       1.3       1.2       1.1       1.1       1.0
                                                                  ***

      ***            ***            ***            ***            ***

                           HYDROGRAPH AT STATION   L

    TOTAL RAINFALL =    7.46, TOTAL LOSS =    1.29, TOTAL EXCESS =    6.18

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR      72-HR    249.10-HR
+   (CFS)       (HR)
                             (CFS)
+       10.    153.00                     5.          2.         1.          1.
                           (INCHES)     1.303       2.494      3.603       6.168
                           (AC-FT)        2.          4.         6.         11.

                           CUMULATIVE AREA =     0.03 SQ MI

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  617 KK    *     M      *
            *            *
            **************

  618 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN         60   TIME INTERVAL IN MINUTES
                       JXDATE   31DEC99   STARTING DATE
```

JXTIME 2400 STARTING TIME

SUBBASIN RUNOFF DATA

645 BA SUBBASIN CHARACTERISTICS
TAREA, 0.07 SUBBASIN AREA

PRECIPITATION DATA

620 PB STORM 7.46 BASIN TOTAL PRECIPITATION

646 LU UNIFORM LOSS RATE
STRTL 0.20 INITIAL LOSS
CNSTL 0.04 UNIFORM LOSS RATE
RTIMP 95.00 PERCENT IMPERVIOUS AREA

645 UI INPUT UNITGRAPH, 160 ORDINATES, VOLUME = 1.00

1.9	4.4	7.2	10.0	13.2	15.8	18.8	23.1	26.6	30.5
34.9	39.3	44.2	49.2	54.4	60.4	66.8	72.8	77.6	79.0
79.8	79.7	78.8	77.4	73.1	68.4	63.6	58.8	54.4	51.0
48.4	45.7	42.7	40.2	38.3	36.3	34.2	32.4	30.8	29.2
27.8	26.4	25.0	24.0	22.9	21.8	20.9	19.9	19.0	18.2
17.5	16.9	16.2	15.5	14.9	14.4	13.8	13.4	13.0	12.4
11.9	11.5	11.0	10.8	10.4	10.1	9.9	9.6	9.4	9.1
8.9	8.6	8.3	8.1	7.9	7.7	7.5	7.3	7.1	6.9
6.7	6.5	6.4	6.2	6.1	5.9	5.7	5.6	5.4	5.3
5.1	5.0	4.9	4.8	4.6	4.5	4.4	4.3	4.1	4.1
4.0	3.9	3.7	3.7	3.6	3.5	3.4	3.3	3.2	3.1
3.0	3.0	2.9	2.8	2.7	2.6	2.5	2.5	2.4	2.4
2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8
1.8	1.8	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.4
1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1
1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.8

***

*** *** *** *** ***

HYDROGRAPH AT STATION M

TOTAL RAINFALL = 7.46, TOTAL LOSS = 0.17, TOTAL EXCESS = 7.30

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	249.10-HR
+ (CFS)	(HR)					
		(CFS)				
+ 20.	153.05		10.	5.	2.	1.
		(INCHES)	1.378	2.825	4.154	7.286
		(AC-FT)	5.	10.	15.	26.

CUMULATIVE AREA = 0.07 SQ MI

*** ***

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*            *
*     N      *
*            *
**************
```

664 KK N

665 IN TIME DATA FOR INPUT TIME SERIES
JXMIN 60 TIME INTERVAL IN MINUTES
JXDATE 31DEC99 STARTING DATE
JXTIME 2400 STARTING TIME

SUBBASIN RUNOFF DATA

692 BA SUBBASIN CHARACTERISTICS
TAREA, 0.04 SUBBASIN AREA

PRECIPITATION DATA

667 PB STORM 7.46 BASIN TOTAL PRECIPITATION

693 LU UNIFORM LOSS RATE
STRTL 0.20 INITIAL LOSS
CNSTL 0.07 UNIFORM LOSS RATE
RTIMP 43.11 PERCENT IMPERVIOUS AREA

692 UI INPUT UNITGRAPH, 117 ORDINATES, VOLUME = 1.00

2.0	4.9	8.0	11.2	13.9	18.3	22.0	26.6	31.3	36.5
42.0	48.4	55.0	59.8	61.1	61.4	60.4	57.7	52.8	47.8
42.9	39.2	36.4	33.4	30.7	28.6	26.5	24.6	23.0	21.4
19.9	18.7	17.5	16.5	15.5	14.5	13.7	13.1	12.3	11.6
11.1	10.5	10.1	9.5	9.1	8.5	8.3	7.8	7.6	7.3
7.1	6.8	6.5	6.3	6.1	5.8	5.6	5.5	5.2	5.0
4.9	4.7	4.5	4.4	4.2	4.0	3.9	3.8	3.7	3.5
3.4	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4
2.4	2.3	2.2	2.1	2.0	1.9	1.9	1.8	1.7	1.7

```
          1.6     1.6     1.5     1.5     1.4     1.4     1.3     1.3     1.2     1.2
          1.1     1.1     1.0     1.0     1.0     1.0     0.9     0.9     0.9     0.8
          0.8     0.8     0.7     0.7     0.7     0.7     0.6
                                          ***

  ***        ***        ***        ***        ***

             HYDROGRAPH AT STATION   N

 TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.60, TOTAL EXCESS =    4.86

 PEAK FLOW     TIME                    MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR      72-HR    249.10-HR
+  (CFS)       (HR)
                        (CFS)
+      11.    153.02                5.         2.         1.          0.
                       (INCHES)   1.173      2.083      2.941       4.856
                        (AC-FT)      2.         4.         6.         10.

                    CUMULATIVE AREA =    0.04 SQ MI
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
 707 KK    *     O      *
           *            *
           **************

 708 IN         TIME DATA FOR INPUT TIME SERIES
                     JXMIN          60  TIME INTERVAL IN MINUTES
                     JXDATE    31DEC99  STARTING DATE
                     JXTIME       2400  STARTING TIME

              SUBBASIN RUNOFF DATA

 735 BA         SUBBASIN CHARACTERISTICS
                     TAREA,       0.04  SUBBASIN AREA

                PRECIPITATION DATA

 710 PB              STORM        7.46  BASIN TOTAL PRECIPITATION

 736 LU         UNIFORM LOSS RATE
                     STRTL        0.20  INITIAL LOSS
                     CNSTL        0.07  UNIFORM LOSS RATE
                     RTIMP       50.00  PERCENT IMPERVIOUS AREA

 735 UI         INPUT UNITGRAPH,  93 ORDINATES,   VOLUME = 1.00
                      3.7     8.6    14.0    18.7    25.8    32.7    40.4    49.1    58.6    69.6
                     79.8    82.0    82.1    79.9    72.3    63.8    55.8    50.5    45.7    41.1
                     37.6    34.0    31.3    28.6    26.1    24.3    22.3    20.7    19.1    17.9
                     16.7    15.5    14.6    13.7    12.8    12.1    11.3    10.7    10.3     9.8
                      9.4     8.9     8.5     8.1     7.7     7.4     7.1     6.7     6.5     6.2
                      5.9     5.6     5.3     5.1     4.9     4.7     4.5     4.3     4.1     3.9
                      3.7     3.6     3.4     3.3     3.1     3.0     2.8     2.7     2.6     2.5
                      2.3     2.2     2.1     2.0     2.0     1.9     1.8     1.7     1.7     1.6
                      1.5     1.4     1.4     1.3     1.3     1.2     1.2     1.1     1.0     1.0
                      1.0     0.9     0.9
                                          ***

  ***        ***        ***        ***        ***

             HYDROGRAPH AT STATION   O

 TOTAL RAINFALL =    7.46, TOTAL LOSS =    2.32, TOTAL EXCESS =    5.15

 PEAK FLOW     TIME                    MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR      72-HR    249.10-HR
+  (CFS)       (HR)
                        (CFS)
+      12.    153.00                5.         2.         1.          1.
                       (INCHES)   1.199      2.162      3.076       5.135
                        (AC-FT)      3.         5.         7.         11.

                    CUMULATIVE AREA =    0.04 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
 748 KK    *     P      *
           *            *
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              **************

   749 IN          TIME DATA FOR INPUT TIME SERIES
                         JXMIN         60  TIME INTERVAL IN MINUTES
                         JXDATE    31DEC99  STARTING DATE
                         JXTIME       2400  STARTING TIME

                 SUBBASIN RUNOFF DATA

   776 BA          SUBBASIN CHARACTERISTICS
                         TAREA,        0.03  SUBBASIN AREA

                   PRECIPITATION DATA

   751 PB                STORM         7.46  BASIN TOTAL PRECIPITATION


   777 LU          UNIFORM LOSS RATE
                         STRTL         0.20  INITIAL LOSS
                         CNSTL         0.06  UNIFORM LOSS RATE
                         RTIMP        56.38  PERCENT IMPERVIOUS AREA

   776 UI          INPUT UNITGRAPH, 102 ORDINATES,  VOLUME = 1.00
                         2.6       6.2      10.0      13.4      18.2      22.8      28.3      34.2      40.5      47.7
                        55.7      62.7      64.3      64.5      63.1      58.5      52.4      46.3      41.5      38.1
                        34.4      31.5      29.0      26.5      24.5      22.6      20.8      19.4      17.9      16.7
                        15.6      14.5      13.7      12.8      12.0      11.3      10.7      10.1       9.6       8.9
                         8.6       8.1       7.8       7.5       7.2       6.9       6.6       6.3       6.0       5.8
                         5.6       5.3       5.1       4.9       4.7       4.5       4.3       4.1       4.0       3.8
                         3.6       3.5       3.3       3.2       3.1       3.0       2.8       2.7       2.6       2.5
                         2.4       2.3       2.2       2.1       2.0       1.9       1.8       1.8       1.7       1.6
                         1.6       1.5       1.5       1.4       1.3       1.3       1.2       1.2       1.1       1.1
                         1.0       1.0       1.0       0.9       0.9       0.8       0.8       0.8       0.8       0.7
                         0.7       0.7

                                                           ***

         ***            ***            ***            ***            ***

                           HYDROGRAPH AT STATION   P

     TOTAL RAINFALL =    7.46, TOTAL LOSS =    1.90, TOTAL EXCESS =    5.56

   PEAK FLOW      TIME                        MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR     249.10-HR
 +   (CFS)        (HR)
                            (CFS)
 +       10.     153.02                  5.          2.          1.           0.
                          (INCHES)   1.245       2.313       3.303        5.562
                           (AC-FT)      2.          4.          6.          10.

                           CUMULATIVE AREA =    0.03 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   790 KK     *   DUMMY3   *
              *            *
              **************

   792 HC          HYDROGRAPH COMBINATION
                         ICOMP            6  NUMBER OF HYDROGRAPHS TO COMBINE

                                                           ***

         ***            ***            ***            ***            ***

                           HYDROGRAPH AT STATION   DUMMY3

   PEAK FLOW      TIME                        MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR       72-HR     249.10-HR
 +   (CFS)        (HR)
                            (CFS)
 +       81.     153.02                 37.         18.          8.           4.
                          (INCHES)   1.255       2.376       3.415        5.799
                           (AC-FT)     18.         35.         50.          85.

                           CUMULATIVE AREA =    0.27 SQ MI

1
                                                   RUNOFF SUMMARY
                                              FLOW IN CUBIC FEET PER SECOND
                                            TIME IN HOURS,  AREA IN SQUARE MILES

                                            PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM    TIME OF
           OPERATION        STATION         FLOW     PEAK                                            AREA      STAGE    MAX STAGE
 +                                                               6-HOUR     24-HOUR     72-HOUR
```

+	HYDROGRAPH AT	A	33.	153.07	16.	7.	4.	0.12
+	HYDROGRAPH AT	B	13.	153.00	6.	3.	1.	0.04
+	HYDROGRAPH AT	C	18.	153.02	8.	4.	2.	0.06
+	HYDROGRAPH AT	D	14.	153.02	6.	3.	1.	0.05
+	HYDROGRAPH AT	E	11.	153.00	5.	2.	1.	0.04
+	5 COMBINED AT	DUMMY1	89.	153.02	41.	19.	9.	0.31
+	HYDROGRAPH AT	F	13.	153.00	6.	3.	1.	0.05
+	HYDROGRAPH AT	G	18.	153.02	8.	3.	2.	0.06
+	HYDROGRAPH AT	H	31.	153.05	14.	6.	3.	0.11
+	HYDROGRAPH AT	I	23.	153.08	11.	5.	2.	0.08
+	HYDROGRAPH AT	J	26.	153.02	12.	6.	3.	0.09
+	HYDROGRAPH AT	OFF-N	162.	153.62	86.	34.	15.	0.84
+	6 COMBINED AT	DUMMY2	252.	153.17	134.	56.	26.	1.23
+	HYDROGRAPH AT	K	18.	153.05	8.	4.	2.	0.06
+	HYDROGRAPH AT	L	10.	153.00	5.	2.	1.	0.03
+	HYDROGRAPH AT	M	20.	153.05	10.	5.	2.	0.07
+	HYDROGRAPH AT	N	11.	153.02	5.	2.	1.	0.04
+	HYDROGRAPH AT	O	12.	153.00	5.	2.	1.	0.04
+	HYDROGRAPH AT	P	10.	153.02	5.	2.	1.	0.03
+	6 COMBINED AT	DUMMY3	81.	153.02	37.	18.	8.	0.27

*** NORMAL END OF HEC-1L ***

Ultimate Conditions HEC-RAS Model

25 100year 24hour Model

```
              HEC-RAS Version 3.1.3 May 2005
               U.S. Army Corp of Engineers
              Hydrologic Engineering Center
                     609 Second Street
                     Davis, California

X      X  XXXXXX   XXXX        XXXX      XX      XXXX
X      X  X       X    X       X   X    X  X    X
X      X  X       X            X   X   X    X   X
XXXXXXX   XXXX    X       XXX  XXXX    XXXXXX    XXXX
X      X  X       X            X  X    X    X        X
X      X  X       X    X       X   X   X    X        X
X      X  XXXXXX   XXXX        X    X  X    X   XXXXX
```

PROJECT DATA
Project Title: GREENBRIAR FARMS
Project File : GB.prj
Run Date and Time: 7/14/2005 3:37:39 PM

Project in English units

Project Description:
References:
1) Offsite Drainage Improvements-Metro Air Park, Exhibit D-2
(Offsite improved channels and Interstate 5 crossing)
2) 100yr-10day &
10yr-10day, STA 0+00, West Drain Stages, Mark Kubik @ Mead & Hunt Inc.

PLAN DATA

Plan Title: P3-100YR24HR-DEVELOP
Plan File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.p03

Geometry Title: DEVELOP
Geometry File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.g01

Flow Title :
Flow File :

```
Plan Summary Information:
Number of:  Cross Sections =  207    Multiple Openings  =   0
            Culverts       =    6    Inline Structures  =   1
            Bridges        =    0    Lateral Structures =   0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow
```

Profile Output Table - Concise Table 1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Chnl (ft/s)	Flow Area (sq ft)
WEST DETENTION	1	5540	Max WS	5.89	11.00	14.90	14.90	0.00	1472.20
WEST DETENTION	1	5460	Max WS	5.88	11.00	14.90	14.90	0.00	1351.94
WEST DETENTION	1	5438	Max WS	5.88	11.00	14.90	14.90	0.01	628.37
WEST DETENTION	1	5412	Max WS	5.88	11.00	14.90	14.90	0.01	531.02
WEST DETENTION	1	4950	Max WS	5.87	11.00	14.90	14.90	0.01	514.07
WEST DETENTION	1	4907	Max WS	5.87	11.00	14.90	14.90	0.01	671.81
WEST DETENTION	1	4611	Max WS	9.41	11.00	14.90	14.90	0.01	659.33
WEST DETENTION	1	4537	Max WS	11.83	11.00	14.90	14.90	0.02	514.64
WEST DETENTION	1	3571	Max WS	11.83	11.00	14.90	14.90	0.02	512.48
WEST DETENTION	1	3570		Culvert					
WEST DETENTION	1	3417	Max WS	11.67	11.00	14.87	14.87	0.02	508.82
WEST DETENTION	1	3400	Max WS	11.67	11.00	14.87	14.87	0.02	508.48
WEST DETENTION	1	3383	Max WS	13.96	11.00	14.87	14.87	0.03	509.83
WEST DETENTION	1	2760	Max WS	16.03	11.00	14.87	14.87	0.03	507.98
WEST DETENTION	1	2722	Max WS	18.58	11.00	14.87	14.87	0.02	909.49
WEST DETENTION	1	2635	Max WS	18.58	11.00	14.87	14.87	0.02	916.87
WEST DETENTION	1	2586	Max WS	18.58	11.00	14.87	14.87	0.01	1301.49
WEST DETENTION	1	2545	Max WS	18.57	11.00	14.87	14.87	0.01	1301.91

WEST DETENTION	1	2507	Max WS	18.57	11.00	14.87	14.87	0.02	925.62
WEST DETENTION	1	2402	Max WS	18.57	11.00	14.87	14.87	0.02	914.81
WEST DETENTION	1	2367	Max WS	21.74	11.00	14.87	14.87	0.04	519.80
WEST DETENTION	1	1987	Max WS	21.73	11.00	14.87	14.87	0.04	510.69
WEST DETENTION	1	1986		Culvert					
WEST DETENTION	1	1922	Max WS	21.70	11.00	14.79	14.79	0.04	497.47
WEST DETENTION	1	1891	Max WS	21.70	11.00	14.79	14.79	0.04	496.93
WEST DETENTION	1	1815	Max WS	23.76	11.00	14.79	14.79	0.02	1052.61
SOUTH DETENTION	3	1636	Max WS	49.37	11.00	14.79	14.79	0.03	1451.36
SOUTH DETENTION	3	1561	Max WS	49.37	11.00	14.79	14.79	0.05	991.54
SOUTH DETENTION	3	1153	Max WS	55.95	11.00	14.79	14.79	0.05	1212.08
SOUTH DETENTION	3	1080	Max WS	55.95	11.00	14.79	14.79	0.05	1045.94
SOUTH DETENTION	3	1012	Max WS	61.46	11.00	14.79	14.79	0.04	1598.14
SOUTH DETENTION	3	945	Max WS	61.46	11.00	14.79	14.79	0.05	1123.51
SOUTH DETENTION	3	942		Inl Struct					
SOUTH DETENTION	3	940	Max WS	61.46	2.70	14.79	14.79	0.02	4385.12
SOUTH DETENTION	3	930	Max WS	61.46	2.70	14.79	14.79	0.02	4385.12
SOUTH DETENTION	3	500		Culvert					
SOUTH DETENTION	3	150	Max WS	61.43	2.20	8.84	8.84	0.03	1919.15
SOUTH DETENTION	3	100	Max WS	61.25	2.20	8.84	8.84	0.03	1919.15
SOUTH DETENTION	3	90	Max WS	61.22	2.20	8.84	8.84	0.03	1919.15
OFFSITE	R8 NORTH	5350	Max WS	402.66	9.00	15.70	15.82	2.72	147.89
OFFSITE	R8 NORTH	1100	Max WS	383.17	6.00	8.84	9.82	7.97	48.09
OFFSITE	R8 NORTH	1050	Max WS	386.23	2.30	9.03	9.08	1.66	232.12
OFFSITE	R8 NORTH	100	Max WS	384.32	2.20	8.84	8.88	1.70	226.60
OFFSITE	R8 SOUTH	3500	Max WS	445.54	2.20	8.84	8.90	1.97	226.60
OFFSITE	R8 SOUTH	3450	Max WS	445.51	2.20	8.85	8.89	1.52	293.71
OFFSITE	R8 SOUTH	3300		Culvert					
OFFSITE	R8 SOUTH	3100	Max WS	444.62	2.00	8.46	8.49	1.58	281.07
OFFSITE	R8 SOUTH	100	Max WS	181.03	1.80	7.56	7.58	0.98	184.16
EAST DETENTION	2	5600	Max WS	-0.89	11.00	14.90	14.90	0.00	1472.54
EAST DETENTION	2	5560	Max WS	-0.89	11.00	14.90	14.90	0.00	1464.29
EAST DETENTION	2	5520	Max WS	-0.89	11.00	14.90	14.90	0.00	1362.87
EAST DETENTION	2	5480	Max WS	-0.89	11.00	14.90	14.90	0.00	624.64
EAST DETENTION	2	5455	Max WS	-0.89	11.00	14.90	14.90	0.00	514.64
EAST DETENTION	2	4920	Max WS	-0.91	11.00	14.90	14.90	0.00	513.99
EAST DETENTION	2	4880	Max WS	-0.91	11.00	14.90	14.90	0.00	898.34
EAST DETENTION	2	4850	Max WS	-0.92	11.00	14.90	14.90	0.00	2129.66
EAST DETENTION	2	4775	Max WS	6.92	11.00	14.90	14.90	0.01	965.98
EAST DETENTION	2	4653	Max WS	8.67	11.00	14.90	14.90	0.02	553.84
EAST DETENTION	2	4126	Max WS	8.66	11.00	14.90	14.90	0.02	515.17
EAST DETENTION	2	3563	Max WS	12.39	11.00	14.90	14.90	0.02	513.52
EAST DETENTION	2	3562		Culvert					
EAST DETENTION	2	3414	Max WS	11.88	11.00	14.86	14.86	0.02	507.39
EAST DETENTION	2	3335	Max WS	11.88	11.00	14.86	14.86	0.03	464.78
EAST DETENTION	2	3282	Max WS	14.06	11.00	14.86	14.86	0.06	221.68
EAST DETENTION	2	2946	Max WS	20.50	11.00	14.86	14.86	0.10	195.65
EAST DETENTION	2	2945		Culvert					
EAST DETENTION	2	2855	Max WS	20.38	11.00	14.79	14.79	0.09	229.22
EAST DETENTION	2	2804	Max WS	20.38	11.00	14.79	14.79	0.08	254.88
EAST DETENTION	2	1864	Max WS	25.61	11.00	14.79	14.79	0.03	809.85
EAST DETENTION	2	1800	Max WS	25.61	11.00	14.79	14.79	0.02	1318.29
DUMMY	4	1	Max WS	5.00	11.00	14.90	14.90	0.01	337.64
DUMMY	4	0	Max WS	5.00	11.00	14.90	14.90	0.01	339.48

Profile Output Table - ChannelVolume

River	Reach	River Sta	Profile	Volume (acre-ft)
WEST DETENTION	1	5540	Max WS	57.07
WEST DETENTION	1	5460	Max WS	54.64
WEST DETENTION	1	5438	Max WS	52.39
WEST DETENTION	1	5412	Max WS	52.01
WEST DETENTION	1	4950	Max WS	46.45
WEST DETENTION	1	4907	Max WS	45.70
WEST DETENTION	1	4611	Max WS	41.03
WEST DETENTION	1	4537	Max WS	40.07
WEST DETENTION	1	3571	Max WS	28.69
WEST DETENTION	1	3570		Culvert
WEST DETENTION	1	3417	Max WS	26.86
WEST DETENTION	1	3400	Max WS	26.66
WEST DETENTION	1	3383	Max WS	26.48
WEST DETENTION	1	2760	Max WS	19.28
WEST DETENTION	1	2722	Max WS	18.30
WEST DETENTION	1	2635	Max WS	16.47
WEST DETENTION	1	2586	Max WS	14.58
WEST DETENTION	1	2545	Max WS	13.37
WEST DETENTION	1	2507	Max WS	11.73
WEST DETENTION	1	2402	Max WS	9.41
WEST DETENTION	1	2367	Max WS	8.39
WEST DETENTION	1	1987	Max WS	3.89
WEST DETENTION	1	1986		Culvert
WEST DETENTION	1	1922	Max WS	3.15
WEST DETENTION	1	1891	Max WS	2.79
WEST DETENTION	1	1815	Max WS	1.44
SOUTH DETENTION	3	1636	Max WS	80.12
SOUTH DETENTION	3	1561	Max WS	78.00
SOUTH DETENTION	3	1153	Max WS	67.68
SOUTH DETENTION	3	1080	Max WS	65.79
SOUTH DETENTION	3	1012	Max WS	63.73
SOUTH DETENTION	3	945	Max WS	61.64
SOUTH DETENTION	3	942		Inl Struct
SOUTH DETENTION	3	940	Max WS	61.32

SOUTH DETENTION	3		930	Max WS	60.32
SOUTH DETENTION	3		500		Culvert
SOUTH DETENTION	3		150	Max WS	3.87
SOUTH DETENTION	3		100	Max WS	1.67
SOUTH DETENTION	3		90	Max WS	1.23
OFFSITE	R8	NORTH	5350	Max WS	17.46
OFFSITE	R8	NORTH	1100	Max WS	5.42
OFFSITE	R8	NORTH	1050	Max WS	5.26
OFFSITE	R8	NORTH	100	Max WS	0.26
OFFSITE	R8	SOUTH	3500	Max WS	18.78
OFFSITE	R8	SOUTH	3450	Max WS	18.48
OFFSITE	R8	SOUTH	3300		Culvert
OFFSITE	R8	SOUTH	3100	Max WS	16.17
OFFSITE	R8	SOUTH	100	Max WS	
EAST DETENTION	2		5600	Max WS	60.85
EAST DETENTION	2		5560	Max WS	59.64
EAST DETENTION	2		5520	Max WS	58.23
EAST DETENTION	2		5480	Max WS	55.94
EAST DETENTION	2		5455	Max WS	55.49
EAST DETENTION	2		4920	Max WS	49.17
EAST DETENTION	2		4880	Max WS	48.19
EAST DETENTION	2		4850	Max WS	42.39
EAST DETENTION	2		4775	Max WS	35.26
EAST DETENTION	2		4653	Max WS	33.14
EAST DETENTION	2		4126	Max WS	26.66
EAST DETENTION	2		3563	Max WS	20.02
EAST DETENTION	2		3562		Culvert
EAST DETENTION	2		3414	Max WS	18.27
EAST DETENTION	2		3335	Max WS	17.39
EAST DETENTION	2		3282	Max WS	16.97
EAST DETENTION	2		2946	Max WS	15.36
EAST DETENTION	2		2945		Culvert
EAST DETENTION	2		2855	Max WS	14.92
EAST DETENTION	2		2804	Max WS	14.63
EAST DETENTION	2		1864	Max WS	3.15
EAST DETENTION	2		1800	Max WS	1.59
DUMMY	4		1	Max WS	0.10
DUMMY	4		0	Max WS	0.02

25 100year 10day Model

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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X      X  XXXXXX    XXXX         XXXX       XX       XXXX
X      X  X        X    X        X   X     X  X     X
X      X  X        X             X   X    X    X    X
XXXXXXX   XXXX     X       XXX   XXXX     XXXXXX     XXXX
X      X  X        X             X  X     X    X         X
X      X  X        X    X        X   X    X    X         X
X      X  XXXXXX    XXXX         X    X   X    X    XXXXX
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PROJECT DATA
Project Title: GREENBRIAR FARMS
Project File : GB.prj
Run Date and Time: 7/14/2005 9:49:06 AM

Project in English units

Project Description:
References:
1) Offsite Drainage Improvements-Metro Air Park, Exhibit D-2
(Offsite improved channels and Interstate 5 crossing)
2) 100yr-10day &
10yr-10day, STA 0+00, West Drain Stages, Mark Kubik @ Mead & Hunt Inc.

PLAN DATA

Plan Title: P1-100YR10DAY-DEVELOP
Plan File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.p01

Geometry Title: DEVELOP
Geometry File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.g01

Flow Title :
Flow File :

Plan Summary Information:

Number of:	Cross Sections =	207	Multiple Openings =	0
	Culverts =	6	Inline Structures =	1
	Bridges =	0	Lateral Structures =	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Profile Output Table - Concise Table 1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Chnl (ft/s)	Flow Area (sq ft)
WEST DETENTION	1	5540	Max WS	6.79	11.00	14.87	14.87	0.00	1461.31
WEST DETENTION	1	5460	Max WS	6.77	11.00	14.87	14.87	0.01	1341.81
WEST DETENTION	1	5438	Max WS	6.76	11.00	14.87	14.87	0.01	623.47
WEST DETENTION	1	5412	Max WS	6.75	11.00	14.87	14.87	0.01	526.81
WEST DETENTION	1	4950	Max WS	6.72	11.00	14.87	14.87	0.01	510.06
WEST DETENTION	1	4907	Max WS	6.71	11.00	14.87	14.87	0.01	666.62
WEST DETENTION	1	4611	Max WS	9.19	11.00	14.87	14.87	0.01	654.24
WEST DETENTION	1	4537	Max WS	10.90	11.00	14.87	14.87	0.02	510.62
WEST DETENTION	1	3571	Max WS	10.81	11.00	14.87	14.87	0.02	508.48
WEST DETENTION	1	3570		Culvert					
WEST DETENTION	1	3417	Max WS	9.75	11.00	14.84	14.84	0.02	505.40
WEST DETENTION	1	3400	Max WS	9.75	11.00	14.84	14.84	0.02	505.06
WEST DETENTION	1	3383	Max WS	11.25	11.00	14.84	14.84	0.02	506.40
WEST DETENTION	1	2760	Max WS	12.95	11.00	14.84	14.84	0.03	504.55
WEST DETENTION	1	2722	Max WS	14.85	11.00	14.84	14.84	0.02	903.57
WEST DETENTION	1	2635	Max WS	14.85	11.00	14.84	14.84	0.02	910.91
WEST DETENTION	1	2586	Max WS	14.84	11.00	14.84	14.84	0.01	1293.13
WEST DETENTION	1	2545	Max WS	14.83	11.00	14.84	14.84	0.01	1293.55
WEST DETENTION	1	2507	Max WS	14.83	11.00	14.84	14.84	0.02	919.60

WEST DETENTION	1	2402	Max WS	14.82	11.00	14.84	14.84	0.02	908.85
WEST DETENTION	1	2367	Max WS	17.26	11.00	14.84	14.84	0.03	516.29
WEST DETENTION	1	1987	Max WS	17.24	11.00	14.84	14.84	0.03	507.23
WEST DETENTION	1	1986		Culvert					
WEST DETENTION	1	1922	Max WS	15.26	11.00	14.80	14.80	0.03	498.95
WEST DETENTION	1	1891	Max WS	15.26	11.00	14.80	14.80	0.03	498.42
WEST DETENTION	1	1815	Max WS	17.30	11.00	14.80	14.80	0.02	1055.66
SOUTH DETENTION	3	1636	Max WS	42.53	11.00	14.80	14.80	0.03	1455.50
SOUTH DETENTION	3	1561	Max WS	42.53	11.00	14.80	14.80	0.04	994.38
SOUTH DETENTION	3	1153	Max WS	53.13	11.00	14.80	14.80	0.04	1215.51
SOUTH DETENTION	3	1080	Max WS	53.12	11.00	14.80	14.80	0.05	1048.91
SOUTH DETENTION	3	1012	Max WS	61.47	11.00	14.80	14.80	0.04	1602.65
SOUTH DETENTION	3	945	Max WS	61.46	11.00	14.80	14.80	0.05	1126.79
SOUTH DETENTION	3	942		Inl Struct					
SOUTH DETENTION	3	940	Max WS	61.46	2.70	14.80	14.80	0.02	4389.69
SOUTH DETENTION	3	930	Max WS	61.46	2.70	14.80	14.80	0.02	4389.69
SOUTH DETENTION	3	500		Culvert					
SOUTH DETENTION	3	150	Max WS	46.18	2.20	11.21	11.21	0.02	2906.49
SOUTH DETENTION	3	100	Max WS	46.18	2.20	11.21	11.21	0.02	2906.49
SOUTH DETENTION	3	90	Max WS	46.18	2.20	11.21	11.21	0.02	2906.49
OFFSITE	R8 NORTH	5350	Max WS	251.59	9.00	14.18	14.27	2.46	102.28
OFFSITE	R8 NORTH	1100	Max WS	19.48	6.00	11.21	11.21	0.18	110.05
OFFSITE	R8 NORTH	1050	Max WS	19.48	2.30	11.21	11.21	0.06	345.95
OFFSITE	R8 NORTH	100	Max WS	19.46	2.20	11.21	11.21	0.06	350.01
OFFSITE	R8 SOUTH	3500	Max WS	65.63	2.20	11.21	11.21	0.19	350.01
OFFSITE	R8 SOUTH	3450	Max WS	65.63	2.20	11.21	11.21	0.15	440.12
OFFSITE	R8 SOUTH	3300		Culvert					
OFFSITE	R8 SOUTH	3100	Max WS	65.63	2.00	11.20	11.20	0.15	449.24
OFFSITE	R8 SOUTH	100	Max WS	63.33	1.80	11.19	11.19	0.17	365.14
EAST DETENTION	2	5600	Max WS	-1.79	11.00	14.87	14.87	0.00	1461.65
EAST DETENTION	2	5560	Max WS	-1.80	11.00	14.87	14.87	0.00	1453.45
EAST DETENTION	2	5520	Max WS	-1.80	11.00	14.87	14.87	0.00	1352.68
EAST DETENTION	2	5460	Max WS	-1.82	11.00	14.87	14.87	0.00	619.76
EAST DETENTION	2	5455	Max WS	-1.82	11.00	14.87	14.87	0.00	510.62
EAST DETENTION	2	4920	Max WS	-1.87	11.00	14.87	14.87	0.00	509.97
EAST DETENTION	2	4880	Max WS	-1.88	11.00	14.87	14.87	0.00	891.37
EAST DETENTION	2	4850	Max WS	-1.92	11.00	14.87	14.87	0.00	2113.88
EAST DETENTION	2	4775	Max WS	6.48	11.00	14.87	14.87	0.01	958.63
EAST DETENTION	2	4653	Max WS	7.42	11.00	14.87	14.87	0.01	549.49
EAST DETENTION	2	4126	Max WS	7.36	11.00	14.87	14.87	0.01	511.14
EAST DETENTION	2	3563	Max WS	10.82	11.00	14.87	14.87	0.02	509.49
EAST DETENTION	2	3562		Culvert					
EAST DETENTION	2	3414	Max WS	8.84	11.00	14.84	14.84	0.02	504.30
EAST DETENTION	2	3335	Max WS	8.84	11.00	14.84	14.84	0.02	461.92
EAST DETENTION	2	3282	Max WS	10.38	11.00	14.84	14.84	0.05	220.17
EAST DETENTION	2	2946	Max WS	16.11	11.00	14.84	14.84	0.08	194.30
EAST DETENTION	2	2945		Culvert					
EAST DETENTION	2	2855	Max WS	15.55	11.00	14.80	14.80	0.07	229.97
EAST DETENTION	2	2804	Max WS	15.55	11.00	14.80	14.80	0.06	255.70
EAST DETENTION	2	1864	Max WS	25.24	11.00	14.80	14.80	0.03	812.18
EAST DETENTION	2	1800	Max WS	25.23	11.00	14.80	14.80	0.02	1322.08
DUMMY	4	1	Max WS	5.00	11.00	14.87	14.87	0.01	334.52
DUMMY	4	0	Max WS	5.00	11.00	14.87	14.87	0.01	336.36

Profile Output Table - ChannelVolume

River	Reach	River Sta	Profile	Volume (acre-ft)
WEST DETENTION	1	5540	Max WS	56.70
WEST DETENTION	1	5460	Max WS	54.28
WEST DETENTION	1	5438	Max WS	52.05
WEST DETENTION	1	5412	Max WS	51.67
WEST DETENTION	1	4950	Max WS	46.15
WEST DETENTION	1	4907	Max WS	45.41
WEST DETENTION	1	4611	Max WS	40.77
WEST DETENTION	1	4537	Max WS	39.82
WEST DETENTION	1	3571	Max WS	28.53
WEST DETENTION	1	3570		Culvert
WEST DETENTION	1	3417	Max WS	26.72
WEST DETENTION	1	3400	Max WS	26.51
WEST DETENTION	1	3383	Max WS	26.33
WEST DETENTION	1	2760	Max WS	19.18
WEST DETENTION	1	2722	Max WS	18.22
WEST DETENTION	1	2635	Max WS	16.39
WEST DETENTION	1	2586	Max WS	14.52
WEST DETENTION	1	2545	Max WS	13.31
WEST DETENTION	1	2507	Max WS	11.68
WEST DETENTION	1	2402	Max WS	9.38
WEST DETENTION	1	2367	Max WS	8.37
WEST DETENTION	1	1987	Max WS	3.90
WEST DETENTION	1	1986		Culvert
WEST DETENTION	1	1922	Max WS	3.16
WEST DETENTION	1	1891	Max WS	2.80
WEST DETENTION	1	1815	Max WS	1.44
SOUTH DETENTION	3	1636	Max WS	91.06
SOUTH DETENTION	3	1561	Max WS	88.93
SOUTH DETENTION	3	1153	Max WS	78.58
SOUTH DETENTION	3	1080	Max WS	76.68
SOUTH DETENTION	3	1012	Max WS	74.62
SOUTH DETENTION	3	945	Max WS	72.52
SOUTH DETENTION	3	942		Inl Struct
SOUTH DETENTION	3	940	Max WS	72.20
SOUTH DETENTION	3	930	Max WS	71.20

SOUTH DETENTION	3	500		Culvert
SOUTH DETENTION	3	150	Max WS	5.87
SOUTH DETENTION	3	100	Max WS	2.54
SOUTH DETENTION	3	90	Max WS	1.87
OFFSITE	R8 NORTH	5350	Max WS	18.01
OFFSITE	R8 NORTH	1100	Max WS	8.25
OFFSITE	R8 NORTH	1050	Max WS	7.99
OFFSITE	R8 NORTH	100	Max WS	0.40
OFFSITE	R8 SOUTH	3500	Max WS	32.09
OFFSITE	R8 SOUTH	3450	Max WS	31.64
OFFSITE	R8 SOUTH	3300		Culvert
OFFSITE	R8 SOUTH	3100	Max WS	28.07
OFFSITE	R8 SOUTH	100	Max WS	
EAST DETENTION	2	5600	Max WS	60.54
EAST DETENTION	2	5560	Max WS	59.35
EAST DETENTION	2	5520	Max WS	57.95
EAST DETENTION	2	5480	Max WS	55.68
EAST DETENTION	2	5455	Max WS	55.23
EAST DETENTION	2	4920	Max WS	48.96
EAST DETENTION	2	4880	Max WS	47.98
EAST DETENTION	2	4850	Max WS	42.23
EAST DETENTION	2	4775	Max WS	35.15
EAST DETENTION	2	4653	Max WS	33.04
EAST DETENTION	2	4126	Max WS	26.62
EAST DETENTION	2	3563	Max WS	20.03
EAST DETENTION	2	3562		Culvert
EAST DETENTION	2	3414	Max WS	18.29
EAST DETENTION	2	3335	Max WS	17.42
EAST DETENTION	2	3282	Max WS	17.00
EAST DETENTION	2	2946	Max WS	15.41
EAST DETENTION	2	2945		Culvert
EAST DETENTION	2	2855	Max WS	14.96
EAST DETENTION	2	2804	Max WS	14.68
EAST DETENTION	2	1864	Max WS	3.16
EAST DETENTION	2	1800	Max WS	1.59
DUMMY	4	1	Max WS	0.10
DUMMY	4	0	Max WS	0.02

25 10year 24hour Model

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HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

x     x  xxxxxx   xxxx        xxxx      xx      xxxx
x     x  x       x    x       x   x    x  x    x
x     x  x       x            x   x   x    x   x
xxxxxxx  xxxx    x      xxx   xxxx    xxxxxx    xxxx
x     x  x       x            x  x    x    x       x
x     x  x       x    x       x   x   x    x       x
x     x  xxxxxx   xxxx        x    x  x    x   xxxxx
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PROJECT DATA
Project Title: GREENBRIAR FARMS
Project File : GB.prj
Run Date and Time: 7/15/2005 10:41:24 AM

Project in English units

Project Description:
References:
1) Offsite Drainage Improvements-Metro Air Park, Exhibit D-2
(Offsite improved channels and Interstate 5 crossing)
2) 100yr-10day &
10yr-10day, STA 0+00, West Drain Stages, Mark Kubik @ Mead & Hunt Inc.

PLAN DATA

Plan Title: P4-10YR24HR-DEVELOP
Plan File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.p05

Geometry Title: DEVELOP
Geometry File : j:\Jobs\1116-GreenbriarFarms\1116-GreenbriarFarms\Civil\Docs\Report\HEC-RAS\GB.g01

Flow Title :
Flow File :

Plan Summary Information:

Number of:				
Cross Sections	= 207	Multiple Openings	=	0
Culverts	= 6	Inline Structures	=	1
Bridges	= 0	Lateral Structures	=	0

Computational Information
- Water surface calculation tolerance = 0.01
- Critical depth calculation tolerance = 0.01
- Maximum number of iterations = 20
- Maximum difference tolerance = 0.3
- Flow tolerance factor = 0.001

Computation Options
- Critical depth computed only where necessary
- Conveyance Calculation Method: At breaks in n values only
- Friction Slope Method: Average Conveyance
- Computational Flow Regime: Subcritical Flow

Profile Output Table - Concise Table 1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	E.G. Elev (ft)	Vel Chnl (ft/s)	Flow Area (sq ft)
WEST DETENTION	1	5540	Max WS	5.83	11.00	13.54	13.54	0.01	950.13
WEST DETENTION	1	5460	Max WS	5.83	11.00	13.54	13.54	0.01	867.68
WEST DETENTION	1	5438	Max WS	5.83	11.00	13.54	13.54	0.01	397.43
WEST DETENTION	1	5412	Max WS	5.83	11.00	13.54	13.54	0.02	333.77
WEST DETENTION	1	4950	Max WS	5.82	11.00	13.54	13.54	0.02	325.08
WEST DETENTION	1	4907	Max WS	5.82	11.00	13.54	13.54	0.01	426.32
WEST DETENTION	1	4611	Max WS	9.27	11.00	13.54	13.54	0.02	418.73
WEST DETENTION	1	4537	Max WS	11.61	11.00	13.54	13.54	0.04	325.44
WEST DETENTION	1	3571	Max WS	11.60	11.00	13.54	13.54	0.04	323.91
WEST DETENTION	1	3570		Culvert					
WEST DETENTION	1	3417	Max WS	11.38	11.00	13.50	13.50	0.04	318.96
WEST DETENTION	1	3400	Max WS	11.38	11.00	13.50	13.50	0.04	318.63
WEST DETENTION	1	3383	Max WS	13.61	11.00	13.50	13.50	0.04	319.72
WEST DETENTION	1	2760	Max WS	15.56	11.00	13.50	13.50	0.05	318.28
WEST DETENTION	1	2722	Max WS	17.94	11.00	13.50	13.50	0.03	578.20
WEST DETENTION	1	2635	Max WS	17.93	11.00	13.50	13.50	0.03	582.88
WEST DETENTION	1	2586	Max WS	17.93	11.00	13.50	13.50	0.02	831.71
WEST DETENTION	1	2545	Max WS	17.93	11.00	13.50	13.50	0.02	832.26

WEST DETENTION	1	2507	Max WS	17.93	11.00	13.50	13.50	0.03	588.23
WEST DETENTION	1	2402	Max WS	17.93	11.00	13.50	13.50	0.03	581.57
WEST DETENTION	1	2367	Max WS	20.91	11.00	13.50	13.50	0.06	325.70
WEST DETENTION	1	1987	Max WS	20.91	11.00	13.50	13.50	0.07	320.13
WEST DETENTION	1	1986		Culvert					
WEST DETENTION	1	1922	Max WS	20.82	11.00	13.41	13.41	0.07	306.61
WEST DETENTION	1	1891	Max WS	20.81	11.00	13.41	13.41	0.07	306.21
WEST DETENTION	1	1815	Max WS	23.06	11.00	13.41	13.41	0.04	656.13
SOUTH DETENTION	3	1636	Max WS	48.55	11.00	13.41	13.41	0.05	910.82
SOUTH DETENTION	3	1561	Max WS	48.54	11.00	13.41	13.41	0.08	620.72
SOUTH DETENTION	3	1153	Max WS	55.63	11.00	13.41	13.41	0.07	761.75
SOUTH DETENTION	3	1080	Max WS	55.62	11.00	13.41	13.41	0.08	656.09
SOUTH DETENTION	3	1012	Max WS	61.38	11.00	13.41	13.41	0.06	1003.90
SOUTH DETENTION	3	945	Max WS	61.37	11.00	13.41	13.41	0.09	695.48
SOUTH DETENTION	3	942		Inl Struct					
SOUTH DETENTION	3	940	Max WS	61.37	2.70	13.40	13.40	0.02	3772.13
SOUTH DETENTION	3	930	Max WS	61.37	2.70	13.40	13.40	0.02	3772.13
SOUTH DETENTION	3	500		Culvert					
SOUTH DETENTION	3	150	Max WS	61.36	2.20	8.19	8.19	0.04	1710.23
SOUTH DETENTION	3	100	Max WS	61.23	2.20	8.19	8.19	0.04	1710.23
SOUTH DETENTION	3	90	Max WS	61.21	2.20	8.19	8.19	0.04	1710.23
OFFSITE	R8 NORTH	5350	Max WS	241.70	9.00	13.95	14.05	2.51	96.17
OFFSITE	R8 NORTH	1100	Max WS	229.18	6.00	8.26	8.89	6.36	36.01
OFFSITE	R8 NORTH	1050	Max WS	229.88	2.30	8.30	8.32	1.16	197.86
OFFSITE	R8 NORTH	100	Max WS	229.04	2.20	8.19	8.21	1.16	196.88
OFFSITE	R8 SOUTH	3500	Max WS	290.25	2.20	8.19	8.22	1.47	196.88
OFFSITE	R8 SOUTH	3450	Max WS	290.23	2.20	8.20	8.22	1.13	257.17
OFFSITE	R8 SOUTH	3300		Culvert					
OFFSITE	R8 SOUTH	3100	Max WS	290.09	2.00	7.99	8.01	1.14	255.17
OFFSITE	R8 SOUTH	100	Max WS	128.88	1.80	7.56	7.57	0.70	184.16
EAST DETENTION	2	5600	Max WS	-0.83	11.00	13.54	13.54	0.00	950.30
EAST DETENTION	2	5560	Max WS	-0.83	11.00	13.54	13.54	0.00	944.64
EAST DETENTION	2	5520	Max WS	-0.83	11.00	13.54	13.54	0.00	876.14
EAST DETENTION	2	5480	Max WS	-0.84	11.00	13.54	13.54	0.00	395.08
EAST DETENTION	2	5455	Max WS	-0.84	11.00	13.54	13.54	0.00	325.47
EAST DETENTION	2	4920	Max WS	-0.84	11.00	13.54	13.54	0.00	324.97
EAST DETENTION	2	4880	Max WS	-0.85	11.00	13.54	13.54	0.00	569.95
EAST DETENTION	2	4850	Max WS	-0.85	11.00	13.54	13.54	0.00	1374.82
EAST DETENTION	2	4775	Max WS	6.76	11.00	13.54	13.54	0.01	617.66
EAST DETENTION	2	4653	Max WS	8.65	11.00	13.54	13.54	0.02	349.80
EAST DETENTION	2	4126	Max WS	8.64	11.00	13.54	13.54	0.03	325.81
EAST DETENTION	2	3563	Max WS	12.18	11.00	13.54	13.54	0.04	324.71
EAST DETENTION	2	3562		Culvert					
EAST DETENTION	2	3414	Max WS	11.15	11.00	13.50	13.50	0.04	317.97
EAST DETENTION	2	3335	Max WS	11.15	11.00	13.50	13.50	0.04	289.72
EAST DETENTION	2	3282	Max WS	13.33	11.00	13.50	13.50	0.10	132.23
EAST DETENTION	2	2946	Max WS	19.77	11.00	13.50	13.50	0.17	116.24
EAST DETENTION	2	2945		Culvert					
EAST DETENTION	2	2855	Max WS	19.76	11.00	13.41	13.41	0.15	135.99
EAST DETENTION	2	2804	Max WS	19.76	11.00	13.41	13.41	0.13	152.17
EAST DETENTION	2	1864	Max WS	25.50	11.00	13.41	13.41	0.05	505.61
EAST DETENTION	2	1800	Max WS	25.49	11.00	13.41	13.41	0.03	823.79
DUMMY	4	1	Max WS	5.00	11.00	13.54	13.54	0.03	198.21
DUMMY	4	0	Max WS	5.00	11.00	13.54	13.54	0.03	199.73

Profile Output Table - ChannelVolume

River	Reach	River Sta	Profile	Volume (acre-ft)
WEST DETENTION	1	5540	Max WS	36.06
WEST DETENTION	1	5460	Max WS	34.49
WEST DETENTION	1	5438	Max WS	33.06
WEST DETENTION	1	5412	Max WS	32.82
WEST DETENTION	1	4950	Max WS	29.31
WEST DETENTION	1	4907	Max WS	28.84
WEST DETENTION	1	4611	Max WS	25.87
WEST DETENTION	1	4537	Max WS	25.27
WEST DETENTION	1	3571	Max WS	18.07
WEST DETENTION	1	3570		Culvert
WEST DETENTION	1	3417	Max WS	16.92
WEST DETENTION	1	3400	Max WS	16.79
WEST DETENTION	1	3383	Max WS	16.68
WEST DETENTION	1	2760	Max WS	12.17
WEST DETENTION	1	2722	Max WS	11.55
WEST DETENTION	1	2635	Max WS	10.38
WEST DETENTION	1	2586	Max WS	9.18
WEST DETENTION	1	2545	Max WS	8.41
WEST DETENTION	1	2507	Max WS	7.36
WEST DETENTION	1	2402	Max WS	5.88
WEST DETENTION	1	2367	Max WS	5.24
WEST DETENTION	1	1987	Max WS	2.42
WEST DETENTION	1	1986		Culvert
WEST DETENTION	1	1922	Max WS	1.96
WEST DETENTION	1	1891	Max WS	1.74
WEST DETENTION	1	1815	Max WS	0.90
SOUTH DETENTION	3	1636	Max WS	65.25
SOUTH DETENTION	3	1561	Max WS	63.92
SOUTH DETENTION	3	1153	Max WS	57.44
SOUTH DETENTION	3	1080	Max WS	56.26
SOUTH DETENTION	3	1012	Max WS	54.96
SOUTH DETENTION	3	945	Max WS	53.66
SOUTH DETENTION	3	942		Inl Struct
SOUTH DETENTION	3	940	Max WS	53.40

SOUTH DETENTION	3	930	Max WS	52.53
SOUTH DETENTION	3	500		Culvert
SOUTH DETENTION	3	150	Max WS	3.45
SOUTH DETENTION	3	100	Max WS	1.49
SOUTH DETENTION	3	90	Max WS	1.09
OFFSITE	R8 NORTH	5350	Max WS	12.94
OFFSITE	R8 NORTH	1100	Max WS	4.66
OFFSITE	R8 NORTH	1050	Max WS	4.53
OFFSITE	R8 NORTH	100	Max WS	0.23
OFFSITE	R8 SOUTH	3500	Max WS	17.48
OFFSITE	R8 SOUTH	3450	Max WS	17.22
OFFSITE	R8 SOUTH	3300		Culvert
OFFSITE	R8 SOUTH	3100	Max WS	15.16
OFFSITE	R8 SOUTH	100	Max WS	
EAST DETENTION	2	5600	Max WS	38.37
EAST DETENTION	2	5560	Max WS	37.60
EAST DETENTION	2	5520	Max WS	36.69
EAST DETENTION	2	5480	Max WS	35.23
EAST DETENTION	2	5455	Max WS	34.94
EAST DETENTION	2	4920	Max WS	30.94
EAST DETENTION	2	4880	Max WS	30.32
EAST DETENTION	2	4850	Max WS	26.60
EAST DETENTION	2	4775	Max WS	22.01
EAST DETENTION	2	4653	Max WS	20.66
EAST DETENTION	2	4126	Max WS	16.56
EAST DETENTION	2	3563	Max WS	12.36
EAST DETENTION	2	3562		Culvert
EAST DETENTION	2	3414	Max WS	11.26
EAST DETENTION	2	3335	Max WS	10.71
EAST DETENTION	2	3282	Max WS	10.46
EAST DETENTION	2	2946	Max WS	9.50
EAST DETENTION	2	2945		Culvert
EAST DETENTION	2	2855	Max WS	9.23
EAST DETENTION	2	2804	Max WS	9.06
EAST DETENTION	2	1864	Max WS	1.97
EAST DETENTION	2	1800	Max WS	1.00
DUMMY	4	1	Max WS	0.06
DUMMY	4	0	Max WS	0.01

8. APPENDIX C –

Existing Culvert Capacities

AppC.TXT
BOX CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

July 15, 2005

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Span (ft)..	8.0
Culvert Rise (ft)..	5.0
FHWA Chart Number..	8
FHWA Scale Number (Type of Culvert Entrance).............	1
Manning's Roughness Coefficient (n-value)................	0.012
Entrance Loss Coefficient of Culvert Opening.............	0.5
Culvert Length (ft)......................................	340.0
Invert Elevation at Downstream end of Culvert (ft).......	5.3
Invert Elevation at Upstream end of Culvert (ft).........	5.5
Culvert Slope (ft/ft)....................................	0.0006
Starting Flow Rate (cfs).................................	301.0
Incremental Flow Rate (cfs)..............................	0.0
Ending Flow Rate (cfs)...................................	301.0
Starting Tailwater Depth (ft)............................	7.0
Incremental Tailwater Depth (ft).........................	4.2
Ending Tailwater Depth (ft)..............................	11.2

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
301.0	7.0	5.73	8.83	5.0	3.53	5.0	7.53
301.0	11.2	5.73	13.03	5.0	3.53	5.0	7.53

Results and Discussion:
Under existing conditions, the 100-year peak flow through the 3-8'x5' box culverts is 904cfs (see Table 1). The culvert was analyzed individually by prorating the flow.

9. APPENDIX D –

Gate Maximum Outflow Calculations

Worksheet
Worksheet for Broad Crested Weir

Project Description	
Worksheet	Weir
Type	Broad Crested Weir
Solve For	Discharge

Input Data		
Headwater Elevation	14.90	ft
Crest Elevation	14.00	ft
Tailwater Elevation	11.20	ft
Crest Surface Type	Paved	
Crest Breadth	6.00	ft
Crest Length	16.00	ft

Results		
Discharge	41.69	cfs
Headwater Height Above Crest	0.90	ft
Tailwater Height Above Crest	-2.80	ft
Discharge Coefficient	3.05	US
Submergence Factor	1.00	
Adjusted Discharge Coefficient	3.05	US
Flow Area	14.4	ft²
Velocity	2.90	ft/s
Wetted Perimeter	17.80	ft
Top Width	16.00	ft

Result and Discussion:
During the peak stage, 14.9', in the pond, the Rubicon gate will close to reduce the total outflow. With the top of the gate at elevation 14.0', there will be weir flow above the gate and the total outflow was determined to be 42 cfs, which is less than the total allowable of 62 cfs.

10. APPENDIX E –

Onsite Drain Pipe Design

10-YEAR STORM EVENT ONSITE HYDRAULIC DESIGN SUMMARY

HGL CALCULATIONS - 10 YEAR

FROM NODE	TO NODE	Upstream (FROM) Flowline (ft)	Downstream (TO) Flowline (ft)	Diameter (in)	Pipe Area (ft^2)	Length (ft)	Design Flow (cfs)	Pipe-full Velocity (ft/s)	Pipe-full Flow (cfs)	HGL Slope (ft/ft)	Head Loss (ft)	Pipe Slope (ft/ft)	U/S HGL (ft)	U/S Crown Elev. (ft)	D/S HGL (ft)	D/S Crown Elev. (ft)	Average Pad Elev. (ft)	Average Gutter Elev. (ft)	Average Target HGL Elev. (ft)	0.5ft Freeboard ok?	Target to Calc. Delta (ft)	Pipe Submerg. (ft)	Pipe Cover (ft)
A01	A02	10.91	10.43	36	7.07	800	22.7	2.0	14.20	0.0015	1.22	0.0006	16.33	13.91	15.10	13.43	[illegible]	[illegible]	18.0	ok	1.67	2.42	4.8
A02	A03	9.43	9.06	48	12.57	900	45.3	2.0	25.28	0.0013	1.19	0.0004	15.10	13.43	13.92	13.06	[illegible]	[illegible]	16.0	ok	0.90	1.68	3.3
A03	A04	9.70	9.56	42	9.62	300	22.7	2.0	19.35	0.0007	0.20	0.0005	14.12	13.20	13.92	13.06	[illegible]	[illegible]	16.0	ok	1.88	0.91	3.5
A04	POND	9.06	9.00	48	12.57	140	[illegible]	2.0	25.28	0.0030	0.42	0.0004	13.92	13.06	13.50	13.00	[illegible]	[illegible]	15.0	ok	1.08	0.86	2.6
B01	B02	10.76	10.22	30	4.91	700	10.0	2.0	9.89	0.0026	1.79	0.0008	16.05	13.26	14.26	12.72	[illegible]	[illegible]	17.0	ok	0.95	2.79	4.4
B02	POND	9.22	9.00	42	9.62	450	36.0	2.0	19.35	0.0017	0.76	0.0005	14.26	12.72	13.50	12.50	[illegible]	[illegible]	15.0	ok	0.74	1.54	3.0
C01	C02	11.73	11.04	30	4.91	900	[illegible]	2.0	9.89	0.0018	1.59	0.0008	16.53	14.23	14.93	13.54	[illegible]	[illegible]	18.0	ok	1.47	2.30	4.5
C02	C03	10.04	9.69	42	9.62	700	30.0	2.0	19.35	0.0012	0.82	0.0005	14.93	13.54	14.11	13.19	[illegible]	[illegible]	17.0	ok	2.07	1.40	4.2
C03	POND	9.19	9.00	48	12.57	470	[illegible]	2.0	25.28	0.0013	0.61	0.0004	14.11	13.19	13.50	13.00	[illegible]	[illegible]	15.0	ok	0.89	0.92	2.5
D01	D02	11.14	10.45	[illegible]	4.91	900	[illegible]	2.0	9.89	0.0023	2.05	0.0008	16.94	13.64	14.89	12.95	[illegible]	[illegible]	18.0	ok	1.06	3.29	5.1
D02	POND	9.45	9.00	42	9.62	[illegible]	[illegible]	2.0	19.35	0.0015	1.39	0.0005	14.89	12.95	13.50	12.50	[illegible]	[illegible]	16.5	ok	1.61	1.94	4.2
E01	E02	10.83	10.44	30	4.91	600	[illegible]	2.0	9.89	0.0019	0.95	0.0008	15.58	13.33	14.63	12.94	[illegible]	[illegible]	16.0	ok	0.42	2.25	3.4
E02	POND	9.44	9.00	42	9.62	900	[illegible]	2.0	19.35	0.0013	1.13	0.0005	14.63	12.94	13.50	12.50	[illegible]	[illegible]	16.0	ok	1.37	1.69	3.8
F01	F02	10.63	10.25	30	4.91	600	[illegible]	2.0	9.89	0.0026	1.28	0.0008	15.62	13.13	14.35	12.75	[illegible]	[illegible]	17.0	ok	1.38	2.49	4.6
F02	POND	9.25	9.00	42	9.62	500	[illegible]	2.0	19.35	0.0017	0.85	0.0005	14.35	12.75	13.50	12.50	[illegible]	[illegible]	15.5	ok	1.15	1.60	3.5
G01	G02	10.04	9.74	[illegible]	7.07	700	[illegible]	2.0	14.20	0.0015	0.75	0.0006	15.53	13.04	14.77	12.74	[illegible]	[illegible]	16.0	ok	0.47	2.49	3.7
G02	POND	9.24	9.00	42	9.62	480	45.0	2.0	19.35	0.0026	1.27	0.0005	14.77	12.74	13.50	12.50	[illegible]	[illegible]	15.0	ok	0.23	2.04	3.0
H01	H02	11.63	11.02	[illegible]	7.07	1020	[illegible]	2.0	14.20	0.0014	1.47	0.0006	16.81	14.63	15.34	14.02	[illegible]	[illegible]	19.5	ok	2.69	2.18	5.6
H02	H03	10.02	9.72	[illegible]	12.57	[illegible]	[illegible]	2.0	25.28	0.0012	0.91	0.0004	15.34	14.02	14.43	13.72	[illegible]	[illegible]	17.5	ok	2.16	1.32	4.2
H03	POND	9.22	9.00	[illegible]	15.90	[illegible]	[illegible]	2.0	31.97	0.0015	0.93	0.0004	14.43	13.72	13.50	13.50	[illegible]	[illegible]	16.0	ok	1.57	0.71	3.0
[illegible]	I02	11.79	11.30	[illegible]	4.91	[illegible]	[illegible]	2.0	9.89	0.0019	1.22	0.0008	17.18	14.29	15.97	13.80	[illegible]	[illegible]	19.0	ok	1.82	2.90	5.4
[illegible]	I03	10.30	9.93	[illegible]	9.62	[illegible]	[illegible]	2.0	19.35	0.0013	0.96	0.0005	15.97	13.80	15.00	13.43	[illegible]	[illegible]	18.0	ok	2.03	2.16	4.9
[illegible]	POND	9.43	9.00	[illegible]	12.57	[illegible]	[illegible]	2.0	25.28	0.0014	1.50	0.0004	15.00	13.43	13.50	13.00	[illegible]	[illegible]	16.0	ok	1.00	1.57	3.3
[illegible]	J02	11.92	11.49	[illegible]	4.91	[illegible]	[illegible]	2.0	9.89	0.0034	1.88	0.0008	16.90	14.42	15.02	13.99	[illegible]	[illegible]	18.0	ok	1.10	2.48	4.3
[illegible]	J03	9.99	9.68	[illegible]	12.57	750	[illegible]	2.0	25.28	0.0011	0.83	0.0004	15.02	13.99	14.18	13.68	[illegible]	[illegible]	17.0	ok	1.98	1.02	3.7
[illegible]	POND	9.18	9.00	[illegible]	15.90	[illegible]	[illegible]	2.0	31.97	0.0013	0.68	0.0004	14.18	13.68	13.50	13.50	[illegible]	[illegible]	15.0	ok	0.82	0.50	2.0
[illegible]	K02	11.05	10.42	[illegible]	4.91	[illegible]	[illegible]	2.0	9.89	0.0030	2.45	0.0008	17.65	13.55	15.19	12.92	[illegible]	[illegible]	18.0	ok	0.35	4.10	5.2
[illegible]	POND	9.42	9.00	42	9.62	[illegible]	[illegible]	2.0	19.35	0.0020	1.69	0.0005	15.19	12.92	13.50	12.50	[illegible]	[illegible]	16.0	ok	0.81	2.27	3.8
[illegible]	POND	9.39	9.00	[illegible]	7.07	[illegible]	[illegible]	2.0	14.20	0.0030	1.98	0.0006	15.48	12.39	13.50	12.00	[illegible]	[illegible]	16.0	ok	0.52	3.09	4.3
N01	N02	10.53	10.12	24	3.14	400	[illegible]	2.0	6.31	0.0047	1.89	0.0010	15.82	12.53	13.93	12.12	[illegible]	[illegible]	16.5	ok	0.68	3.29	4.7
N02	POND	9.12	9.00	36	7.07	200	[illegible]	2.0	14.20	0.0022	0.43	0.0006	13.93	12.12	13.50	12.00	[illegible]	[illegible]	15.0	ok	1.07	1.81	3.6
N03	N02	10.12	9.62	30	4.91	650	[illegible]	2.0	9.89	0.0014	0.93	0.0008	14.87	12.82	13.93	12.12	[illegible]	[illegible]	15.0	ok	0.13	2.25	3.1
O01	O03	11.15	10.57	30	4.91	750	[illegible]	2.0	9.89	0.0009	0.67	0.0008	14.28	13.65	13.61	13.07	[illegible]	[illegible]	15.0	ok	0.72	0.64	2.1
O02	O03	10.66	10.07	36	7.07	980	[illegible]	2.0	14.20	0.0014	1.33	0.0006	14.94	13.66	13.61	13.07	[illegible]	[illegible]	15.0	ok	0.06	1.28	2.0
O03	POND	9.07	9.00	48	12.57	170	[illegible]	2.0	25.28	0.0007	0.11	0.0004	13.61	13.07	13.50	13.00	[illegible]	[illegible]	14.5	ok	0.89	0.54	2.1
P01	P02	10.86	10.32	30	4.91	700	9.0	2.0	9.89	0.0008	0.54	0.0008	14.61	13.36	14.07	12.82	[illegible]	[illegible]	15.0	ok	0.39	1.25	2.3
P02	P03	9.82	9.67	36	7.07	250	[illegible]	2.0	14.20	0.0010	0.24	0.0006	14.07	12.82	13.83	12.67	[illegible]	[illegible]	15.0	ok	0.93	1.25	2.9
P03	POND	9.17	9.00	42	9.62	300	27.0	2.0	19.35	0.0010	0.33	0.0005	13.83	12.67	13.50	12.50	[illegible]	[illegible]	15.0	ok	1.17	1.16	3.0
R04	R03	10.96	10.67	24	3.14	280	9.0	2.0	6.31	0.0021	0.59	0.0010	14.42	12.96	13.83	12.67	[illegible]	[illegible]	16.5	ok	2.08	1.46	4.2
POND		9.00											13.50										

Input Data	
Ext. Pipe	P01

Design Flow=Prorated flow from SacCalc peak flow

APPENDIX K

WATER SUPPLY ASSESSMENT

Greenbriar Development Project
Sacramento, California

SB 610 Water Supply Assessment

Prepared for:

City of Sacramento
Environmental Planning Services

July 2006

EDAW

Greenbriar Development Project
Sacramento, California

SB 610 Water Supply Assessment

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July 2006

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05110011.01

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<u>Exhibits</u>

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1 EXECUTIVE SUMMARY

A water supply assessment (WSA) was prepared pursuant to Senate Bill 610 (SB 610 Water Code, Section 10910 et. seq., Chapter 643, statutes of 2001) for the proposed Greenbriar development project in Sacramento County. The Greenbriar site is located adjacent to and west of the City of Sacramento (City) City limits and outside of the City's Sphere of Influence (SOI); as such the project applicant is seeking to annex the project site to the City. The Greenbriar project is a proposed residential development centered on a common water feature including a total of 3,473 housing units and approximately 28 acres of retail and commercial space.

The water supply for Greenbriar would come from the City's water rights and a 1957 settlement contract with the United States Bureau of Reclamation (USBR). Under the contract, the City is entitled to divert up to 326,800 acre-feet per year (AFY) in 2030. As a signatory of the Water Forum Agreement (WFA), the City has agreed to limitations on diversions from the American River during certain specified conditions. During the conference year scenario, analogous to extremely dry years, the WFA limits annual withdrawal from the American River to 50,000 AFY. However, the WFA does not limit withdrawal from the Sacramento River; therefore, entitled American River water may be diverted further downstream at the Sacramento River Water Treatment Plant (WTP) below the confluence of the American and Sacramento Rivers. The resulting annual limitation is a function of the annual treatment plant capacity at the Sacramento River WTP, resulting in a total supply of 230,000 AFY, a maximum daily supply of 260 mgd. The total supply during the conference year scenario can meet the anticipated annual water demand through buildout of the City's SOI (2030).

During conference years when low flow conditions occur, the WFA limits the diversion rate from the American River to 155 cubic feet per second (cfs) during June through August when the peak demand occurs. Assuming treatment at the reduced diversion rate from the American River and maximum treatment at the Sacramento River WTP, the total surface water supply available to the City of Sacramento is 260 mgd. The projected maximum day demand within the City of Sacramento would exceed 260 mgd in 2015 by 4.6 mgd. However, groundwater sources supply 30 mgd in addition to available surface water supplies and would ensure maximum day demand in dry years is met through 2030. The additional demand from the proposed project would not significantly alter this timeline. The City is already undertaking studies to evaluate an additional Sacramento River diversion and treatment facility. While the City has sufficient water supplies through 2030, continued efforts to secure additional treatment capacity on the Sacramento River would ensure that the City has sufficient time to provide reliable delivery of water for the proposed project and future demand past 2030.

This WSA finds:

- The City has sufficient water to serve the proposed project and projected future demands over the next twenty years.

- Under normal water years, the City has sufficient capacity within its WTPs to serve the proposed project and projected future demands over the next twenty years.

- During conference years the City has sufficient supply to serve the average daily demands of the proposed project and projected future demands if the WTPs operate at maximum production capacity.

- During conference years, under a peak demand scenario, the City's peak demands would exceed available capacity of the WTPs by the year 2015 due to limitations in the summer months of the production capacity of the City's WTPs,

- Available groundwater supply (30 mgd) would provide additional supply to meet peak demands during conference years.

2 INTRODUCTION

This report presents the WSA prepared pursuant to Senate Bill 610 (SB 610 Water Code, Section 10910 et. seq., Chapter 643, statutes of 2001) for the proposed Greenbriar development project in Sacramento County. The Greenbriar site is located adjacent and west of the City of Sacramento (City) limits and outside of the City's Sphere of Influence (SOI); as such the project applicant is seeking to annex the project site to the City. Annexation will require approval of pre-zoning entitlements from the City, approval of an amendment to the City's SOI and annexation approval from the Sacramento County Local Formation Commission (LAFCo). The Greenbriar development is a residential development centered on a common water feature with a total of 3,473 housing units and approximately 28 acres of retail and commercial space.

The City is proceeding with environmental review of the project in conformance with the requirements of the California Environmental Quality Act (CEQA). The environmental review for the proposed project includes an assessment of the available water supply to serve the project, and a WSA is required under SB 610. Greenbriar would be annexed to the City and would be the water supplier. The City, as the water supplier is required to make a determination through the WSA whether sufficient water supplies are available to meet project demands under normal, single-dry, and multiple-dry water years over a 20-year planning horizon. Assuming that the WSA makes this determination, the City would adopt the WSA as part of the CEQA documentation prepared for the project.

2.1 SENATE BILL 610

SB 610 became effective January 1, 2002. The purpose of SB 610 is to strengthen the process by which local agencies determine the adequacy and sufficiency of current and future water supplies to meet current and future demands. SB 610 amended the California Public Resources Code to incorporate Water Code requirements within the CEQA process for certain types of projects. SB 610 also amended the Water Code to broaden the types of information included in Urban Water Management Plans (UWMP) (Water Code Section 10620 et. seq.).

2.1.1 WATER CODE PART 2.10

Water Code Part 2.10 clarifies the roles and responsibilities of the Lead Agency under CEQA and the water supplier (i.e., public water system) with respect to describing current and future supplies compared to current and future demands, it defines the projects that are required to prepare a WSA, and the Lead Agency's responsibilities related to the WSA. A WSA is required for:

1. A proposed residential development of more than 500 dwelling units;

2. A proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space;

3. A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space;

4. A proposed hotel or motel, or both, having more than 500 rooms;

5. A proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area;

6. A mixed-use development that includes one or more of the uses described above;

7. A development that would demand an amount of water equivalent to or greater than the amount of water required by a 500-dwelling-unit project; and

8. For Lead Agencies with fewer than 5,000 water service connections, any new development that will increase the number of water service connections in the service area by 10% or more.

Under Part 2.10, the Lead Agency must identify the affected water supplier and ask the water supplier whether the new demands associated with the project are included in the suppliers' UWMP. If the UWMP includes the demands it may be incorporated by reference in the WSA (Water Code Section 10910[C][2]). If there is no public water system to serve the project, the Lead Agency must prepare the WSA itself. (Water Code Section 10910[b]).

2.2 THE URBAN WATER MANAGEMENT PLANNING ACT

The Urban Water Management Planning Act requires a water supplier to document water supplies available during normal, single dry, and multiple dry water years during a 20-year projection and the existing and projected future water demand during a 20-year projection. The act requires that the projected supplies and demands be presented in 5-year increments for the 20-year projection (Water Code Section 10631).

3 GREENBRIAR DEVELOPMENT PROJECT

3.1 PROJECT LOCATION

The Greenbriar project site encompasses 577 acres located at the northwest intersection of State Route 99 (SR 99) and Interstate 5 (I-5) in Sacramento County. The project site is located in the unincorporated portion of Sacramento County, adjacent to and west of the City of Sacramento (City). The project site is located outside the current SOI for the City of Sacramento (Exhibit 1).

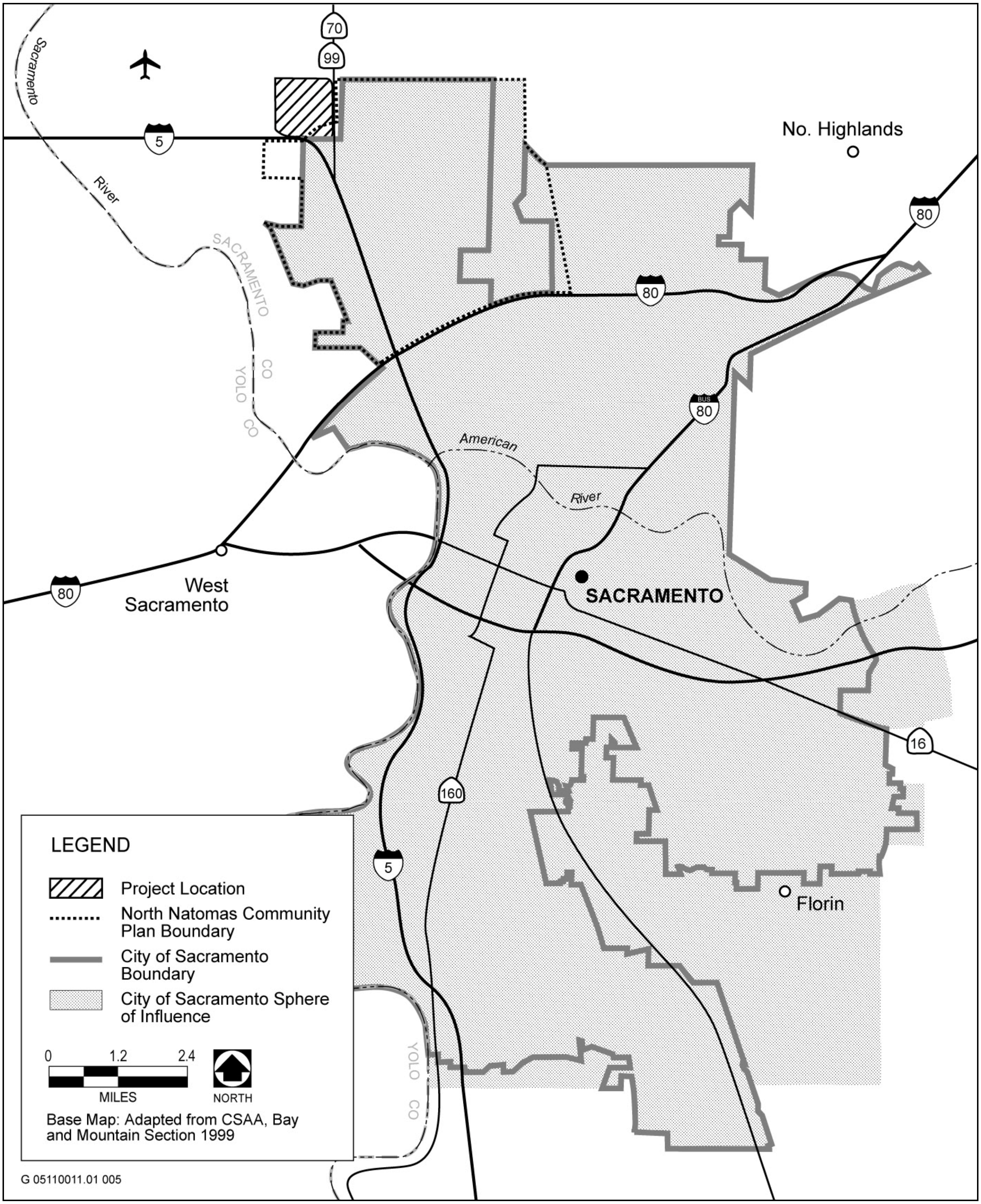
The project site is bordered by agricultural and rural residential land uses to the west and north, I-5 and agricultural lands to the south, and SR 99 and a new residential community currently under development within North Natomas to the east. The recently approved Metro Airpark development area is located adjacent to the western boundary of the project site, within Sacramento County and adjacent to the eastern boundary of the Sacramento International Airport. The Metro Airpark development area includes existing and proposed commercial, hotel, and recreational (i.e., golf course) land uses. The City's North Natomas Community Plan area is located adjacent to the eastern boundary of the project site and across SR 99.

3.2 EXISTING LAND USE

The project site is currently undeveloped, fallow, and active farmlands. All farmlands on the property are irrigated with local groundwater wells. Existing water demands are limited to the water demands necessary for cross cultivating the property. Historic groundwater pumping volumes from the site are not available. There is currently no infrastructure on the property to deliver water to the property via the City's public water system.

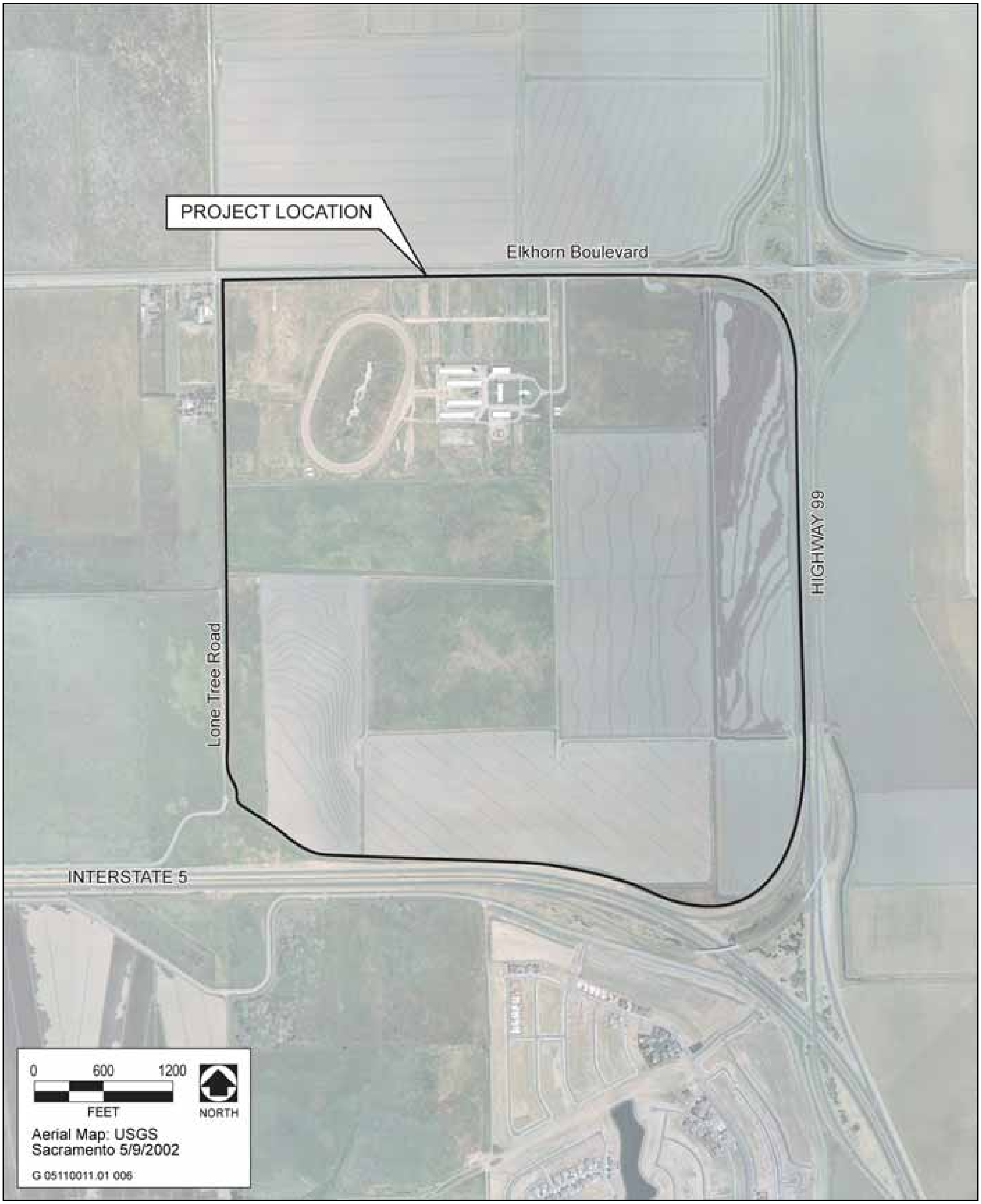
3.3 PROPOSED DEVELOPMENT

The City is considering approval of a residential mixed-use development at the project site. The project includes the construction of a range of housing types (e.g., high, medium, low density) that would be located within close proximity to public transportation systems. The proposed land use plan is predominantly a residential development centered on a common water feature (approximately 39 acres) (Exhibit 2). A total of 3,473 housing units and approximately 28 acres of retail and commercial space would be provided on site. A 10-acre (net) elementary school would be provided in the southeastern portion of the project site and would serve the school demands of the project site. A total of 8 neighborhood parks (approximately 49 acres) would be provided throughout the community and would be connected by the central lake/detention basin and pedestrian paths and trails.



Source: EDAW 2005

Project Location Map **Exhibit 1**



Source: EDAW 2005

Aerial Map of the Project **Exhibit 2**

3.4 WATER SUPPLY PLANNING FOR THE GREENBRIAR DEVELOPMENT PROJECT

The City's 2000 UWMP does not incorporate water demands for Greenbriar because Greenbriar is not currently located within the City's SOI. The City is currently in the process of preparing its 2005 UWMP, which would include demands associated with the Greenbriar project. Because the 2005 UWMP is not complete, this WSA uses the information provided in the 2000 UWMP as well as information provided by the City. Because the City's service area and water demands have grown since the 2000 UWMP was prepared and adopted, the City provided additional information related to this growth including updated water demand data. The 2000 UWMP and updated information provided by the City are the most recent and best information available addressing existing and future water demands, supplies, and facilities within the City of Sacramento.

The City is a signatory to the Water Forum Agreement (WFA). The WFA is a plan that provides for the effective long-term management of the Sacramento region's water resources. The WFA was developed by a diverse group of stakeholders known as the Water Forum, which consisted of water agencies, business groups, agricultural interests, environmentalists, citizen groups, and local governments and was formulated based on the two coequal objectives: 1) provide a reliable and safe water supply for the region's economic health and planned development through the year 2030; and 2) preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River.

As a signatory party to the WFA, the City has agreed to withdrawal limitations from the American River. These limitations have been and will continue to be incorporated into water supply planning for future development in the City limits, including the Greenbriar development and are described in greater detail in Section 4.4, "Supply Reliability Analysis."

3.5 EXISTING AND PROJECTED GREENBRIAR PROJECT WATER DEMANDS

Average daily water demand for the proposed Greenbriar development was calculated to be approximately 2.39 million gallons per day (mgd), or 2,680 acre-feet (AF) per year at full project build out (Table 1) (Wood Rodgers 2005). Maximum daily demand (MDD) is estimated to be 4.3 mgd. The MDD was determined by applying a factor of 1.8 to the Average Daily Demand (ADD) estimates. Buildout of the project is expected to be complete approximately 5–10 years after construction begins.

Table 1
Water Demand Projections for Greenbriar

Land Use Designation	Total		ADD Unit Water Demand		Demand		
	Acres[1] (net)	Dwelling Units	gpm/ac	gpm/du	Average Daily		Average Annual (AF)
					gpm	mgd	
Low Density Residential	81	671	—	0.44	295	0.42	476
Medium Density Residential	145	2,215	—	0.44	975	1.40	1,573
High Density Residential	30	587	2.48	—	74	0.11	119
Commercial	28	—	1.86	—	52	0.07	84
Parks/Landscape	51	—	2.6	—	133	0.19	215
Schools	10	—	1.55	—	16	0.02	26
Subtotal	**345**	**3,473**	—	—	**1,545**	**2.22**	**2,493**
7.5% System Losses	—	—	—	—	**116**	**0.17**	**187**
Totals	—	—	—	—	**1,661**	**2.39**	**2,680**

Notes: gpm = gallons per minute, mgd = million gallons per day
[1] Net acreage does not include street right of way.
Source: Wood Rodgers 2005

3.6 EXISTING AND PROJECT WATER DEMANDS FOR THE CITY OF SACRAMENTO

The City's historical surface and groundwater deliveries for the last five years are shown in Table 2. The total water supplied by the City from June 2003 to July 2004 was 143,784 AF. Over the past seven years, 17% of the delivered water has been supplied from groundwater (i.e., average of 20,454 AFY).

Table 2
City of Sacramento Historical Water Deliveries to Meet Demand

Year	Surface Water			Groundwater	Total Water Delivered		
	Annual Surface Water Delivered (AFY)	Maximum Day Water Delivered (mgd)	Maximum Day to Average Day Ratio	Annual Groundwater Delivered (AFY)	Total Annual Water Delivered (AFY)	Average (mgd)	Percent Increase
1997–98	92,031	191	1.71	22,053	114,034	99.9	—
1998–99	102,180	213	1.58	24,630	126,810	111.1	11.15
1999–00	112,547	220	1.61	24,149	136,696	119.8	7.8
2000–01	114,172	213	2.10	23,578	137,750	122.7	0.77
2001–02	113,979	215	1.57	24,271	138,250	123.41	0.36
2002–03	111,539	227	2.35	23,997	135,536	120.7	-1.96
2003–04	128,412	223	2.33	15,372	143,784	128.31	6.09
2004–05	116,305	—	—	19,271	135,576	120.7	-5.71
Average	*111,396*	*214.57*	*1.89*	*22,165*	*133,561*	*117.09*	*2.64*

Source: City of Sacramento 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005

The City has identified current and future water demands through buildout of their service area. The demand analysis includes projects that have been recently approved but not fully constructed as well as projects that have pending development applications with the City and are within the City's SOI. Table 3 presents the City's projected demands through build out (2030). Average annual demands are presented to determine whether or not the City has adequate water supply to meet its demands. Peak or maximum day demand estimates are presented to determine if the WTPs have adequate capacity to handle peak day demands.

Table 3
Projected 2030 Annual and Maximum Day Demand for the City of Sacramento

Area	Annual Demand (AFY)	Annual Demand (mgd)	Maximum Day Demand (mgd)
Development within Existing City Limits	193,497	139	250.2
SMUD Cogeneration Facility	622	0.56	1.0
Panhandle Annexation [a]	4,199 [d]	3.00	5.4
Airport/Metro Air Park Wholesale Wheeling Assessment	6,538	6.50	11.7
SSWD Wholesale [b,c]	26,064	16.67	30.0
Cal Am Parkway Wholesale Agreement	2,580	0.61	1.1
Zone 40 Wheeling Service	10,000	6.11	11.0
Total	243,500	172	310

Notes: [a] This includes the demands within the County's Northgate system and the proposed Panhandle development. [b] SSWD does not take City wholesale water during times of Hodge restrictions. [c] SSWD has the option to contract for up to 10 mgd of additional firm or non-firm capacity in addition to the 20 mgd of firm capacity under the Wholesale Agreement. [d] Assumes a conservation rate of 7.5%.
Source: Peifer, pers. comm., 2005

The City's projected water demands in 2030 were estimated to be 243,500 AFY with a average daily demand of 172 mgd and a maximum day demand of 310 mgd.

The 2030 projected water demands do not include the increased demand associated with the Greenbriar project. Therefore, the project would increase the City's 2030 water demands by 2,680 AFY, or approximately 1.4 % of the projected 2030 demand. The City's total 2030 water demands with the project would be 195,818 AFY with a projected average daily demand of 174.8 and a maximum day demand of 314.7 mgd.

4 WATER SUPPLY ASSESSMENT FOR THE GREENBRIAR PROJECT

4.1 INTRODUCTION

4.1.1 RESPONSIBILITIES OF THE LEAD AGENCY

The City of Sacramento is the CEQA Lead Agency responsible for evaluating the environmental impacts of the project in compliance with CEQA, certifying the EIR, and issuing the associated entitlements.

The City would be the retail water provider for the project and would be the agency responsible for preparation and approval of the WSA. In preparing the WSA, The City must do the following:

- Determine the sufficiency of the supply to meet the project demands under normal, single dry and multiple dry years over a 20-year projection.
- Identify existing water supply entitlements and water rights for the proposed project and quantify water received in prior years pursuant to these existing entitlements and rights.
- Describe the groundwater basin from which the proposed project will be supplied, if applicable. The description must include information regarding overdraft in the basin. The amount and location of groundwater pumped by the City must be quantified, based on reasonably available information.
- Describe and analyze the amount and location of groundwater projected to be pumped by the City from the basin from which the project will be supplied. The assessment must include an analysis of the sufficiency of groundwater from the basin to meet the projected water demand associated with the proposed project.
- Provide information related to capital outlay programs for financing delivery of water supply.
- Provide information on federal, state, and local permits for construction of necessary infrastructure and regulatory requirements associated with delivery of the water supply.

4.2 REQUIREMENTS OF THE WSA

SB 610, as described in California Water Code Sections 10910–10915 requires that a WSA for a project include the following information:

- A description and quantification of the existing and planned water sources.
- A description of the reliability and vulnerability of the water supply to seasonal or climatic shortages in the average water year, single dry water year, and multiple dry water year during a 20-year projection.
- Contingency plans including demand management and conjunctive use potential.

- A description of current and projected water demands.
- A description of all water supply projects and water supply programs that may be undertaken by the City to meet the total projected water use.

In addition, because the City uses groundwater as one of its supply sources, the WSA should include:

- A description of any groundwater basin (or basins) from which the City pumps groundwater.
- Information that characterizes the condition of the groundwater basin and a description of the measures currently being taken by the City to minimize any potential for overdraft conditions to occur.
- A detailed description and analysis of the amount and location of groundwater pumped by the City for the past five years from any groundwater basin from which the proposed project will be supplied.
- An analysis of the location, amount, and sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project.

The following analysis presents the WSA for the Greenbriar project in compliance with the requirements of SB 610.

4.3 COMPLIANCE WITH PROVISIONS OF THE WATER CODE

4.3.1 DETERMINE WHETHER PROJECT IS SUBJECT TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) [WATER CODE SECTION 10910(A)]

The City has made the determination that the Greenbriar project is subject to CEQA and is a “project” as defined by Water Code Section 10912(a) because it would result in the construction of greater than 500 dwelling units, as well as commercial and retail office space. All criteria for projects requiring a WSA apply to the project.

4.3.2 IDENTIFY THE PUBLIC WATER SYSTEM THAT WILL SUPPLY WATER FOR THE PROJECT [WATER CODE SECTION 10910(B)]

The property where the proposed Greenbriar project would be located would be annexed to the City and served by the City’s Utilities Department. The Utilities Department is a public water agency that served 131,745 connections as of June 2004. The City operates two water treatment plants (WTP). The Sacramento River WTP is located on the east bank of the Sacramento River, about one half mile downstream of the confluence of the American and Sacramento Rivers and the E.A. Fairbairn WTP (formally American River WTP) is located adjacent to the American River between the H Street and Howe Avenue bridges, approximately seven miles upstream of the confluence of the American and Sacramento Rivers. The city has 34 municipal drinking water wells; of these 23 are active and nine are on standby (Sherry, pers. comm., 2005).

4.3.3 IS THERE AN ADOPTED URBAN WATER MANAGEMENT PLAN (UWMP) [WATER CODE SECTION 10910(C)]

As described above, the City completed and adopted its 2000 UWMP (City of Sacramento 2001). Because the Greenbriar development is not currently within the City limits, the plan does not incorporate demands associated with the Greenbriar project. The City is currently preparing its 2005 UWMP, which would address water demands associated with Greenbriar. This document is anticipated to be adopted in early 2006. Because the 2005 UWMP is not complete, this WSA relies on the information provided in the 2000 UWMP and other relevant water supply information provided by the City including, water demand data, and existing operational constraints.

4.3.4 ARE THE PROJECTED WATER DEMANDS ASSOCIATED WITH THE PROPOSED PROJECT ACCOUNTED FOR IN THE MOST RECENTLY ADOPTED URBAN WATER MANAGEMENT PLAN [WATER CODE SECTION 10910(C)]

The most recently adopted UWMP (City of Sacramento 2001) does not account for projected water demands associated with the proposed Greenbriar project because the Greenbriar property was not within the City of Sacramento's sphere of influence (SOI) or under their planning jurisdiction at the time of preparation.

4.3.5 IDENTIFY EXISTING WATER SUPPLIES FOR THE PROJECT [WATER CODE SECTION 10910(D)]

Water Code Section 10910(d)(1) requires identification of existing water supply entitlements, water rights, or water service contracts relevant to the Greenbriar project and a description of the quantities of water obtained by the City pursuant to these water supply entitlements, water rights, or water service contracts in previous years.

The City would be the retail water purveyor for the project. The water supplies for the project have been addressed in existing City water supply plans and agreements including:

- *Water Forum Agreement* (City-County Office of Metropolitan Water Supply Planning)
- *2000 Urban Water Management Plan* (City of Sacramento 2001)

CITY OF SACRAMENTO SURFACE WATER SUPPLIES

The City has a permanent water right settlement contract with the USBR that limits the City's annual surface water diversion to 81,800 AF from the Sacramento River, and 245,000 AF from the American River. The maximum total combined water supply from both the Sacramento and American River by the year 2030 is 326,800 AF (Table 4). The projected incremental increases are shown in Table 4.

Table 4
City of Sacramento USBR Contracted Annual Surface Water Entitlements (AFY)

Source	2005	2010	2015	2020	2025	2030
American River	123,200	145,700	170,200	196,200	222,200	245,000
Sacramento River	81,800	81,800	81,800	81,800	81,800	81,800
Total	205,000	227,500	252,000	278,000	304,000	326,800

Sacramento and American River Diversion Rights

The City has used surface water since 1854 and claims pre-1914 rights to divert 75 cubic feet per second (cfs) from the Sacramento River. Currently, the City holds five water right permits: one for diversion of Sacramento River water and four for diversion of American River water. The Sacramento River permit, Permit 992, has a priority date of March 20, 1920. Permits 11358 through 11361, on the American River, have priorities ranging from October 1947 to September 1954. The water right permits are on file with the City of Sacramento Utilities Engineering Department.

The Sacramento River permit and two of the American River permits (11358 and 11361) authorize direct diversion. The other two permits (11359 and 11360) authorize rediversion and consumptive uses of American River tributary water stored and released at SMUD's Upper American River Project power development reservoirs. The reservoirs (Union Valley, Ice House, Rubicon, Rockbound, Loon Lake and Gerle) are located in the Crystal Basin area of the Sierra Nevada Mountains east of Sacramento and north of U.S. Highway 50.

In 1957, USBR and the City entered into a permanent water rights settlement contract which provides, among other things, that:

- USBR agreed to regulate flows at Folsom Reservoir to ensure the City's ability to divert up to 245,000 AFY under the City's American River water rights and to operate CVP reservoirs so that they do not interfere with the City's exercise of its Sacramento River water rights.

- The City agreed to:

    1. Limit its total diversion rates to 225 cfs of Sacramento River water and 675 cfs of American River water; and

    2. Limit its total diversion of Sacramento and American River water to 326,800 AFY (81,800 AF of Sacramento River water and 245,000 AF of American River water per year).

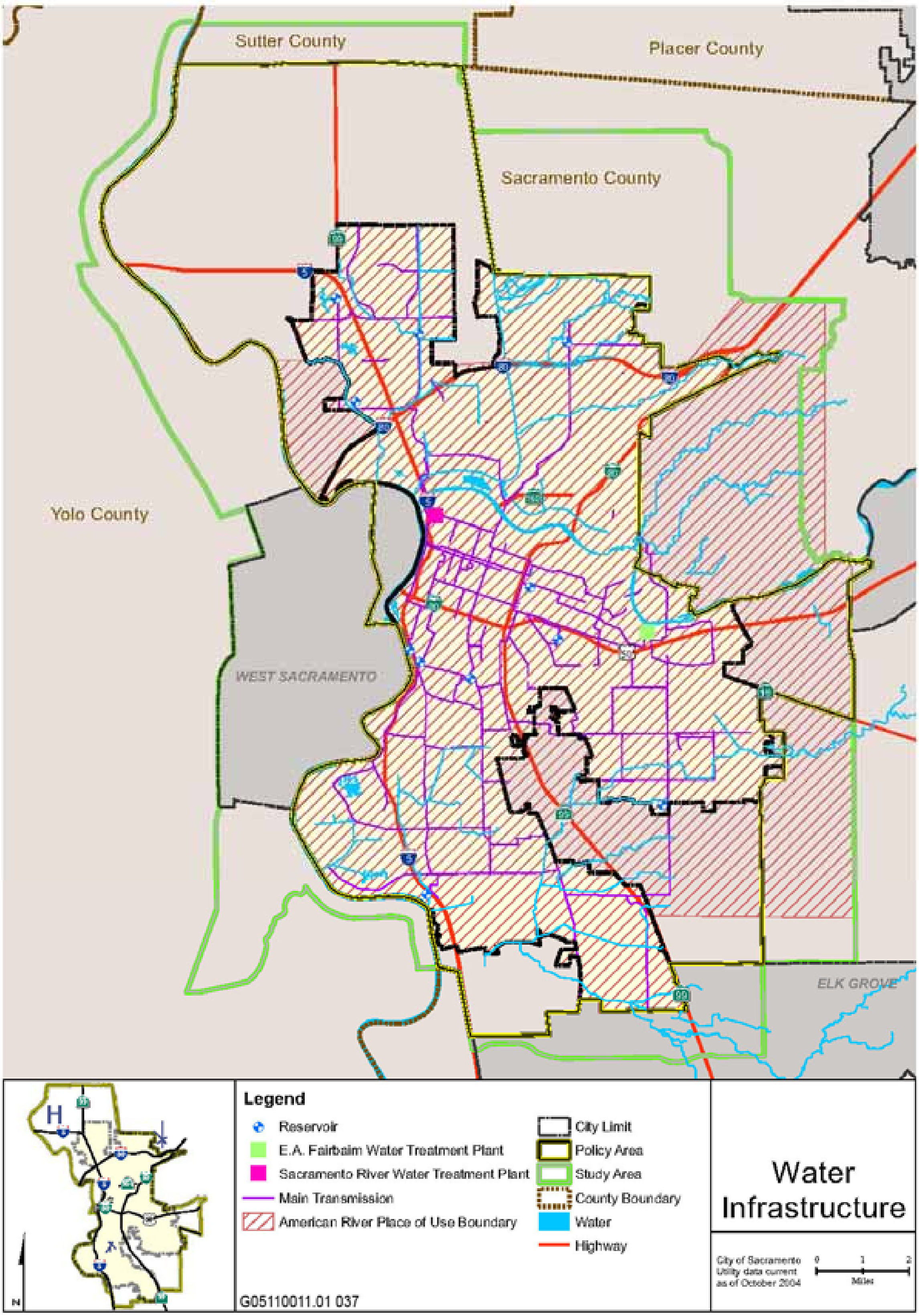
- The City is not required to take pro-rata reductions in dry years.

The City's water right permits allow authorized water diversions to be used within specified areas described as authorized places of use (POU). Permit 992 designates lands within the City of Sacramento as the authorized place of use. Permits 11358 and 11361 designate a 79,500 acre area within and adjacent to the City as the authorized POU. Permits 11359 and 11360 designate a 96,000-acre area within and adjacent to the City as the POU. Exhibit 3 illustrates the City's Water Service Area, showing the 96,000-acre authorized POU and current City limits. The Greenbriar project is adjacent to the City's POU, but will become part of the POU under Permit 992 if the area is annexed to the City.

As a signatory of the 2000 WFA, the City has agreed to reduce its diversions from the American River when flows are below Hodge flow criteria. Hodge flow criteria were defined as a result of *Environmental Defense Fund et al. v. East Bay Municipal Utility District (EBMUD)* which addressed the ability of EBMUD to divert water from the lower American River at the Folsom South Canal. Hodge flows are named after the judge presiding over the case and are minimum flow values in the Lower American River which must be met as a condition of EBMUD's diversion of contracted water. These flows are set at 2,000 cfs October 15–February; 3,000 cfs March–June; and 1,750 cfs July–October 14. The City agreed in the WFA to reduce its diversion from the American River during conference years and when flows bypassing the City's diversion are below the Hodge flow criteria. The City's authorized diversions with and without the WFA diversion restrictions are listed in Table 5. As shown in the table, under dry year conditions the City would not be subject to reductions in entitlement volumes only diversion rates.

Water Code Section 10910(d)(2)(A) requires information related to written contracts or other proof of entitlements to the water supplies identified to serve the project.

As described above, the City has existing surface water entitlements and maintains active groundwater wells which would supply the proposed project. At build-out in 2030, the USBR contract provides the City with a maximum annual diversion of 326,800 AFY. Copies of the City's permits and the USBR Contract are available for review at the City of Sacramento, Utilities Department.



Source: City of Sacramento 2005

Water Infrastructure **Exhibit 3**

Table 5 City of Sacramento Surface Water Entitlements with Water Forum Agreement			
Permit	Authorized Diversion	Maximum Permitted Diversion	
		AFY	cfs
1957 USBR 2030 Contractual Maximum[a]	American River	245,000	675
	Sacramento River	81,800	225
	Total Combined Diversion	**326,800**	**900**
2000 WFA Maximum	American River	245,000	310[b]
	Sacramento River	81,800	290[c]
	Total Combined Diversion	**326,800**	**900**

Notes:

[a] Based on permits 00922, 011358, 011359, 011360, and 011361.

[b] 310 cfs is a maximum withdrawal rate, additional restrictions apply.

[c] There is no maximum withdrawal rate from the Sacramento River in the WFA. However, the total maximum withdrawal rate from the American and Sacramento rivers can not exceed 900 cfs. The Sacramento WTP is below the confluence the American and Sacramento Rivers.

Sources: City of Sacramento and Sacramento City-County Office of Metropolitan Water Planning

Water Code Section 10910(d)(2)(B) requires information related to copies of the capital outlay program for financing the delivery of the identified water supply.

The infrastructure necessary to deliver water to the project site would be funded from the 2005–2010 Capital Improvement Program (CIP). A copy of the CIP is available for viewing at City of Sacramento Utilities Department. In summary, the 2005-2010 CIP totals $366.8 million from all funding sources. The General Fund portion of the five-year program is $12.4 million or 3% of the total. The first year of the CIP, the FY2005/06 CIP Budget totals $105.4 million. These appropriations will add to currently active project appropriations of approximately $1 billion. Expenditures are planned in the following major program areas: General Government; Public Safety; Convention, Culture and Leisure; Parks and Recreation; Transportation and Utilities. The bulk of the project budgets are for Utilities and Transportation projects supported by the Water, Sewer, Drainage, Measure A Sales Tax, Gas Tax, and Major Street Construction Funds.

The project would connect into the City's existing water distribution network. No new water treatment or diversion structures would be required to serve the project. The project includes the preparation of the Greenbriar Finance Plan. A summary of the Greenbriar Finance Plan is provided in Appendix C of the Greenbriar EIR. This plan would ensure the project applicants pay their fair share portion of necessary infrastructure costs (e.g., water supply infrastructure) necessary for delivering water to the project.

Water Code Section 10910(d)(2)(C) requires information related to federal, state, and local permits for construction of infrastructure necessary for delivering the water supply.

As described above the City has sufficient water rights and entitlements to meet existing and future water demands within City over a 20-year period. All water supply infrastructure necessary to meet existing demands is constructed and all necessary approvals for the delivery and use of this water within City have been secured.

The City is pursuing construction of a new water treatment plant along the Sacramento River near Elverta Road (northeast of the project site). This treatment plant would provide additional treatment capacity to ensure the provision of water to City customers beyond 2025. Permits and authorizations that may be required for construction of the new water treatment plant are listed below in Table 6.

Table 6
Possible Required Permits and Authorizations for Water Supply Infrastructure

Federal	State	Local
U.S. Army Corps of Engineers – Section 404 Permit	California Department of Fish and Game (DFG) - Streambed Alteration Agreement	Department of Health Services review and approval
U.S. Fish and Wildlife Service – Endangered Species Act Consultation	Regional Water Quality Control Board - Section 401 Water Quality Certification, National Pollutant Discharge Elimination System Construction Stormwater Permit	
U.S. Bureau of Reclamation – Review and approval	Sacramento Metropolitan Air Quality Management District – Authority to Construct	

The project would not require any additional water supply infrastructure above and beyond what is currently available or planned for by the City. The project would be required to extend water conveyance infrastructure to the site, which is being evaluated as part of the EIR. No additional permits are needed.

Water Code Section 10910(d)(2)(D) requires information related to any regulatory approvals required for delivery of the water supply.

No regulatory approvals would be required to deliver water to the Greenbriar project site. The City has secured all water supply entitlements and regulatory approvals necessary to distribute groundwater and surface water within its service area.

4.3.6 IDENTIFY PARTIES DEPENDENT ON PROPOSED SUPPLY. [WATER CODE SECTION 10910(E)]

The intent of this section is to identify any potential conflicts that may arise from the exercise of water supply entitlements, water rights, or water service contracts to serve a proposed project if such water supply entitlements, water rights, or water service contracts have not been previously exercised.

The proposed project would be served by the City through its existing water supply entitlements and groundwater supplies. The City's surface water entitlements and contracts have all historically been exercised, and groundwater has been historically pumped. There are no unexercised water service contracts that will be used to serve the proposed project and therefore no potential conflicts would arise from supplying water to the proposed project.

4.3.7 DOES THE SUPPLY INCLUDE GROUNDWATER AS A SOURCE? [WATER CODE SECTION 10910(F)]

A portion of the water demand from the proposed project would be met with groundwater. Consequently, Section 10910(f) requires the following additional information.

Water Code Section 10910(f)(1) requires a review of groundwater data contained in the UWMP.

The City maintains 34 wells for potable and non-potable use. Of these wells, 32 potable wells are north of the American River, and two are south of the American River (Peifer, pers. comm.., 2005). The current groundwater system can supply 30 mgd and produce approximately 33,600 AFY. Historical average annual groundwater use for the period 1997-98 through 2003-04 was 20,454 AFY (Table 2).

Water Code Section 10910(f)(2) requires a description of the groundwater basin and the efforts being taken to prevent long-term overdraft.

The City is located in the 548-square mile North American Groundwater Subbasin (Department of Water Resources 2003). The Subbasin's boundaries are the Feather and Sacramento Rivers on the west, the Bear River to the north, the American River on the south, and the Sierra Nevada on the east. The underlying geology of the basin consists of a variety of geologic formations that make up the water bearing units. There are two aquifer systems: an upper unconfined system consisting of the Victor, Fair Oaks, and Laguna Formations, and a lower, semi-confined system in the Mehrten Formation. These geologic formations are composed of lenses and layers of inter-bedded sand, silt, and clay with coarsegrained stream channel deposits. The groundwater contained in the upper aquifer system of the Victor, Fair Oaks and Laguna Formations is of superior quality compared to that in the lower semi-confined system, mainly because the water in the Mehrten Formation is higher in iron and manganese, and requires additional treatment. The upper unconfined system only requires chlorination treatment to be potable (Sacramento Groundwater Authority 2003).

The City is a member of the Sacramento Groundwater Authority (SGA). The SGA is a joint powers authority created in 1998 by a coordinated effort between the Sacramento Metropolitan Water Authority and the WFA to manage the region's North Area Groundwater Basin, a sub-region of the North American Subbasin. The signatory participants are managing the basin in a cooperative fashion by allowing representatives from the local water purveyors, the agricultural community, and other groundwater pumpers to serve on the Board of the SGA. The goal of the SGA is the responsible management of the groundwater basin through a commitment to not exceed the negotiated sustainable yield of the basin, which is approximately 131,000 AFY according to the WFA. The SGA developed a Groundwater Management Plan (GMP) to ensure a safe, reliable water supply for the rapidly growing northern Sacramento County area. Within this program the SGA will continually assess the status of the groundwater basin and make appropriate management decisions to sustain the basin.

The City and other SGA members, in accordance with the WFA, have implemented a conjunctive use program to responsibly manage and use the groundwater system. The program accounts for the annual climatic variability of the region, whereby in normal or wet years of precipitation the water providers will divert more surface water and reduce or eliminate groundwater use, allowing the groundwater system to recharge. In dry years when Lower American River flows must be maintained, groundwater will be pumped and used to supplement the reduced diversions from the river systems (Sacramento Groundwater Authority 2003).

Water Code Section 10910(f)(3) requires a description of the volume and geographic distribution of groundwater extractions from the basin for the last five years.

The City's historical average annual groundwater use for the period 1997-98 through 2003-04 was 20,454 AFY (Table 2). The City's active municipal groundwater wells are located primarily in the northern areas of the City. Thirty-two of the wells are located north of the American River and the two wells are south of the river.

4.4 SUPPLY RELIABILITY ANALYSIS

The WFA is important to consider when discussing water supplies and reliability within the Sacramento region. The WFA is an agreement between multiple stakeholders of the Sacramento metropolitan area and lower foothill regions. After seven years of meetings, sub-committee negotiations and small group operations, the Water Forum members established a working agreement that provides water quality and reliability for all participants. The WFA's coequal goals were to (1) provide a reliable and safe water supply for the region's economic health and planned development through to the year 2030, and (2) preserve the fishery, wildlife, recreational and aesthetic values of the Lower American River (Sacramento City-County Office of Metropolitan Water Planning 2000).

From these coequal goals, the Water Forum signatories determined seven major elements that must be implemented during the next thirty years if the agreement is to be successful. The elements specific to water supply reliability include:

- Increased Surface Water Diversions,
- Actions to Meet Customers' Needs While Reducing Diversion Impacts in Drier Years,
- Water Conservation,
- Groundwater Management and the Water Forum Successor Effort.

Each of these elements plays a vital role in the Water Forum's coequal objectives. As a signatory of the WFA, the City's Utilities department is actively participating in all seven elements.

The City is continuing to develop a water supply consistent with the WFA. Public Law 106-554 authorized the preparation of the Sacramento River Water Reliability Study, which includes a feasibility study for the construction of a second Sacramento River diversion. The Sacramento River Water Reliability Study includes development of water supply alternatives, an environmental evaluation, and consultation with federal and state agencies regarding potential impacts. The Draft Planning report is scheduled for review in early 2006.

The WFA places flow restrictions on diversions from the American River when flow is below the Hodge flows as defined in *Environmental Defense Fund et al. v. East Bay Municipal Utility District* (flow levels of 2,000 cfs from October 15 through February; 3,000 cfs from March through June; and 1,750 cfs from July to October 14). The City's WFA diversion limits change seasonally and are listed in Table 7. Approximately 59% of the years will experience Hodge flow conditions during the peak months of June through August based on historic operations of Folsom Reservoir.

Table 7
Restricted American River Diversion Rates

Month	Diversion Limit [a]	
	cfs	AF
January	120	7,400
February	120	6,700
March	120	7,400
April	120	7,100
May	120	7,400
June	155	9,200
July	155	9,500
August	155	9,500
September	120	7,100
October	100	6,100
November	100	6,000
December	100	6,100

Notes:
[a] Restriction occurs when the flow passing the WTP is below the Hodge flow condition.
Source: Sacramento City-County Office of Metropolitan Water Planning 2000

The Sacramento River WTP has a capacity of 160 mgd (179,200 AFY). Fairbairn WTP has a treatment capacity of 200 mgd (224,000 AFY), equal to the maximum diversion rate allowed in the WFA. If both plants operated at their maximum production, the combined theoretical output would be approximately 360 mgd.

To account for future growth past 2030, and increased reliability, the City is evaluating the construction of a 145 mgd (225 cfs) WTP on the Sacramento River near Elverta Road, north of the Sacramento International Airport. The proposed water treatment plant is anticipated to be operational within the next 6 to 10 years. With the addition of the new Sacramento River WTP, the City's combined maximum production would be 505 mgd (an additional 145 mgd) and the dry year or Hodge Flow conditions production would be 405 mgd (the 100 mgd reduction at the American River because of dry year conditions would result in an additional 45 mgd of treatment capacity). Maximum day production before and after completion of a 145 mgd Sacramento WTP is shown in Table 8.

Table 8
Maximum Day Production

Source	Production Limit with Flows Above Hodge Criteria (mgd)	Production Limit with Flows Below Hodge Criteria (mgd)
Fairbairn WTP	200	100
Sacramento WTP	160	160
Groundwater	30	30
Total	**390**	**290**
New Sacramento WTP	145	145
Total with new WTP	**535**	**435**

Source: Sacramento City-County Office of Metropolitan Water Planning 2000

During years when the projected unimpaired inflow to Folsom Reservoir is less than 400,000 AF, the WFA limits all diversions from the American River to 50,000 AFY. The WFA has labeled the extremely low flow conditions as a "conference year" where signatories will meet to discuss water management strategies. A conference type year scenario has a 1.8% probability of occurring and did occur in 1924 and in 1977. The WFA does not restrict diversion of American River entitlements from a Sacramento River diversion point; therefore normal year and dry year supplies are identical for the City as shown in Table 9. However, annual surface water diversions are limited by the diversion capacity from the Sacramento River. Assuming 50,000 AFY from the Fairbairn WTP and a maximum production from the Sacramento WTP of 179,000 AFY, the current drought limiting scenario would allow for a theoretical maximum surface water production of 230,000 AFY.

Table 9
2005 Annual Surface Water Supplies During a Hypothetical Three Year Consecutive Conference Year Period (AFY)

Source	2005 City of Sacramento Surface Water Rights (AFY)	2005 to 2007 Dry Year Supply [a]		
		First Conference Year 2005 (AFY)	Second Conference Year 2006 (AFY)	Third Conference Year 2007 (AFY)
American River	123,200	50,000	50,000	50,000
American River diverted from Sacramento River	---	73,200	77,700	82,200
Sacramento River	81,800	81,800	81,800	81,800
Total [b]	**205,000**	**205,000**	**209,500**	**214,000**

Notes:
[a] Diversion capacity from Sacramento River is 180,000 AFY, allowing a drought year production of 230,000 AFY.
[b] Total supply increases pursuant to USBR contract.
Source: City of Sacramento

The theoretical maximum "conference year" production of 230,000 AFY over estimates the current drought year production, because the existing Sacramento WTP could not operate at maximum capacity of 160 mgd in the winter months**.** In the winter months, demand is less than the maximum treatment capacity of 160 mgd and no storage is available to store excess treated water. Therefore, the treatment plant would operate at maximum demand, which is some increment less than maximum capacity.

COMPARISON OF AVAILABLE WATER SUPPLIES VERSUS DEMAND

ANNUAL SUPPLY AND DEMAND

The City's 2004 water demand of 143,764 AFY was below the current USBR contracted entitlements of 200,000 AFY. The City's projected (2030) annual water demand remains approximately 59% of the USBR contracted annual entitlements. Water demands were estimated for the City from 2005 to 2030 by assuming a constant linear growth rate in water demands between 2005 and 2030 (Table 10). The project's total demand of 2,680 AFY would result in an increase in total demand in 2030 equal to 195,818 AFY. The table shows that under normal year types, sufficient water supplies are available to meet the project and City projected future demands under a 25 year planning horizon.

Table 10
City of Sacramento Supply and Demand Comparison during Normal Year Types 2005 through 2030 (AFY)

	2005	2010	2015	2020	2025	2030
Surface Water Supply						
American River	123,200	145,700	170,200	196,200	222,200	245,000
Sacramento River	81,800	81,800	81,800	81,800	81,800	81,800
Total Surface Water Supply	**205,000**	**227,500**	**252,000**	**278,000**	**304,000**	**326,800**
Demand	161,342	167,714	174,073	180,432	186,791	193,138
Project Demand	0	2,680	2,680	2,680	2,680	2,680
Total Demand	**161,342**	**170,394**	**176,753**	**183,112**	**189,471**	**195,818**
Additional Water Supply	**43,658**	**57,106**	**75,247**	**94,888**	**114,529**	**130,982**

The WFA limits the driest year diversion to 50,000 AFY from the American River, but does not limit the diversion for the American River entitlement from the Sacramento River. Therefore, the City would not be subjected to reductions in contracted deliveries for single or multiple dry years. Annual supply is only limited by diversion and treatment capacity of the Sacramento River during dry year conditions. Current theoretical maximum production during the conference years is approximately 230,000 AFY. Table 11 shows a comparison of supply and demand during conference years. As shown in the table, at maximum production rates sufficient water is available to meet project demands during conference years (i.e., single dry and multiple dry years) in addition to existing and projected future demands over a 25-year planning period. In dry years, the City's total water demands are reduced because the city does not supply water to Sacramento Suburban Water District (SSWD). However, because demand would not be equal to maximum production capacity and no storage is available, the conference year production estimate of 230,000 AFY may over estimate the current drought supply. Therefore, it is important that maximum day demand is also evaluated as described below.

Table 11 Supply and Demand Comparison during Conference Years						
	2005	2010	2015	2020	2025	2030
Surface Water Supply						
American River	50,000	50,000	50,000	50,000	50,000	50,000
American River diverted from the Sacramento River	73,200	95,700	120,200	146,200	172,200	179,000
Sacramento River	81,800	81,800	81,800	81,800	81,800	81,800
Total Surface Water Supply [a]	**205,000**	**227,500**	**252,000**	**278,000**	**304,000**	**310,800**
Demand [b]	135,576	157,036	178,496	199,957	221,417	242,877
Project Demand	0	2,680	2,680	2,680	2,680	2,680
Total Demand	**135,576**	**159,716**	**181,176**	**202,637**	**224,097**	**245,557**
Additional Water Supply	**69,424**	**67,784**	**70,824**	**75,363**	**79,903**	**65,243**

Notes: Conference Year, as defined by the WFA, when the projected unimpaired inflow to Folsom Reservoir is less than 400,000 AF.

[a] Total surface water supply shown is based on USBR contracted deliveries and not maximum dry year treatment and diversion capacity of 230,000 AFY

[b] Dry/Conference year demand reduced because City does not provide water to SSWD in dry years.

Source: City of Sacramento

Maximum Day Demand

Because of diversion limitations during Hodge flow conditions, the maximum peak day demand should also be considered when comparing supply to demand. Table 12 shows the maximum day surface water supply and demand under normal flow conditions. Table 13 shows the maximum day surface water supply and demand under Hodge flow conditions. Table 12 shows that the City would meet the anticipated peak day demands under normal flow conditions through the year 2030, even without the new WTP. Table 13 shows that during Hodge flow conditions, treatment capacity at Fairbairn is reduced from 200 mgd to 100 mgd, resulting in a total treatment capacity of 260 mgd. Peak day demands under Hodge flow conditions would be met through 2010 with available surface water treatment capacity. The City currently can pump up to 30 mgd of groundwater which would supplement the available surface water. The City's surface and groundwater supplies would provide adequate supplies to meet peak daily demands during a conference year through 2030.

Table 12 Maximum Day Surface Water Supply and Demand Comparison during Normal Flow Conditions (mgd)						
	2005	2010	2015	2020	2025	2030
Surface Water Supply						
American River [a]	200	200	200	200	200	200
Sacramento River [a]	160	160	160	160	160	160
Total Surface Water Supply	**360**	**360**	**360**	**360**	**360**	**360**
Demand	218	234	251	267	283	300
Project Demand	-	4.3	4.3	4.3	4.3	4.3
Total demand	**218**	**238**	**255**	**271**	**287**	**304**
Additional Water Supply	**142**	**122**	**105**	**89**	**73**	**56**

Notes: [a] Surface supply is based on plant capacity.

Source: City of Sacramento

Table 13 Peak Day Surface Water Supply and Demand Comparison during Hodge Flow Conditions (mgd)						
	2005	2010	2015	2020	2025	2030
Surface Water Supply						
American River [a]	100	100	100	100	100	100
Sacramento River [b]	160	160	160	160	160	160
Total Surface Water Supply	**260**	**260**	**260**	**260**	**260**	**260**
Demand [c]	239.3	251.94	260.16	268.38	276.6	280.4
Project Demand	-	4.3	4.3	4.3	4.3	4.3
Total Demand	**239.3**	**256.2**	**264.5**	**272.7**	**280.9**	**284.7**
Surplus	**20.7**	**3.8**	**-4.5**	**-12.7**	**-20.9**	**-24.7**
Groundwater	30	30	30	30	30	30
Additional Water Supply	**50.7**	**33.8**	**25.5**	**17.3**	**9.1**	**5.3**

Notes:
[a] American River diversion is limited to 100 mgd during Hodge flow conditions.
[b] Sacramento WTP peak day supply is based on plant capacity.
[c] Dry/Conference year demand reduced because City does not provide water to SSWD in dry years.
Source: City of Sacramento

SUPPLY RELIABILITY ASSESSMENT

The City's has sufficient water supplies to meet their existing and projected future demands in addition to the proposed project through 2030. During normal water years, the City would be able to meet its anticipated demands by using available surface water supplies and surface water treatment capacity. During conference years, or when flows are below Hodge conditions, the City's peak daily demands, including the proposed project, could be met with available surface water treatment capacity through 2015 and through 2030 with combined use of available surface water and groundwater supplies.

The City is a partner in the Sacramento River Water Reliability Study, which is investigating alternatives for an additional diversion on the Sacramento River. The environmental documents for the alternatives analysis are scheduled to be complete in 2006. The proposed 145 mgd diversion facility and WTP included in the Sacramento River Water Reliability Study would provide additional assurance for the delivery of the entitled water for the City, as well as all wholesale and wheeling agreements past 2030.

This WSA finds:

- The City has sufficient water supplies to serve the proposed project and projected future demands over the next 25 years.

- Under normal year types, the City has sufficient capacity within its existing WTPs to serve the proposed project and projected future demands over the next 25 years.

- During conference years (analogous to dry years and multiple dry years) the City has sufficient supply to serve the proposed project and projected future demands if the WTPs operate at maximum production capacity.

- During conference years, under a peak demand scenario, with limitations in production capacity of the WTPs (whereby demands do not equal maximum capacity), the City's peak demands would exceed available capacity of the WTPs by the year 2020. However, the City's existing groundwater supplies (up to 30 mgd) would ensure peak demands would be met through 2030.

- The City's proposed 145-mgd diversion and WTP on the Sacramento River near Elverta Road would provide additional flexibility for managing water supplies, especially with respect to meeting peak demand during dry years.

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Misc

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Mitigation Table, Summary Mitigation Measures

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APPENDIX L

LAND USE DENSITY CALCULATIONS

Greenbriar CLUP Analysis - Safety Zone Compliance
Overview

8/15/2005

Greenbriar Land Uses Identified in CLUP	CLUP Compatibility*	Description
Single-family detached	Yes**	See "persons per hour detail"
Mulfi-family dwellings	Yes**	Same
Streets, roads and Highways	Yes*	
Light rail lines: passenger	Yes*	
Passenger terminals and stations	No	"Over-ride" needed
Parking lots	Yes*	
Grocery stores	Yes**	See "persons per hour detail"
Eating and Drinking	Yes**	Same
Miscellaneous Retail Trade	Yes**	Same
Neighborhood shopping centers	Yes**	Same
Neighborhood parks	Maybe	
Open space, natural and water areas	Yes*	

* As per the Sacramento International Airport CLUP, amended January 1994
** As per CLUP "concentration" guidelines - see attached analyses

Conclusion:
The Greenbriar project complies with the Sacramento International Airport CLUP in all instances except for the light rail station. The project complies with the spirit and intent of the CLUP as it relates to parks, by siting "Regional-serving" larger parks outside of the safety zone. However, park consistency with the CLUP may require some attention due to a footnote in the CLUP stating that the parks may not contain any "structured playgrounds, ballfields or picnic pavilions."

Greenbriar Safety Zone Densities - Summary

8/15/2005

25 Persons Per Acre Per Average Hour:

Gross Persons Within Safety Zone Per "Average Hour"	8368
Allowable Persons Within Safety Zone Per "Average Hour"	10125
Persons Per Acre Per Average Hour Within Safety Zone	21
Allowable Persons Per Acre Per Average Hour Within Safety Zone	25

50 Persons Per Acre Maximum:

Gross Persons Within Safety Zone At Any Given Time	12543
Allowable Persons Within Safety Zone At Any Given Time	20250
Maximum Average Persons Per Acre Within Safety Zone At Any Given Time	31
Maximum Allowable Average Persons Per Acre Within Safety Zone At Any Given Time	50

8/15/2005

Greenbriar Safety Zone Densities - Persons per Hour

<u>25 Persons Per Acre Per Average Hour</u>							<u>Explanation</u>
Gross acreage within safety zone			405				per April 29 submission of "formal" development application
Allowable persons per acre per "average hour"			25				per CLUP, page 36 and Appendix A-1
Total allowable persons within safety zone ("on average")			**10125**				
RESIDENTIAL							
Assumptions:							
Persons per household - single family detached*			2.86				number came from Jim McDonald, LRP - from historical 10-year City of Sac census info
Persons per household - two-four-plex*			2.26				number came from Jim McDonald, LRP - from historical 10-year City of Sac census info
Persons per household - 5-plex+ (apartments)*			1.9				number came from Jim McDonald, LRP - from historical 10-year City of Sac census info
Calculations:							
Single-family households - total # of persons			6003				2099 total detached units x 2.86 (1119 LDR, 1005 MDR)
Multi-family households - total # of persons			428				225 total multi-family units x 1.9
Total Maximum Persons Occupying Residential Units			**6431**				
Occupied an average of 75% of the day			**4823**				For purposes of "averaging" - assume people at home 18 hours per day, on average
COMMERCIAL							
Large Commercial Area:							
	Area	Use	%	Area	Factor	Occ. Load	
Market	65,000	Store	90%	58,500	30	1,950	"Factor" is population factor - persons per square foot maximums as set forth in
		Storage	10%	6,500	300	22	Table 10-A of the 2001 California Building Code (2001 is current edition).
Restaurant	22,300	Dining	80%	17,840	15	1,189	Occupancy Load #s are "maximum" persons per square foot derived from CA Building Code
		Kitchen	20%	4,460	200	22.3	
Shops	45,000	Store	85%	38,250	30	1275	Not shown on "Conceptual Plan," but included here to be conservative and provide flexibility later.
		Storage	15%	6,750	300	22.5	
Total Max Occupancy Load						4,481	Only those commercial uses that fall within the safety line are analyzed in this section.
Meister Way Commercial:							
Restaurant	14,000	Dinning	80%	11,200	15	747	
		Kitchen	20%	2,800	200	14	
Shops	25,000	Store	85%	21,250	30	708	"Conceptual Plan" shows 14,700 sf; more analyzed here to be conservative and provide flexibility later
		Storage	15%	3,750	300	13	
Office	15,000	Office	100%	15,000	100	150	
Total Max Occupancy Load						1632	
Total Maximum Persons Occupying Commercial Units			6112				
Occupied for 14 hours per day			**3545**				For purposes of "averaging" - assume commercial units empty for 10 hours per day
PARKS**							Population totals attributable to parks have no noticeable impact on overall density evaluation, due to the siting of "Regional" parks outside of the safety line. See footnote below.
TOTAL PERSONS PER AVG HOUR WITHIN SAFETY ZONE			**8368**				
TOTAL ALLOWABLE PERSONS WITHIN SAFETY ZONE			**10125**				
TOTAL PERSONS PER ACRE PER AVG HOUR WITHIN SAFETY ZONE			**21**				
TOTAL ALLOWABLE PERSONS PER ACRE PER AVG HOUR WITHIN SAFETY ZON			**25**				
<u>50 Persons Per Acre Maximum</u>							
Gross acreage within safety zone			405				per April 29 submission of formal development application
Allowable persons			50				
Total maximum allowable persons within safety zone at any given time			20250				
RESIDENTIAL							

Total Maximum Persons Occupying Residential Units	6431	per analysis above
COMMERCIAL		
Total Maximum Persons Occupying Commercial Units	6112	
PARKS*		Population totals attributable to parks have no noticeable impact on overall density evaluation, due to the siting of "Regional" parks outside of the safety line. See footnote below.
TOTAL MAXIMUM PERSONS WITHIN SAFETY ZONE AT ANY GIVEN TIME	**12543**	
TOTAL ALLOWABLE PERSONS WITHIN SAFETY ZONE	**20250**	
TOTAL PERSONS PER ACRE WITHIN SAFETY ZONE AT ANY GIVEN TIME	**31**	
TOTAL MAXIMUM ALLOWABLE PERSONS PER ACRE WITHIN SAFETY ZONE	**50**	

* Census data: I used the more conservative of two estimates on household population assumptions. The 2000 U.S. Census Bureau states that for the City of Sacramento, Total Average Houshold Size is 2.57 persons/house. The detail states that of that, "Owner Occupied" (probably a good surrogage for single-family detached) is 2.65 persons/house and "Renter Occupied" is 2.50 persons/house.

** Parks The only parks sited within the safety zone are neighborhood parks. In other words, people using those parks come primarily from within the project area and thus those population numbers are already captured in the analysis above. There will be no lighted ballfield "complexes" within the safety zone. While there is the potential for one or two ballfields on the 5 or 7 acre park, maximum "occupancy" on those fields would probably be 300 to 400 persons on the busiest days. Those numbers are not nearly large enough to make a difference in the overall calculation.

APPENDIX M

BERRYMAN ECOLOGICAL SURVEYS

DRAFT

Patterns of Winter Avian Abundance in Rice Fields and Urban Lakes in the Natomas Basin

Sacramento County, California

Prepared for: RWI Investments

Date: February, 2006

Prepared by: BERRYMAN Ecological

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1.0 INTRODUCTION

1.1 Purpose

This study was designed to compare winter avian use of rice fields and urban lakes in the Natomas Basin of Sacramento County, California, and to assess the relative degree to which each of these habitat types may attract birds that pose a risk to aircraft.

1.2 Background

The Natomas Basin is located in California's Sacramento Valley, one of the most important wintering and migratory areas for waterfowl and other bird species in North America. Approximately 60 percent or more of the waterfowl population in the Pacific Flyway winter in or migrate through the Sacramento Valley (Ducks Unlimited 1995a). These waterfowl and other bird species pose a hazard to aircraft using the Sacramento International Airport, located at the heart of the Natomas Basin (**Figure 1**).

The location of the Sacramento International Airport along the Pacific Flyway poses a significant challenge to airport operators attempting to minimize the risk of aircraft bird strikes (Larson 2003). Aircraft bird strikes present a significant human safety risk and cost to the airline industry. The Federal Aviation Administration (FAA) estimates that wildlife strikes cost the U.S. civil avaition industry $500 million annually. Approximately 6,100 strikes were reported at civil airports in 2003 alone (Wildlife Services 2004). The level of bird aircraft strike risk at Sacramento International Airport has warranted full-time assistance from USDA to manage wildlife hazards (Wildlife Services 2004).

Changing land use patterns have altered the landscape of the Natomas Bain significantly, although a large proportion of this historic floodplain has continued to provide waterfowl habitat. The Natomas Basin is a low-lying area located along the east side of the Sacramento River, upstream of its confluence with the American River. Prior to 1914, this basin consisted of an alluvial plain with several large lakes and sloughs that provided surface drainage to the American River and habitat for an abundance of waterfowl (Hinds 1952, USFWS 2003; see **Appendix A**, 1908 Land Cover). After 1914, reclamation efforts such as construction of canals, levees, and pumping stations converted much of the Natomas Basin to agricultural production, primarily rice (USFWS 2003). As the natural wetlands were converted to ricelands, waterfowl wintering in the basin came to rely on winter flooded rice. Indeed, because of the limited amount of natural wetlands remaining, the large numbers of waterfowl wintering in California could not be supported without small-grain production such as commercial rice (Ducks Unlimited 1995b).

More recently, approximately 11% of the Natomas Basin has been converted from agricultural to urban uses (City of Sacramento, Sutter County, NBC 2002). Urban lakes have been constructed and are planned for construction in these urbanizing areas to provide surface storage for flood control purposes and conjunctive uses such as recreation and storm water pollution prevention.

The FAA discourages land uses that increase aircraft strike hazards by attracting birds into airport overflight zones. Urban lakes such as those constructed in the Natomas Basin may attract waterfowl including geese, gulls, and other species known to be involved in aircraft strikes. However, as described above, the Natomas Basin has historically supported waterfowl because of its low position in the watershed, itstendency to flood. In assessing the impacts of constructing urban lakes, one must make a comparison with pre-project conditions. This study was designed to compare the level of aircraft strike risk posed by these urban lakes as compared with pre-urbanization conditions (i.e., flooded agriculture).

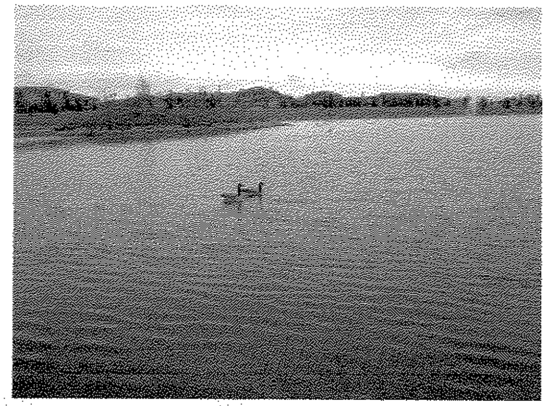
Figure 1: Study Area and Study Sites

2.0 METHODS

2.1 Study Area

The study area was the Natomas Basin, located in Sacramento County in the northern Sacramento Valley (**Figure 1**). Three man-made lakes were surveyed within the study area: these are described below and their locations in relation to the Natomas Basin are shown on **Figure 1**:

1. <u>Northborough Lake</u> is a large, L-shaped lake at the corner of Truxel Road and North Park Drive. It has gently sloping sides of approximately 25 degrees and consisted of round boulders of varying sizes. It has two islands that have similar sides as the periphery of the lake and small shrubs and willow trees.

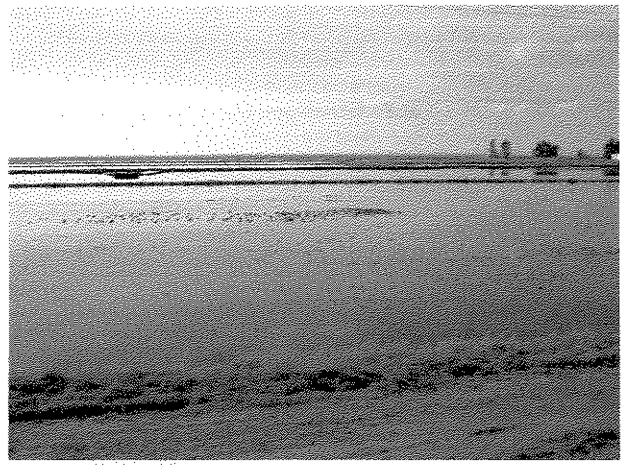


2. <u>Alleghany Lake</u> is just east of the corner of Truxel Road and Terracina Drive. Like Northborough Lake, it has gently sloping sides of approximately 25 degrees. It has one island that also has similar sides as the periphery of the lake and has small shrubs and willow trees.

3. <u>Gateway North Lake</u> is in the middle of Gateway North subdivision and is just east of El Centro Road and north of Arena Boulevard on the west side of Interstate 5 freeway. It has 90 degree rock sides and the lakeside homes abut the lakeshore.

Rice fields were surveyed along on a driving route that was chosen based on presence of flooded agriculture, lack of disturbance such as hunting pressure, and accessibility of the survey points. The survey route started at Sankey Road near Pacific Road, then east to east levee road, then south to west Elverta Road and to the Interstate 5 freeway (**Figure 1**).

Elverta Road Ricef Field



East Levee Road Rice Field

Sankey Road Rice Field

2.2 Survey Method

A standard 10-minute point count method was used, by which the observer recorded all birds seen and heard from a single point (survey point) during a 10 minute period (Howe et al. 1997, Ralph et al. 1993). The surveys for both urban lakes and rice fields started at ten minutes after sunrise, and ended no later than three hours after sunrise. The same observer surveys both the lakes and rice fields to avoid observer biases. At each point count, the observer recorded the number of birds observed for each species. For numbers between 100 and 200, the observer estimated to the nearest 10. For numbers between 200 and 1,000, the observer estimated to the nearest 50. For numbers greater than 1,000, the observer estimated to the nearest 100.

At the lake sites, survey points were spaced to maximize visibility of the entire lake without double-counting. Due to its L-shape, Northborough Lake had to be surveyed from two points to view the entire lake. The entirity of Alleghany Lake could be surveyed from one point. Due to the lakeshore homes of Gateway Lake, it could only be surveyed from two points, one point at the east side of the lake and one at the west side. Survey points at the rice fields were spaced 200 meters apart to maximize coverage and avoid double-counting. The observer would drive to each survey point and walk to the edge of the rice field for the point count.

2.3 Data Analysis

Assuming the number of birds per point count does not follow a Gaussian distribution, a nonparametric test was used to compare the total number of birds per point count in rice fields and urban lakes. A Mann-Whitney *U*-test was applied and significance was assessed at a 99% confidence interval. P-values ≤ 0.01 were considered statistically signficant. Data were also summarized by species observed at rice fields vs. urban lakes, and the range of numbers of individuals per species at rice fields vs. lakes. Species observed were lumped into various categories consistent with the categories used in the FAA National Wildlife Strike Database (e.g., ducks, geese, gulls . . .: FAA 2000) . Data was then summarized by the mean number of birds observed per survey site per species category.

3.0 RESULTS

3.1 Bird Abundance in Urban Lakes and Rice Fields

The number of birds observed per point count was significantly higher for rice fields than for urban lakes (**Table 1:** U = 224, *P* <0.0001). For rice fields, the total number of birds observed per point count ranged from 1 to 2,652, while for urban lakes, the total number ranged from 0 to 37. The mean number of birds per point count was 224.12 (*SD* ± *428.69*) for rice fields and 12.12 (*SD* ± *11.55*) for urban lakes.

Table 1: Median Number of Birds per Point Count

Location	n	Median	U
Rice Field	48	83	224
Urban Lakes	50	10	2176
Mann-Whitney U: 224			
99.0% CI: 44.000-113.000, **P:** <0.0001			

3.2 Species Observed

The diversity of bird species observed was higher at rice fields than at urban lakes: there were 18 species observed at rice fields and 10 at urban lakes (**Table 2**). Species observed at rice fields that were not observed at urban lakes were American widgeon, black-necked stilt, curlew, double-crested cormorant, green-winged teal, northern pintail, northern shoveller, phalarope, snow goose, snowy egret, sandpiper *sp.*, white-faced ibis, and western grebe. Species observed at urban lakes but not at rice fields included Canada goose, common merganser, green heron, and western grebe.

Table 2: Species Observed at Rice Fields and Urban Lakes

Species	Rice Fields	Urban Lakes	Group
American coot	0 – 1,000	0 - 6	Other
American widgeon	0 - 44	0	Ducks
Black-necked stilt	0 - 32	0	Shorebirds
Canada goose	0	0 - 23	Geese
Common grebe	0 - 2	0 - 3	Other
Common merganser	0	0 - 18	Ducks
Curlew	0 - 47	0	Shorebirds
Double-crested Cormorant	0 - 4	0	Other

Table 3: Species Observed at Rice Fields and Urban Lakes- Continued

Species	Rice Fields	Urban Lakes	Group
Great blue heron	0 - 2	0 - 1	Herons/egrets
Great egret	0 - 12	0 - 2	Herons/egrets
Greater yellowlegs	0 - 4	0	Shorebirds
Green heron	0	0 – 4	Herons/egrets
Green-winged teal	0 - 32	0	Ducks
Mallard	0 - 39	0 – 22	Ducks
Northern pintail	0 - 950	0	Ducks
Northern Shoveller	0 - 26	0	Ducks
Phalarope	0 - 19	0	Shorebirds
Snow goose	0 - 450	0	Geese
Snowy egret	0 - 22	0	Herons/egrets
Gull	0 - 130	0 – 9	Gulls
Sandpiper spp.	0 - 80	0	Shorebirds
White-faced ibis	0 - 33	0	Other
White fronted goose	0 - 750	0	Geese
Western grebe	0	0 – 1	Other
Total # Species present	**18**	**10**	

3.3 Number of Birds per Species Group

The mean number of birds per point count were higher at rice fields than at urban lakes for all groups (**Table 4**). Although Canada geese were present only at urban lakes, large flocks of snow geese and white fronted geese were observed at rice fields, so that birds in the geese group were much more abundant in rice fields than at the urban lakes.

Although the mean number of birds per point count per group were quite variable between sites, they were consistently higher at rice fields than urban lakes (**Figures 3,4**). Gateway Lake differed from the other two lakes in that it had no ducks or geese, but had a higher number of gulls than the other two lakes. Gateway Lake also had a moderate number of birds lumped as "other".

Table 4: Mean Number Birds per Group

Group	Habitat	Location	Total Birds	Mean Number*	Mean # when Observed* (dropping zeros)
Ducks	Rice	Elverta Rd.	3281	68.35	121.52
		Levee Rd.	730	15.2	91.25
		Sankey Rd.	345	7.18	38.33
	Lake	Alleghany lake	110	2.2	10
		Northborough lake	177	3.54	8.85
		Gateway Lake	0	0	null
Geese	Rice	Elverta Rd.	1180	24.58	393.33
		Levee Rd.	0	0	null
		Sankey Rd.	1050	21.88	350
	Lake	Alleghany lake	98	1.96	16.33
		Northborough lake	133	2.66	11.08
		Gateway Lake	0	0	null
Gulls	Rice	Elverta Rd.	562	11.71	40.14
		Levee Rd.	57	1.1875	57
		Sankey Rd.	110	2.3	27.5
	Lakes	Alleghany lake	0	0	null
		Northborough lake	8	0.16	8
		Gateway Lake	14	0.28	7
Herons/Egrets	Rice	Elverta Rd.	167	3.48	6.42
		Levee Rd.	10	0.21	3.33
		Sankey Rd.	10	0.21	5
	Lake	Alleghany lake	5	0.1	1
		Northborough lake	25	0.5	1.92
		Gateway Lake	0	0	0
Shorebirds	Rice	Elverta Rd.	447	9.3125	34.38
		Levee Rd.	50	1.04	50
		Sankey Rd.	71	1.48	17.75
	Lake	Alleghany lake	0	0	null
		Northborough lake	0	0	null
		Gateway Lake	0	0	null
Other	Rice	Elverta Rd.	1614	33.63	67.25
		Levee Rd.	1074	22.38	214.8
		Sankey Rd.	0	0	null
	Lake	Alleghany lake	9	0.18	1.29
		Northborough lake	23	0.46	2.09
		Gateway Lake	13	0.26	1.86

Figure 2: Bird Groups – Mean Numbers per Point Count, Rice vs. Lake

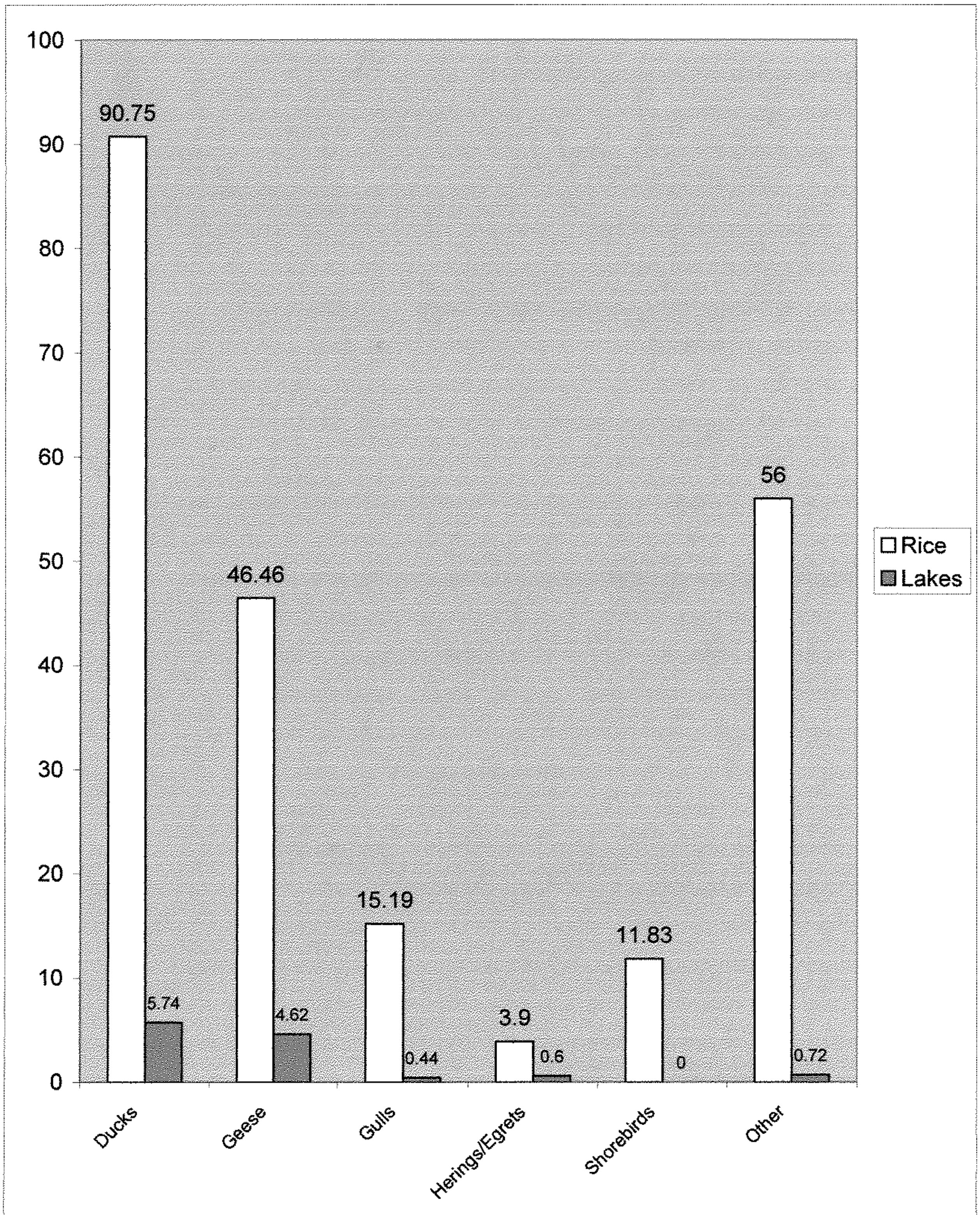


Figure 3: Urban Lakes – Mean Number per Point Count per Study Site

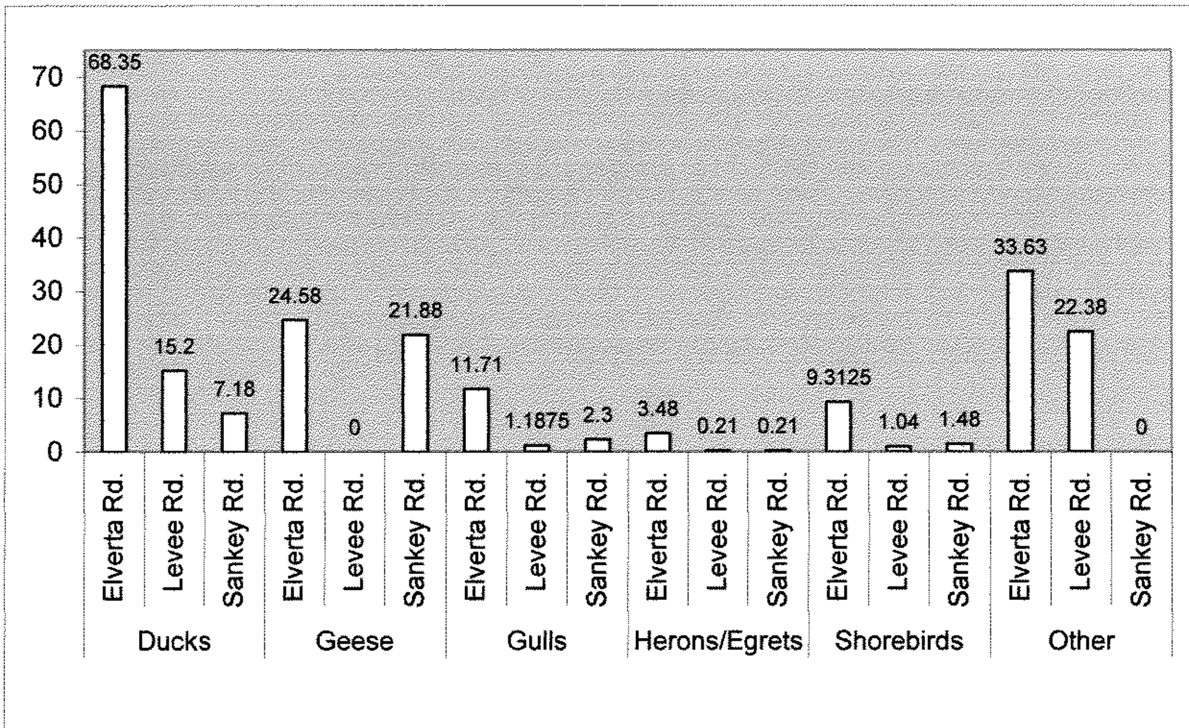
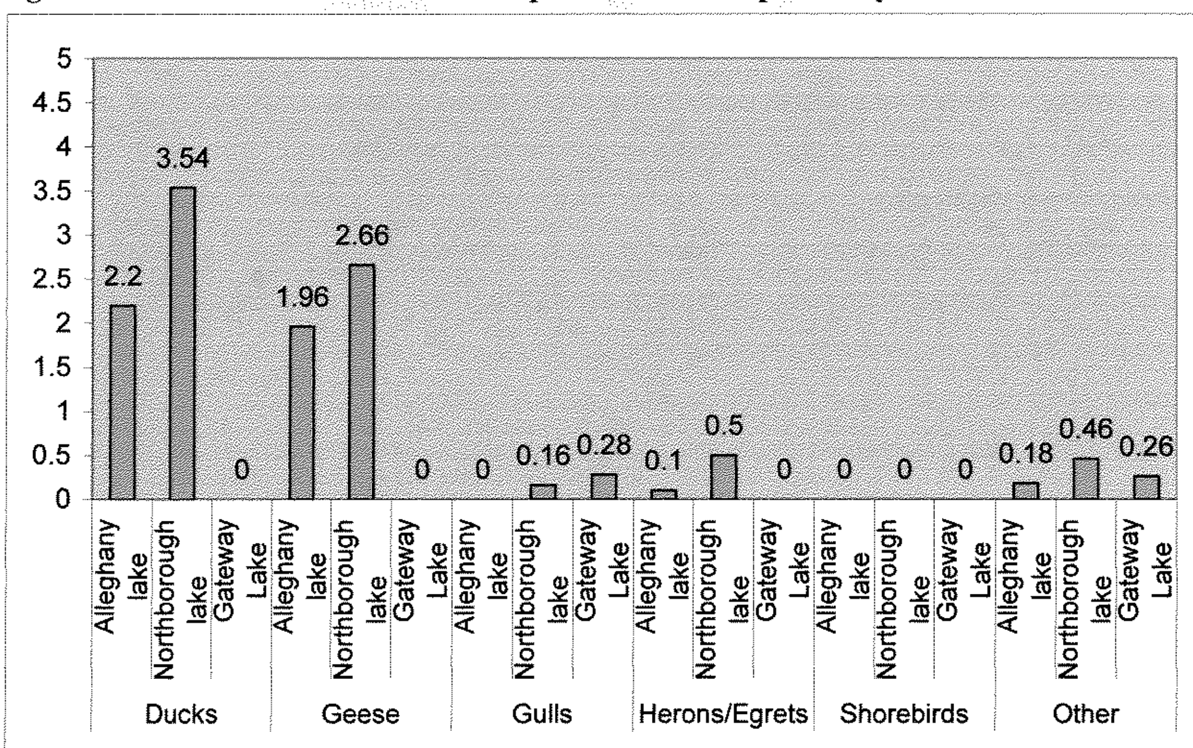


Figure 4: Rice Fields – Mean Number per Point Count per Study Site



Species grouped as "other" were those that did not fit into any of the categories in the FAA National Wildlife Strike Database. However, because of the large number of birds lumped into this category found in rice fields, and the relatively large proportion of lake birds designated as "other", this category was broken down further in assessing the relative proportions of different bird types present.

At both urban lakes and rice fields, ducks made up the highest proportion of total birds observed (**Figure 5**, **Figure 6**). Geese were the second most abundant group at urban lakes, while coots were the second most abundant group at rice fields, although geese also made up a large proportion of birds observed at rice fields. For both rice and urban lakes, the remaining categories made up less than 25% of total birds observed.

Figure 5: Urban Lakes – Proportion of Each Group

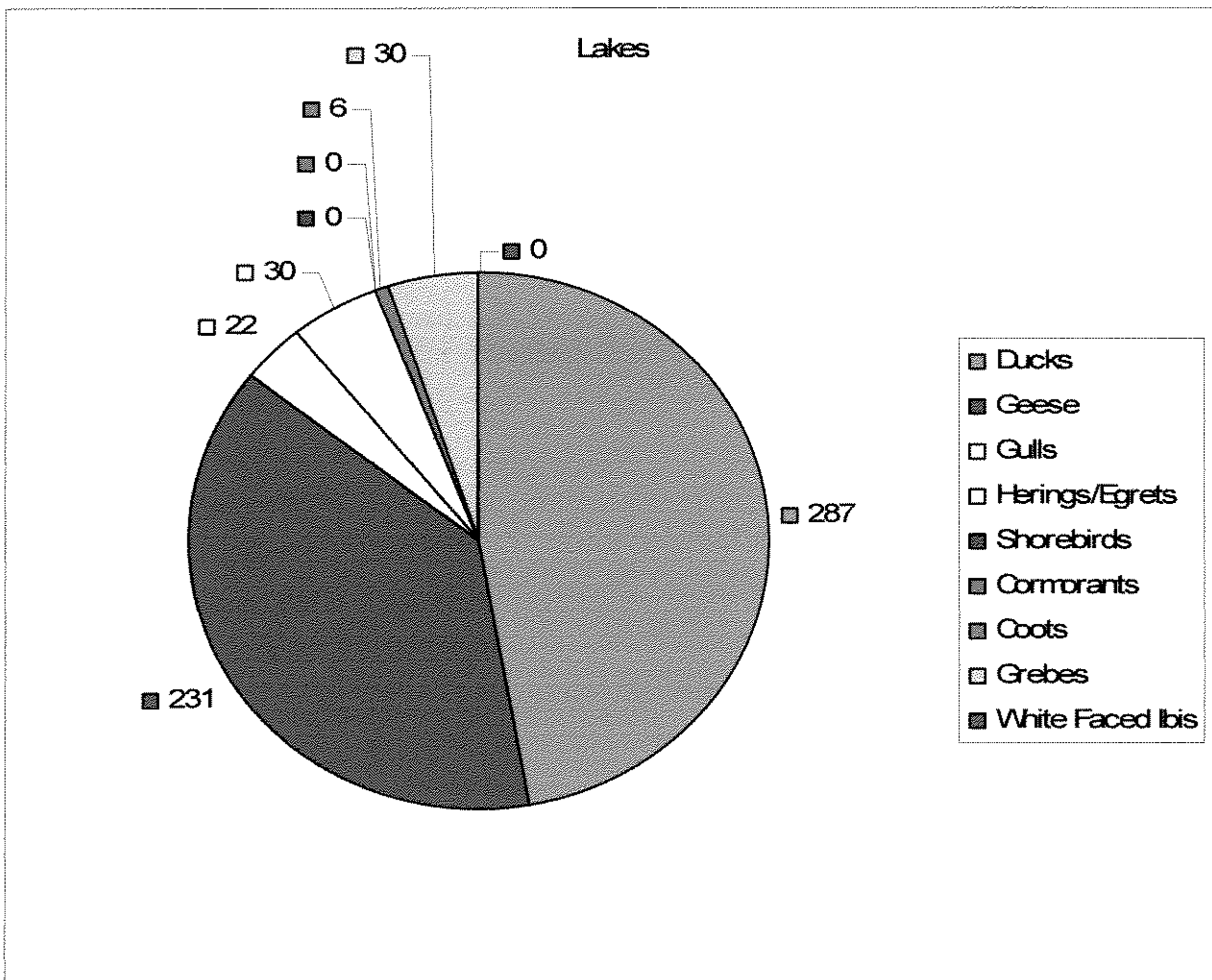
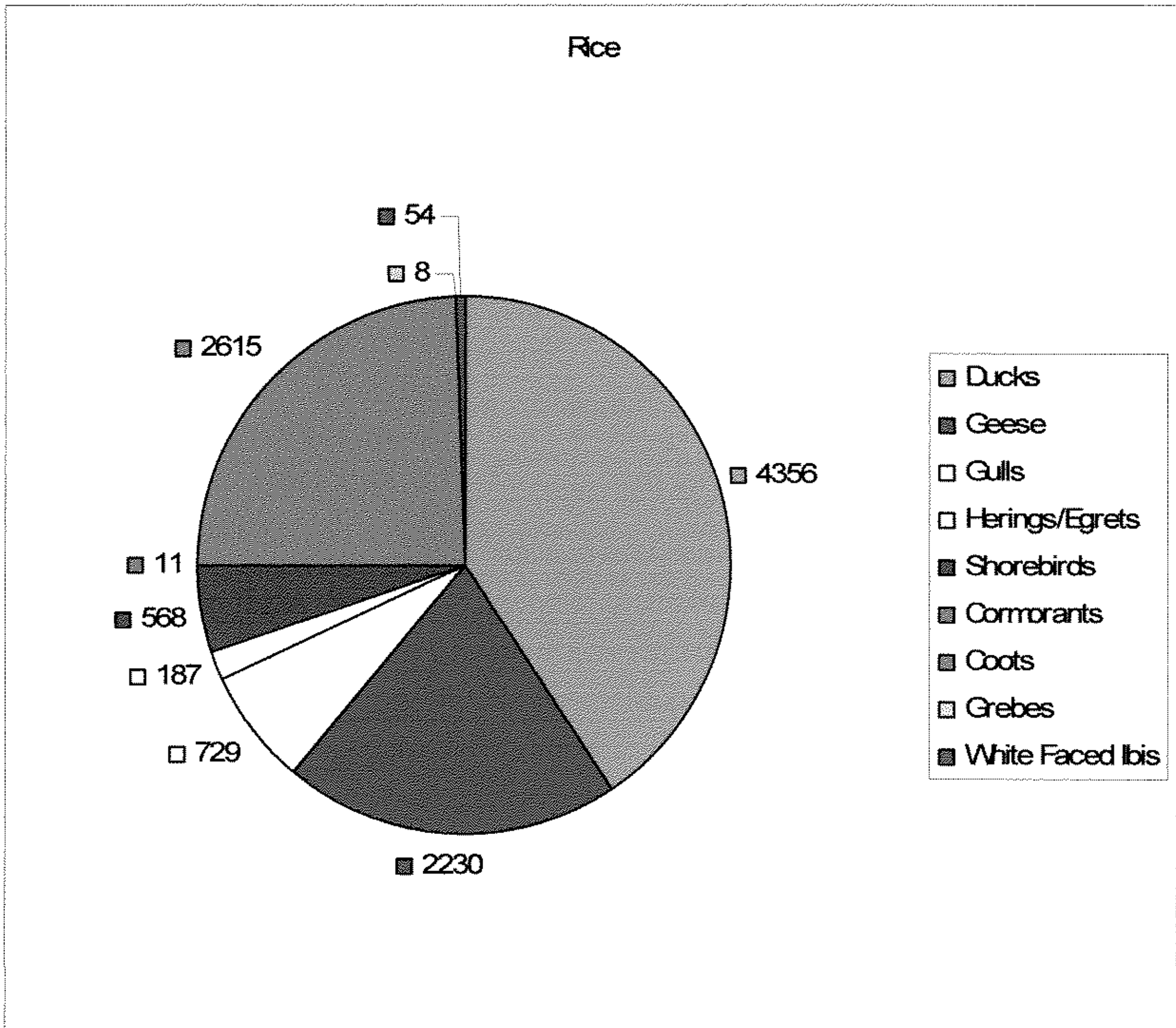


Figure 6: Rice Fields – Proportion of Each Group



3.4 Aircraft Hazard Levels

The FAA National Wildlife Strike Database (FAA) ranks various groups of birds in terms of relative hazard to aircraft as shown on Table 5.

Table 5: FAA Database – Wildlife Hazards to Aviation in the U.S.

Species	Relative hazard (1-100)	This study: lakes	This study: rice fields
Vultures	63	O	O
Geese	52	X	X
Cranes	48	O	O
Osprey	50	O	O
Pelicans	44	O	O
Ducks	37	X	X
Hawks	25	O	O
Eagles	1	O	O
Rock dove	24	O	O
Gulls	22	X	X
Herons	22	X	X
Mourning dove	17	O	O
Owls	16	O	O
American kestrel	14	O	O
Shorebirds	12	O	X
Crows/ravens	12	O	O
Blackbirds/starlings	9	O	O
Sparrows	4	O	O
Swallows	2	O	O

High risk species categories in **Table 4** and found at both urban lakes and rice fields are geese, ducks, gulls, and herons (grouped with egrets). Shorebirds, also idenfied as an aircraft hazard, were found only at rice fields and not urban lakes. As described in section 3.3, for all groups identified above as an airstrike hazard, greater numbers were found at rice fields than at urban lakes.

Additionally, based on data compiled from 1990 to 1992 (Cleary et al. 2003), the top 20 bird species causing damage to civil aircraft in the United States were listed (**Table 6**). **Table 6** shows that four of the species identified in the top 20 were observed at urban lakes, while five of these species were observed at rice fields. Among these top 20 species, the number of birds observed per point count ranged higher at rice fields than at urban lakes. The species ranked highest in terms of aircraft hazard, Canada goose, was observed at urban lakes and not at rice fields.

Table 6: Data Comparison with Top 20 Bird Species Causing Damage to Aircraft

A. Rank	B. Species	C. Category of reported damage				D. Total	E. Urban Lakes[1]	F. Rice Fields
		Destroyed	Minor	Uncertain	Substantial			
1	Canada goose	1	163	64	111	339	0 - 23	0
2	Rock dove		49	16	54	119	0	0
3	Turkey vulture	1	42	18	32	93	0	0
4	Red-tailed hawk		33	14	24	71	0	0
5	Mallard		29	7	29	40	0 - 22	0 – 39
6	Mourning dove		15	15	20	50	0	0
7	European starling		24	8	15	47	0	0
8	Herring gull		7	4	29	40	0[2]	0
9	Snow goose		11	5	7	33	0	0 - 450
10	Ring-billed gull		7	5	12	24	0-9[3]	0 - 130
11	American crow		10	1	7	18	0	0
12	Great blue heron		11	4	3	18	0-1	0-2
13	Bald eagle		13	2	2	17	0	0
14	Osprey		8	1	7	16	0	0
15	Sandhill crane		10		6	16	0	0
16	Killdeer		7	6	2	15	0	0
17	Double-crested cormorant		4	2	5	11	0	0-4
18	Brown pelican	1	7	2	1	11	0	0
19	American kestral		1	3	6	10	0	0
20	Barn owl		2	1	7	10	0	0
	101 other species	O	92	26	111	229		

[1] Numbers in these E and F represent the range of total # of birds of a given species observed during a single point count.

[2] Although gull data was not recorded to species, herring gulls are not known to occur in the Sacramento area.

[3] Gull data was not recorded to species – these numbers are for all gull species observed.

4.0 DISCUSSION

4.1 Avian use of Rice Fields

Waterfowl arriving in the Central Valley require a diet rich in carbohydrates to replenish fat reserves lost during fall migration. Rice crops are eaten by many species of waterfowl because they are widespread, easily accessible, and provide high levels of carbohydrates. Historically, migratory waterfowl were viewed as major rice pests by farmers because of the amount of pre-harvest rice seed they consumed.

After harvest, up to 300 pounds of rice can remain on each acre of a rice field (Ducks Unlimited 1995b). This is a tremendous food resource for many forms of wildlife, especially when coupled with the variety of aquatic and terrestrial weeds found in rice fields. The seeds from all of these plants, along with the invertebrates commonly found there, provide a varied diet for a broad range of waterbirds. Waterfowl are among the most numerous of the species that are known to use rice fields. During fall and winter, after rice fields have been harvested, tens-of-thousands of ducks, geese, and swans can be seen resting and feeding in rice fields throughout the Sacramento Valley. Later, once grain and weed seeds are depleted, waterfowl and shorebirds still use fields to continue feeding on the insects and snails that occur on the decaying straw.

California has lost 90-95 percent of its original wetlands and the majority of these drained wetlands have been converted to rice fields (Ducks Unlimited 1995a). These rice fields are flooded in the spring and summer during the growing season and now have become surrogate wetlands for the locally breeding waterfowl like mallards. Ducklings need escape cover from predators and the rice stalks provide this needed habitat type. Moreover, the rice stalks provide a perfect substrate for invertebrates to cling to and feed on and the shallow water in rice fields provides a constant warm temperature for many invertebrate species.

All species of waterbirds have increased protein requirements during molt and egg laying. Agricultural fields flooded through late winter provide critical invertebrate food resources that provide the needed protein for molting and prelaying females (Ducks Unlimited, 1995b; Brouder, and Hill 1995). Rice fields provide about 250 pounds per acre of naturally occurring food sources such as small invertebrates, macroinvertebrates, tubers, edible shoots, and seeds. In addition, after harvest an average of 350 pounds per acre of rice is available to waterfowl. Rice fields managed as wetlands can provide as much as 600 pounds of food per acre, or 80 percent of the amount of food found in natural wetlands (Brouder and Hill, 1995). It is believed the reason for this is rice fields have a tremendous food base for waterbirds. Microinvertebrates are an important food base for waterfowl and shorebirds and are present in large numbers in rice fields.

Dabbling ducks are the most prevalent duck in the Central Valley. These include mallards, northern pintails, greenwing teal, northern shovelers, and American widgeon. When feeding in water, these birds as well as all the goose species, feed by tipping up in shallow water. Therefore they only have access to food resources that are not deeper than their outstretched necks when tipping. Typically, 4-10 inches is the preferred feeding depth for dabbling ducks and this is the depth that rice fields are kept during spring and summer growing seasons and during the winter when farmers flood their rice fields for straw decomposition. Farmers need to dispose of the rice straw to make way for the next years crop. Burning traditionally was the preferred method but in 1991, the Legislature passed the Rice Straw Burning Reduction Act which gradually reduced the amount of acres that could use burning to dispose of the straw. Now, only 1/4 of the cropland can use the burn disposal method and only the farmer can prove that a disease is prevalent. Many farmers now flood their fields in the fall to help decompose the rice straw and they keep the water levels shallow for maximum oxygen and soil incorporation with the straw. This helps the straw rot and break down and also provides great habitat for shallow water loving species like waterfowl, shorebirds and wading birds.

The rice fields that were surveyed were also heavily used by shorebirds, including sandpipers, phalaropes, curlews, and dowitchers. These shorebirds also need shallow water to feed. Rice fields provide excellent habitat for invertebrates that are important for shorebirds and waterfowl (Wildlife Habitat Management Institute 2000). These invertebrate species include water boatman, backswimmers, water scorpions, giant water beetles, water beetles, dragonfly nymphs, and larva of mosquitoes, flies, midges, crane flies, soldier flies, dance flies, snipe flies, horse flies, and brineflies. Shorebirds prefer depths between 1-6 inches to forage for these prey invertebrate prey items.

Many wading birds such as egrets and herons were also observed in the rice fields. These wading birds also prefer shallow water for foraging and will feed in water up to 15 inches (Colwell and Taft 2000). These wading birds prefer larger macroinvertebrates like crayfish and vertebrates like rodents that frequent rice fields.

4.2 Avian Use of Urban Lakes

The man-made lakes that were surveyed are deeper than the water in the flooded rice fields and therefore these birds cannot feed efficiently in the lakes. Additionally, the water levels in the manmade lakes do not fluctuate for seed germination of emergent vegetation. The emergent vegetation seeds need exposed mud flats to germinate and grow, while the man-made lake levels are managed for a constant level.

Waterfowl use the man-made lakes primarily for loafing, and they are not found in large numbers in this habitat type. Gradually sloped sides like those of Allegheny and Northborough lakes in our survey appear to be more attractive to waterfowl because this allows the birds to climb out of the water to rest and preen. This behavior was observed in our surveys. The lakes that had sloping sides had more birds and the birds observed on these waters were frequently seen resting out of the water. Gateway North Lake, which has 90 degree sides that prevent waterfowl from exiting to rest and preen had virtually no waterfowl during our surveys.

4.3 Aircraft Strike Hazard: Urban Lakes versus Rice Fields

The results of this study indicate that not only are total numbers of birds higher at rice fields than at urban lakes, but numbers of birds belonging to species known to pose a hazard to aircraft are also higher in rice fields. Indeed, numbers were higher at rice fields than urban lakes for all species groups.

4.4 Canada Geese

Canada goose, the species identified in **Table 6** as the greatest hazard to aircraft, was observed only at urban lakes and not at rice fields. While the numbers of Canada geese observed at urban lakes were low (0 to 23 per point count) compared with other geese such as snow geese (0-450) at rice fields, the increasing numbers of Canda geese in the United States is a concern to the USDA in their efforts to minimize wildlife strikes hazards (pers. comm. Scott Beckerman, USDA, January 13, 2005).

The number of Canada geese that nest and/or reside predominantly within the conterminous United States has increased dramatically in the past 20 years. The total number of Canada geese counted during winter in North America has increased from 980,000 in 1960 to 3,734,500 in 2000 (Mid-winter Survey unpublished reports), and Canada geese are now thought to be more abundant in the United States than at any time in history (USFWS 2005). Recent surveys suggest that the Nation's resident breeding population now exceeds 1 million birds in both the Atlantic and the Mississippi Flyways and is continuing to increase. In the Mississippi Flyway alone, the 1998 spring Canada goose population estimate exceeded 1.1 million birds, an increase of 21 percent from 1997. Data collected on California populations of Canada geese between 1970 and 1999, however, indicate that populations have not been increasing along the Pacific Flyway as dramatically as along the Atlantic and Mississippi Flyways (USFWS 2005).

The increase in resident Canada goose populations in the United States is partially attributed to increasing urban and suburban development which has resulted in the creation of ideal goose habitat; that is, parklike open areas with short grass adjacent to small bodies of water. Urban lakes may therefore pose a risk to aircraft by attracting Canada geese, and if population levels grow along the Pacific Flyway as they have been along the Atlantic and Mississippi Flyways, the risk may increase over time. However, a number of design and management measures can be implemented to minimize attraction of Canada geese to urban lakes. The following are among a variety of measures frequently used to make property less attractive to geese:

- Post signs prohibiting feeding of geese.
- Do not plant grass along the lakeshore, leave a 20-30 foot barrier strip of tall grass (6 inches or more) adjacent to lakeshore, or place fencing or other barriers between the lakeshore and surrounding grasslands.
- Plant dense hedges or erect fencing near lakeshore areas to reduce access to your lawn

- Check property frequently for nest building activity in the spring, and remove any nesting materials found

5.0 CONCLUSION

In conclusion, the results of this study indicate that winter rice fields in the Natomas Basin attract a greater number of birds that pose a risk to aircraft than do urban lakes in the Natomas Basin. Although the urban lakes observed supported a greater quantity of Canada geese (a high-risk species for aircraft strikes) than rice fields, the low numbers of these geese found at urban lakes indicate that the overall degree of hazard presented by urban lakes is lower than rice fields. While Canada goose populations are believed to be increasing in the coterminous United States and therefore could pose a greater future risk, a number of design and management measures can be implemented at urban lakes to minimize attractants. The data suggests that replacement of flooded agriculture in the Natomas Basin with urban lakes is expected to reduce risk of aircraft strikes at the Sacramento International Airport.

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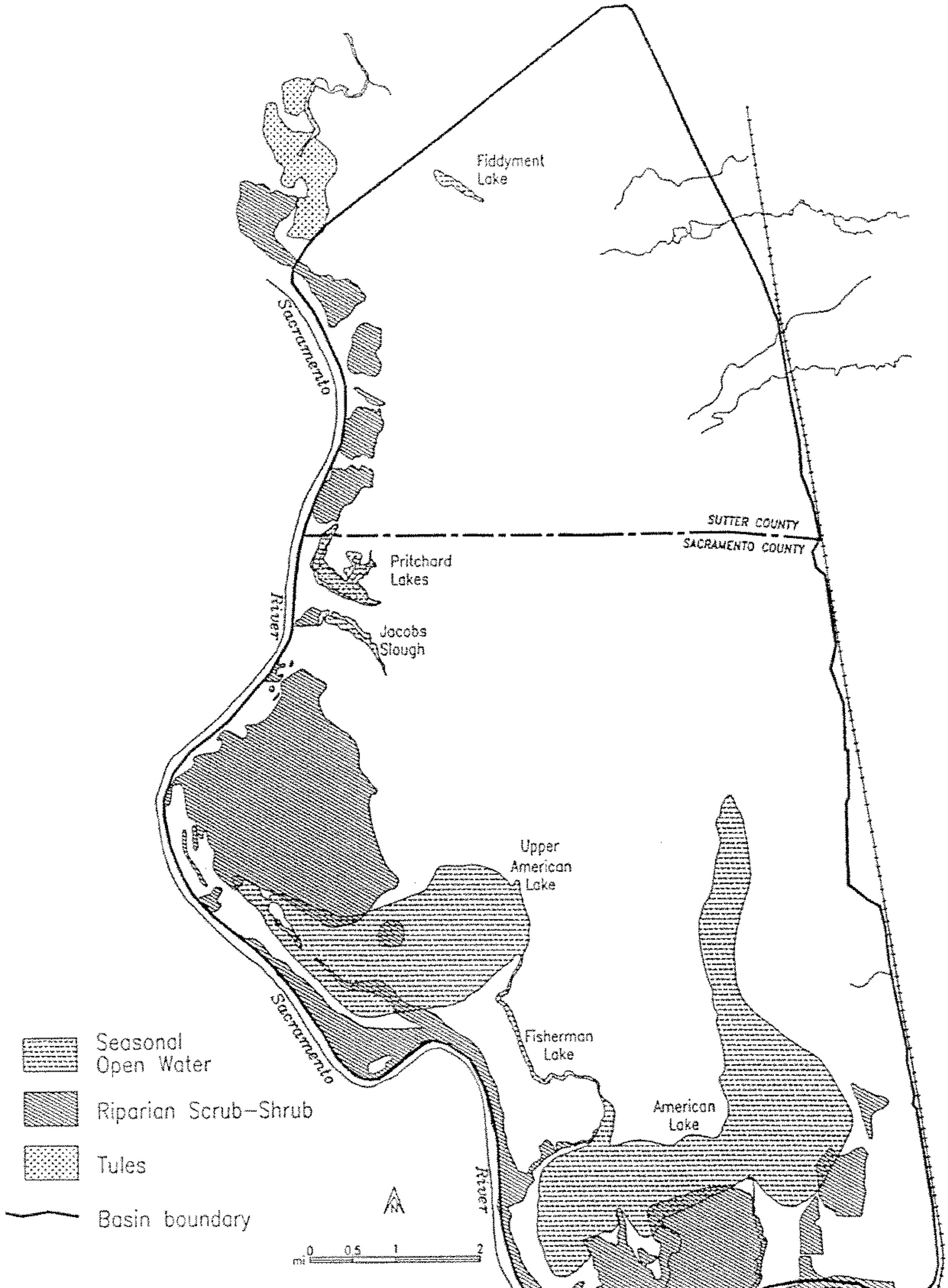
Appendix A – 1908 Land Cover



Source: Thomas Reid Associates based on Map of the American Basin in Sacramento and Sutter Counties surveys made for Natomas Consolidated of California under direction of Stephen E. Kieffer. M. AM. Soc. C.E. 1908-1909.

FIGURE 5
1908 LAND COVER
REVISED NATOMAS BASIN HCP

Appendix B – Data Sets

Natomas Man-made Waterbird Survey Point Counts					
Survey #	Date	Survey Point	Species Detected	Number	Total per Point Count
1	2-Jan	East side of Northborough lake	Mallard Canada Goose Green Heron	8 9 4	21
2	2-Jan	West side of Northborough lake	Mallard Canada Goose Common Grebe	12 12 2	26
3	2-Jan	West side of Gateway lake			0
4	2-Jan	East side of Gateway lake			0
5	2-Jan	Alleghany lake	Canada Goose Mallard Western Grebe	23 13 1	37
6	4-Jan	East side of Northborough lake	Mallard Canada Goose American Coot Green Heron	8 16 6 2	32
7	4-Jan	West side of Northborough lake	Mallard Common Grebe Common Merganser	5 2 1	8
8	4-Jan	West side of Gateway lake	Common Grebe	1	1
9	4-Jan	East side of Gateway lake			0
10	4-Jan	Alleghany lake	Mallard Canada Goose Great Blue Heron Common Merganser Green Heron	11 15 1 1 1	29
11	7-Jan	East side of Northborough lake	Mallard Canada Goose	9 8	17
12	7-Jan	West side of Northborough lake	Mallard Canada Goose	8 2	10
13	7-Jan	West side of Gateway lake	Common Grebe	1	1
14	7-Jan	East side of Gateway lake			0
15	7-Jan	Alleghany lake	Mallard Canada Goose Western Grebe	16 16 1	33
16	8-Jan	East side of Northborough lake	Mallard Great Blue Heron Green Heron	7 1 2	10
17	8-Jan	West side of Northborough lake	Mallard Unknown Gull Species Western Grebe	11 8 1	20

18	8-Jan	West side of Gateway lake			0
19	8-Jan	East side of Gateway lake			0
20	8-Jan	Alleghany lake	Mallard Canada Goose Common Grebe	8 12 2	22
21	10-Jan	East side of Northborough lake	Mallard Common Grebe	22 1	23
22	10-Jan	West side of Northborough lake	Mallard Common Grebe Western Grebe Great Egret	4 3 1 2	10
23	10-Jan	West side of Gateway lake	Unknown Gull Species Common Grebe	5 1	6
24	10-Jan	East side of Gateway lake			0
25	10-Jan	Alleghany lake	Mallard Common Merganser Common Grebe	9 18 1	28
26	11-Jan	East side of Northborough lake	Mallard Great Blue Heron Common Merganser Green Heron	6 1 2 4	13
27	11-Jan	West side of Northborough lake	Mallard Canada Goose	12 14	26
28	11-Jan	West side of Gateway lake			0
29	11-Jan	East side of Gateway lake			0
30	11-Jan	Alleghany lake	Green Heron Common Grebe	1 1	2
31	13-Jan	East side of Northborough lake	Great Egret Canada Goose Mallard	2 18 8	28
32	13-Jan	West side of Northborough lake	Common Grebe Mallard	2 10	12
33	13-Jan	West side of Gateway lake			0
34	13-Jan	East side of Gateway lake			0
35	13-Jan	Alleghany lake	Mallard Canada Goose Common Merganser	6 18 8	32
36	14-Jan	East side of Northborough lake	Mallard Common Grebe Great Blue Heron	14 2 1	17
37	14-Jan	West side of Northborough lake	Mallard Canada Goose Green Heron	8 10 2	20

38	14-Jan	West side of Gateway lake			0
39	14-Jan	East side of Gateway lake			0
40	14-Jan	Alleghany lake	Canada Goose Green Heron	14 1	15
41	16-Jan	East side of Northborough lake	Canada Goose Mallard	12 8	20
42	16-Jan	West side of Northborough lake	Canada Goose Great Blue Heron Green Heron	8 1 2	11
43	16-Jan	West side of Gateway lake	Common Grebe Unknown Gull Species	1 9	10
44	16-Jan	East side of Gateway lake			0
45	16-Jan	Alleghany lake	Mallard Green Heron Common Grebe	12 1 2	15
46	17-Jan	East side of Northborough lake	Western Grebe Canada Goose	1 16	17
47	17-Jan	West side of Northborough lake	Mallard Canada Goose Great Blue Heron Common Grebe	14 8 1 2	25
48	17-Jan	West side of Gateway lake			0
49	17-Jan	East side of Gateway lake			0
50	17-Jan	Alleghany lake	Mallard Common Grebe	8 1	9

Natomas Rice Field Waterbird Survey Point Counts					
Survey #	Date	Survey Point	Species Detected	Number	Total per Point Count
1	2-Jan	Sankey Rd., half way between Pacific and E. levee	Black-necked stilt	16	64
			Unknown Gull Species	1	
			Mallard	39	
			Northern Pintail	1	
			Greenwing Teal	2	
			Greater Yellow leg	4	
			Great Blue Heron	1	
2	2-Jan	Levee Rd., Dewit Farms	American Coot	250	707
			Unknown Gull Species	57	
			Northern Pintail	360	
			Mallard	8	
			Greenwing Teal	32	
3	2-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	950	968
			Unknown Gull Species	18	
4	2-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	95	221
			Unknown Gull Species	126	
5	2-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	76	102
			Northern Shoveler	26	
6	2-Jan	Elverta Rd., 200 Meters west of last point	American Coot	1000	2652
			White-fronted goose	750	
			Northern Pintail	900	
			Great Egret	2	
7	2-Jan	Elverta Rd., 200 Meters west of last point	American Coot	95	98
			Double-crested Cormorant	3	
8	2-Jan	Elverta Rd., 200 meters west of last point	Common Grebe	1	86
			Unknown Gull Species	82	
			Curlew	3	
9	2-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	8	140
			Great Egret	1	
			Northern Pintail	127	
			Double-crested Cormorant	4	
10	2-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	4	4
11	2-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	1	178
			Curlew	47	
			Unknown Gull Species	130	
12	2-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	1
13	4-Jan	Sankey Rd., half way between Pacific and E. levee	White-fronted Goose	250	451
			Northern Pintail	120	
			Black-necked Stilt	32	
			Unknown Gull Species	49	
14	4-Jan	Levee Rd., Dewit Farms	American Coot	300	487
			Northern Pintail	180	
			Great Blue Heron	1	
			Great Egret	5	
			Common Grebe	1	
15	4-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	83	117
			Great Egret	2	
			Northern Shoveler	26	
			Mallard	6	
16	4-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	12	14
			Double-crested Cormorant	2	
17	4-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	135	257
			American Coot	78	
			American Wigeon	44	
18	4-Jan	Elverta Rd., 200 Meters west of last point	American Coot	67	76
			Great Egret	9	

19	4-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	1
20	4-Jan	Elverta Rd., 200 Meters west of last point	Mallard American Wigeon American Coot Common Grebe	22 44 56 1	123
21	4-Jan	Elverta Rd., 200 Meters west of last point	Curlew Snowy Egret	47 21	68
22	4-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail Northern Shoveler American Coot	98 17 19	134
23	4-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species Curlew	39 31	70
24	4-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron Common Grebe Double-crested Cormorant	1 2 1	4
25	7-Jan	Sankey Rd., half way between Pacific and E. levee	Unknown Gull Species Phallarope Mallard	31 19 6	56
26	7-Jan	Levee Rd., Dewit Farms	American Coot Northern Pintail Mallard	400 92 4	496
27	7-Jan	Elverta Rd., Near shed on south side of road	White-fronted Goose Snow Goose Northern Pintail	180 250 200	630
28	7-Jan	Elverta Rd., 200 Meters west of last point	Great Egret Great Blue Heron Northern Pintail	9 1 33	43
29	7-Jan	Elverta Rd., 200 Meters west of last point	American Coot	48	48
30	7-Jan	Elverta Rd., 200 Meters west of last point	Snowy Egret Common Grebe	22 1	23
31	7-Jan	Elverta Rd., 200 Meters west of last point	White-faced Ibis Black-necked Stilt American Coot	33 14 67	114
32	7-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species Curlew Great Egret	48 31 12	91
33	7-Jan	Elverta Rd., 200 Meters west of last point	Great Egret Snowy Egret Great Blue Heron Unknown Gull Species	7 15 2 18	42
34	7-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species Northern Pintail American Wigeon Mallard Northern Shoveler	5 130 26 12 23	196
35	7-Jan	Elverta Rd., 200 Meters west of last point	Double-crested Cormorant Great Egret Curlew	1 11 33	45
36	7-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron Unknown Gull Species	1 6	7
37	8-Jan	Sankey Rd., half way between Pacific and E. levee	White-fronted Goose Snow Goose Mallard Northern Pintail American Wigeon Green-winged Teal Great Egret Unknown Gull Species	350 450 34 90 35 18 9 29	1015

38	8-Jan	Levee Rd., Dewit Farms	American Coot	123	231
			Great Egret	4	
			Northern Pintail	46	
			Mallard	8	
			Western or Least Sandpiper	50	
39	8-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	97	220
			American Coot	43	
			Western or Least Sandpiper	80	
40	8-Jan	Elverta Rd., 200 Meters west of last point	Uknown Gull Species	6	8
			Great Blue Heron	2	
41	8-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	61	61
42	8-Jan	Elverta Rd., 200 Meters west of last point	American Coot	34	50
			Snowy Egret	7	
			Great Egret	9	
43	8-Jan	Elverta Rd., 200 Meters west of last point	Phallarope	12	79
			Black-necked Stilt	8	
			Great Blue Heron	1	
			Unknown Gull Species	58	
44	8-Jan	Elverta Rd., 200 Meters west of last point	Mallard	6	30
			American Coot	24	
45	8-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	33	44
			Mallard	2	
			Northern Shoveler	9	
46	8-Jan	Elverta Rd., 200 Meters west of last point	American Coot	11	35
			Great Blue Heron	1	
			Common Grebe	2	
			White-faced Ibis	21	
47	8-Jan	Elverta Rd., 200 Meters west of last point	Curlew	36	66
			Snowy Egret	16	
			Great Egret	8	
			Unknown Gull Species	6	
48	8-Jan	Elverta Rd., 200 Meters west of last point	Western or Least Sandpiper	80	105
			Curlew	25	

APPENDIX N

LESA MODELING

Soil Name	Map Symbol	Storie Index Grade	Acres	%	Nonirrigtaed capability classification	Irrigated capability classification
Clear Lake clay	115	4	421.2	72.21%	3S	2S
Jacktone clay	127	2	75.54	12.95%	3S	3S
San Joaquin silt loam	137	5	9.61	1.65%	3S	3S
Consumnes silt loam	161	4	13.45	2.31%	3W	2W
Durixeralfs	213	4	7.61	1.30%	4S	4S
San Joaquin -Durixeralfs complex	216	4	45.27	7.76%	4S	unknown
San Joaquin-Xerarents complex	221	4	10.63	1.82%	3S	3S
TOTAL ACREAGE			**583.4**			

LCC Class	I	IIe	IIs,w	IIIe	IIIs,w	IVe	IVs,w	V	VIe,s,w	VIIe,s,w	VIII
Points	100	90	80	70	60	50	40	30	20	10	0

Land Evaluation Worksheet

Soil Map Unit	Project Acres	Proportion	LCC*	LCC Rating	LCC Score	Storie Index	Storie Index Score
Clear Lake clay	421.24	72.21%	3S	60	43.326	4	2.89
Jacktone clay	75.54	12.95%	3S	60	7.7696	2	0.26
San Joaquin silt loam	9.61	1.65%	3S	60	0.9884	5	0.08
Consumnes silt loam	13.45	2.31%	3W	60	1.3834	4	0.09
Durixeralfs	7.61	1.30%	4S	40	0.5218	4	0.05
San Joaquin -Durixeralfs complex	45.27	7.76%	4S	40	3.1041	4	0.31
San Joaquin-Xerarents complex	10.63	1.82%	3S	60	1.0933	4	0.07
	583.35	100.00%			58.187		3.76

* Based on nonirrigated capability classification

Site Assessment Worksheet 1

	LCC Class I-II	LCC Class III	LCC Class IV-VIII
		421.24	
		75.54	
		9.61	
		13.45	
			7.61
			45.27
		10.63	
Total Acres		530.47	52.88
Project Size Scores		100	20
Highest Project Size Score		100	

Project Size Scoring Table

Class I or II		Class III		Class IV or Lower	
Acreage	Points	Acreage	Points	Acreage	Points
>80	100	>160	100	>320	100
60-79	90	120-159	90	240-319	80
40-59	80	80-119	80	160-239	60
20-39	50	60-79	70	100-159	40
10-19	30	40-59	60	40-99	20
10<	0	20-39	30	40<	0
		10-19	10		
		10<	0		

Site Assessment Worksheet 2

Project Portion	Water Resource	Project Area %	Water Availability Score	Weighted Availability Score
1	irrigated	100%	90	90
2				
3				
4				
5				
6				
	Total Water Resource Score			90

	Factor Scores	Factor Weight	Weighted Factor Scores	
LE Factors				
Land Capability Classification	58.19	0.25	14.55	
Storie Index	3.76	0.25	0.94	
LE Total		0.50	**15.49**	
SA Factors				
Project Size	100	0.15	15	
Water Resource Availability	90	0.15	13.5	
Surrounding Agricultural Land	10	0.15	1.5	
Protected Resource Land	0	0.05	0	
		0.50	**30**	
			45.49	**FINAL LESA SCORE**

APPENDIX O

DELINEATION OF WATERS OF THE UNITED STATES

Delineation of Waters of the United States

Greenbriar ±569-Acre Site and Associated Utility Alignments
Sacramento County, California

Prepared for: U.S. Army Corps of Engineers

Contracted By: AKT Development Corporation

November 3, 2005

Submitted by:
FOOTHILL ASSOCIATES

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1.0 INTRODUCTION

The purpose of this document is to present the results of a formal delineation of jurisdictional waters of the United States, including wetlands, on the ±569-acre Greenbriar site and utility alignments located in northwestern Sacramento County, California (**Figure 1**).

This report presents the results of Foothill Associates review of available literature, aerial photographs, soil surveys, and fieldwork on the site. These results are summarized to depict jurisdictional waters of the United States following the technical guidelines provided in the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual for identifying wetlands and distinguishing them from aquatic habitats and other nonwetlands.

The delineation methodology is described in this report, followed by the results of the delineation. Details regarding soils, topography, hydrology, and vegetation are summarized and routine wetland determination data forms are provided in **Appendix B**. A detailed delineation map illustrates waters of the U.S. on the site (**Figure 3**).

2.0 REGULATORY BACKGROUND

The U.S. Army Corps of Engineers (Corps) regulates discharge of dredged or fill material into waters of the United States under Section 404 of the Clean Water Act (CWA). "Discharges of fill material" is defined as the addition of fill material into waters of the U.S., including, but not limited to the following: placement of fill that is necessary for the construction of any structure, or impoundment requiring rock, sand, dirt, or other material for its construction; site-development fills for recreational, industrial, commercial, residential, and other uses; causeways or road fills; fill for intake and outfall pipes and subaqueous utility lines [33 C.F.R. §328.2(f)]. In addition, Section 401 of the CWA (33 U.S.C. 1341) requires any applicant for a federal license or permit to conduct any activity that may result in a discharge of a pollutant into waters of the United States to obtain a certification that the discharge will comply with the applicable effluent limitations and water quality standards.

2.1 Waters of the United States

Waters of the U.S. include a wide range of features such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs and wet meadows as well as tributaries to such features. The term tributary generally refers to a feature which contributes its waters to another feature (example: a stream that flows into a larger river is a tributary to that river). Boundaries between jurisdictional waters and uplands are determined in a variety of ways depending on which type of water is present. Methods for delineating wetlands and non-tidal waters are described below.

Wetlands are defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" [33 C.F.R. §328.3(b)]. Presently, to be a wetland, a site must exhibit positive indicators of three wetland criteria: hydrophytic vegetation, hydric soils, and wetland hydrology existing under the "normal circumstances" for the site.

The lateral extent of non-tidal waters is determined by delineating the ordinary high water mark (OHWM) [33 C.F.R. §328.4(c)(1)]. The OHWM is defined by the Corps as "that line on shore established by the fluctuations of water and indicated by physical character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" [33 C.F.R. §328.3(e)].

3.0 METHODOLOGY

3.1 Site-Specific References

Available information pertaining to the natural resources of the region was reviewed. All references reviewed for this delineation are listed in Section 5.0. Pertinent site-specific reports and general references utilized concurrent with the delineation include the following:

- Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual*. U.S. Army Corps of Engineers Waterways Experiment Station. Vicksburg, MS;
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- U.S. Geological Survey. 1967. Photorevised 1975. *Taylor Monument*, *California*. 7.5 -minute series topographic quadrangle. U.S. Department of the Interior; and

- U.S. Geological Survey. 1967. Photorevised 1980. *Taylor Monument, California*. 7.5 -minute series topographic quadrangle. U.S. Department of the Interior.

3.2 Research and Field Methodology

This delineation utilized the Corps 1987 three-parameter (vegetation, hydrology, and soils) methodology to delineate jurisdictional waters of the U.S., focusing specifically on jurisdictional wetlands. This methodology requires the collection of data on soils, vegetation, and hydrology at several locations to establish the jurisdictional boundary of wetlands. Additional methods to identify and delineate other waters of the U.S. (e.g. streams, drainages, lakes, etc.) were used as applicable.

A review of historic and current aerial photographs, topographic maps and soils survey data was conducted before delineating the site on December 28^{th}, 2004 as well as concurrently with delineation work on January 4^{th}, July 7^{th}, August 15^{th}, August 22^{nd} and October 3^{rd}, 2005. Wetland biologists visually inspected the entire site and collected data on vegetation and hydrology. Soils were also examined and correlations were developed between the three parameters to make wetland determinations. Specifically, data points were evaluated to determine the composition and identification of dominant plant species. The indicator status of all dominant plant species (as determined by the U.S. Fish and Wildlife Service National List of Plant Species that Occur in Wetlands: 1988 California (Region 0)) was applied and evaluated as part of the vegetation assessment portion of the wetland determination process. Additionally, immediate sub surface soils conditions were examined for hydric attributes or a lack thereof. Observations were made and recorded for both primary and secondary wetland hydrology indicators, if present. In addition to sampling representative wetland types, routine determination data points were collected within the interior portions of the site currently or historically used for agricultural activities in order to collect baseline data for all of the mapped soils types occurring on the site. The routine determination points were collected in January, July and August of 2005. The location of each data point is depicted in **Figure 3** and corresponding routine wetland determination data forms are provided in **Appendix B**.

As part of the fieldwork, we also visually inspected several offsite areas to determine the surface hydrological connection between the ditches on the site. Several culverts and other water conveyance features were mapped during the delineation illustrated in **Figure 3**.

3.3 GPS Data Integration

Boundaries of wetlands and other waters of the U.S. within the site were surveyed and mapped with a Trimble GeoXT GPS (Global Positioning System) hand-held unit. This is a mapping-grade GPS unit capable of real-time differential correction and sub-meter accuracy. The GPS data were downloaded from the unit and differentially corrected utilizing Trimble Pathfinder Office software and appropriate base station data, and then converted to ESRI ® shape file format. Data are typically exported to the Geographic

Information System (GIS) software in the State Plane coordinate system (NAD 83) with units as "survey feet." Within the GIS, data are edited and linear features are built into polygons using recorded width information. All wetland shape files are merged to create a single wetland file with calculated acreages. These results are presented in **Figure 3**.

4.0 RESULTS

4.1 Study Area Description, Land Use

4.1.1 Study Area Location

The ±569 acre site and associated utility alignments are located in northwestern Sacramento County, approximately two miles southeast of the Sacramento International Airport and two miles northeast of Sacramento River. The site is bound by Interstate 5 on the south, State Highways 70/99 on the east, and Elkhorn Boulevard on the north. The utility alignments include areas along the south edge of Elkhorn Boulevard, east to Natomas Boulevard and the east edge of the site, south along State Route 99. The site is bound on the west by rural residences and agricultural lands. The site is located within Townships 9 and 10 North, Range 4 East and occupies portions of sections 4 and 33 of the U.S.G.S. Taylor Monument 7.5' quadrangle map (**Figure 1**).

4.1.2 Land Use

The site is currently in agricultural use, with dry farmed wheat. A portion of the site was in rice cultivation until 2002. A horse race track and an irrigated polo field were present in the northern portion of the site from approximately 1980 to the early 2000's. For several years the horse ranch subleased the northwest corner of the property to a highway construction company, who stored equipment there. For at least the last 20 years, the remainder of the property outside the horse ranch area has been in agricultural use (rice, sugar beets, wheat).

4.1.3 Site History and Description

A review of historic aerial imagery indicates the site has been utilized for agricultural activities, mainly rice production, since 1937. The site was planted in rice as recently as 2002, according to review of aerial imagery. A conversation with the land manager confirmed that the site was planted with rice in 2003 and 2004, as well. In the 2005 growing season the site was planted with wheat (Johas, pers. comm.). At the cessation of this year's crop harvesting activities, the majority of the site was disced. Areas not disced within the site during the initial stage of the delineation include the following two locations: the northwestern portion of the site west of the equestrian track and north of ditch feature #14, west to the site boundary and continuing north to Elkhorn Boulevard; the northeastern portion of the site south of Elkhorn Boulevard and north and west of the ditch and canal segments labeled #13 and #21, respectively (**Figure 3**).

The natural hydrologic regime on the site has been altered to facilitate agricultural production processes since at least 1937 and is discussed in detail in section 4.2.4. The predominant features constructed on the site for water conveyance include ditches and canals. During past periods of rice cultivation, an extensive network of checks and berms also existed on the site. These features were deconstructed in coincidence with the cessation of rice cultivating activities on the site which occurred as recently as 2004.

Soils on the site developed in an area that appears to have historically supported wetlands based on a review of the 1937 aerial photographs. Therefore, hydric soil indicators documented on the site may be the result of natural, historic conditions. However, the production of rice over a large portion of the site and over a long period of time has likely contributed to the current condition of soils on the site, potentially including the presence of secondary indicators of wetland hydrology and hydric soil indicators. Consequently, the soils may not be a reliable indicator of current conditions.

4.2 Physical Features

4.2.1 Soils

The Natural Resources Conservation Service (NRCS) has identified and mapped eight soils occurring on the site and associated utility alignments (**Figure 2**): **Clear Lake clay, hardpan substratum, drained, 0 to 1 percent slopes, Cosumnes silt loam, partially drained, 0 to 2 percent slopes, Durixeralfs, 0 to 1 percent slopes, Jacktone clay, drained, 0 to 2 percent slopes, San Joaquin silt loam leveled, 0 to 1 percent slopes, San Joaquin-Durixeralfs complex, 0 to 1 percent slopes and San Joaquin-Xerarents complex, leveled, 0 to 1 percent slopes**. General characteristics and properties associated with these soils are described below.

- **Clear Lake clay, hardpan substratum, drained, 0 to 1 percent slopes:** This deep to very deep artificially drained soil is located in basins between five to 30 feet above Mean Sea Level (MSL). A system of levees and large upstream dams has reduced the hazard of flooding. The construction of levees, drainage ditches and pumps has lowered the water table and altered the drainage of the soil. This soil formed from fine textured alluvium derived from mixed rock sources. Permeability is slow, available water capacity is moderate and runoff is very slow. This soil is subject to rare flooding and is typically used for irrigated crops such as rice, corn, tomatoes, sugar beets and wheat. Vegetation in uncultivated areas mainly consists of annual grasses and herbaceous species. The hydric soils list for Sacramento County identifies on type of hydric inclusion occurring within this soil type: Cosumnes, located on the low floodplain. The hydric soils list for Sacramento County also identifies one type of hydric component occurring within this soil type: Clearlake, located on basin floors.

- **Cosumnes silt loam, partially drained, 0 to 2 percent slopes:** This very deep, artificially drained soil is located on low floodplains at elevation between five to 20 feet above MSL. A system of levees and large upstream dams has reduced the hazard of flooding. Levees, open and closed drains and pumps have lowered the water table and altered the drainage of the soil. This soil formed in somewhat poorly drained alluvium derived from mixed rock sources. Permeability is slow, available water capacity is high and runoff is slow. This soil is subject to rare flooding and is typically used for irrigated crops such as rice, corn, tomatoes, sugar beets and wheat. Vegetation in uncultivated areas mainly consists of annual grasses and herbaceous species. The hydric soils list for Sacramento County identifies three types of hydric inclusions occurring within this soil type: Clearlake, located on basin floors, Columbia, located on the low floodplain and Sailboat, located on the low floodplain. The hydric soils list for Sacramento County also identifies one type of hydric component occurring within this soil type: Cosumnes, located on the low floodplain.

- **Durixeralfs, 0 to 1 percent slopes:** This soil unit is a shallow or moderately deep, well drained, altered soil located on low terraces between 20-150 feet above MSL. Most or the entire original surface layer has been removed. The soils developed from alluvium derived from mixed granitic rocks. Slopes are plane due to artificial leveling. Water permeability is slow to very slow, available water capacity is very low or low and runoff is very slow. This soil unit is used for irrigated hay and pasture or for irrigated crops. Typically, vegetation in uncultivated areas within this soil unit consists of non-native annual grasses and herbaceous plant species. The hydric soils list for Sacramento County does not identify any hydric inclusions or components occurring within this soil unit.

- **Jacktone clay, drained, 0 to 2 percent slopes:** This moderately deep, artificially drained soil is located in high areas in basins between 10-25 feet above MSL. It is protected against flooding by a system of levees and large upstream dams. The construction of levees, drainage ditches and pumps has lowered the water table and altered the drainage of the soil. This soil formed in alluvium derived from mixed rock sources. Permeability is slow, available water capacity is moderate and runoff is very slow. This soil is subject to rare flooding. This soil is typically used for irrigated crops such as rice, barley, wheat and corn. Vegetation in uncultivated areas mainly consists of annual grasses and herbaceous species. The hydric soils list for Sacramento County identifies two types of hydric inclusions occurring within this soil type: Cosumnes, located on the low floodplain, and Clearlake, located on basin floors. The hydric soils list for Sacramento County also identifies one type of hydric component occurring within this soil type: Jacktone, located on basin rims.

- **San Joaquin silt loam, leveled, 0 to 1 percent slopes:** This soil unit is located on low terraces at an elevation of 20 to 125 feet above MSL. Slopes are plane due to land leveling processes. San Joaquin silt loam is a moderately deep, moderately well drained soil formed in alluvium derived from dominantly granitic rocks. Permeability is very slow, available water capacity is low and runoff is very slow. Vegetation typically found on this soil unit consists of non-native annual grasses and herbaceous plant species, and a few scattered native oaks (*Quercus* spp.). The hydric soils list for Sacramento County does not identify any hydric inclusions within this soil type.

- **San Joaquin silt loam, 0 to 3 percent slopes:** This soil unit is located on low terraces. San Joaquin silt loam is a moderately deep, moderately well drained soil formed in alluvium derived from dominantly granitic rocks. Permeability is very slow, available water capacity is low and runoff is very slow. Vegetation typically found on this soil unit consists of non-native annual grasses and herbaceous plant species, and a few scattered native oaks (*Quercus* spp.). The hydric soils list for Sacramento County identifies one type of hydric inclusion occurring within this soil type: Galt, located within depressions.

- **San Joaquin-Durixeralfs complex, 0 to 1 percent slopes:** This soil complex is located on low terraces at elevations of 20 to 100 feet above MSL. Slopes are plane due to land leveling processes. The San Joaquin soil is a moderately deep, well drained soil formed in alluvium derived from granitic rock. Permeability is very slow, available water capacity is low and runoff is very slow. The Durixeralfs formed in alluvium derived from mixed granitic rocks and are shallow or moderately deep, well drained and altered. Permeability is slow or very slow in the Durixeralfs, available water capacity is very low or low and runoff is very slow. Vegetation typically associated with uncultivated portions of this soil complex is typically composed of annual grasses and herbaceous plant species. The hydric soils list for Sacramento County identifies one type of hydric inclusion occurring within this soil type: Galt, located within depressions.

- **San Joaquin-Xerarents complex, leveled, 0 to 1 percent slopes:** This soil complex is located on low terraces at elevations of 20 to 125 feet above MSL. Slopes are plane due to land leveling processes. The San Joaquin soil is a moderately deep, moderately well drained soil formed in alluvium derived from granitic rock. Permeability is very slow, available water capacity is low and runoff is very slow. The Xerarents are moderately deep to very deep, well drained and altered and formed in fill material mixed by leveling processes. The fill material is derived from mixed but predominantly granitic rock sources. Permeability is moderate to very slow in the Xerarents, available capacity is moderate or high and runoff is very slow. Prior to leveling, areas with these soils consisted of depressions and narrow channels along drainageways. Typically, areas with these soils are used for irrigated crop production. Vegetation associated with uncultivated portions of this soil complex is primarily composed of annual grasses and herbaceous plant species. The hydric soils list for Sacramento County identifies four types of hydric inclusions occurring within this soil type: Galt, located in depressions; Clearlake, located on basin floors; Columbia, located on low floodplains and Sailboat, located on low floodplains.

In summary, and according to the hydric soils list and soil survey for Sacramento County, the following hydric soil inclusions and/or components and the landform types they are associated with are listed as occurring within six of the eight soil types mapped by NRCS: Columbia hydric inclusions that are located on the low floodplain, Cosumnes hydric inclusions that are located on the low floodplain, Clearlake hydric inclusions that are located on basin floors, Galt hydric inclusions that are located in depressions, Sailboat hydric inclusions that are located on the low floodplain, hydric components of Clearlake that are located on basin floors, hydric components of Cosumnes that are located on the low floodplain, hydric components of Jacktone that are located on basin rims and hydric components of Galt that are located within depressions.

4.2.2 Topography

The natural topography of the site has been altered to facilitate agricultural production processes. Historically, the site was largely flat and is located in an area that was part of the original floodplain of the Sacramento River. Throughout the past several decades, the site has been repeatedly leveled, drained and/or disced for the process of rice production and most recently for wheat production. Other common agricultural maintenance activities or practices influencing the topography and drainage on the site include ditching and mechanical harvesting processes. The slopes throughout the site range from approximately 0 to 2 percent. The elevation on the site ranges from approximately 11 to 22 feet above MSL.

4.2.3 Regional Hydrology

The site is located in the Natomas Basin approximately two miles northeast of Sacramento River within the northern Sacramento Valley portion of the Great Central Valley. Historically, the Sacramento River and many of its main tributaries flooded seasonally, creating areas that remained inundated for substantial periods during the rainy season. As a result, large-scale flood-control projects, diversion dams, and water-control structures were built on tributary rivers entering the valley in the 1930's. As a result of the construction of these fortified structures, natural flooding events were reduced in frequency and intensity. As the demand for agricultural production processes in the region increased, the development of a complex system of canals and ditches to maximize water conveyance and storage ensued. A review of the U.S.G.S. Davisville topographic map of 1905 indicates that the site is within the former location of historic Bush Lake which was drained as a result of the construction of the Natomas Drainage Canal.

4.2.4 Site-Specific Hydrology

The site is within the historic 100-year floodplain (FEMA, 1996) of Sacramento River. The hydrologic regime on the site is supplemented by seasonal storm water run off and precipitation, primarily between November and March. The majority of seasonal surface run off is conveyed throughout the site via altered, leveled topography and/or artificial water conveyance features such as ditches and canals. The hydrology of the site has been altered for the conveyance of water to, from, and throughout the site via a network of ditches and canals in order to facilitate agricultural production processes. Hydrologic features identified and mapped within the site include the following: depressional seasonal wetland, depressional seasonal marsh, depressional perennial marsh, excavated pond and ditch/canal (**Figure 3**). Diagnostic characteristics of the features mapped on the site are defined and discussed in Section 4.4.

The ditches and canals on the site are physically connected to the West Drainage canal via a series of culverts, and the West Drainage Canal is tributary to Sacramento River.

However, not all the ditches appear to be functionally connected via natural flows to or from the West Drainage Canal, specifically features #46, #48 and #49. The ditches are man made and appear to constitute the remnants of artificial water conveyance facilities associated with past agricultural practices on the site. As a result, these features or a portion or portions thereof may be considered non-jurisdictional by the Corps.

The Final Natomas Basin Habitat Conservation Plan has identified and described the ditches/canals along the western, southern and eastern site boundary as part of a water *drainage* system, and the ditches within the interior site boundary are identified as part of a water *delivery* system. At no time was standing or flowing water observed within these interior, remnant ditches that are classified as part of a water delivery system.

The depressional seasonal wetlands on the site are characterized by saturation rather than inundation. The depressional seasonal marshes are seasonally inundated or saturated, but inundation/saturation persists for some period into the warm season. The depressional perennial marshes are depressions that typically remain inundated or saturated throughout the year. The excavated ponds are supplied by seasonal precipitation and are isolated from any other wetlands or waters.

4.3 Vegetation

The vegetation assemblages and habitat types occurring on the site include the following: agricultural cropland, California annual grassland alliance, depressional seasonal wetland, depressional seasonal marsh and depressional perennial marsh.

4.3.1 Agricultural Cropland

The majority of the site is composed of leveled agricultural cropland (wheat). According to the land manager, the wheat crop was planted in November of 2005 and harvested in July 2005.

4.3.2 California Annual Grassland Alliance

California annual grassland alliance consists of a myriad of native and non-native annual plant species and occurs in a majority of the state at elevations from sea level to approximately 4,000 feet above MSL. Composition of this vegetation community varies depending on distribution, geographic location and land use. Additional major influences on this vegetation community include soil type, annual precipitation and fall temperatures. Dominant plant species within the California annual grassland on the site include the following: Italian ryegrass (*Lolium multiflorum*), soft brome (*Bromus hordeaceus*), wild oat (*Avena* sp.), mouse-tail grass (*Vulpia myuros*), medusahead (*Taeniatherum caput-medusae*), long-beaked filaree (*Erodium botrys*), woodland geranium (*Geranium molle*), chick weed (*Stellaria media*), milk thistle (*Silybum marianum*), star thistle (*Centaurea solstitialis*), barley (*Hordeum murinum* ssp. *leporinum*), wild oat (*Avena* sp.), clover (*Trifolium* sp.) and shepherd's purse (*Capsella bursa-pastoris*). California annual grassland alliance occurs primarily in between the leveled agricultural fields, along the berms above the ditches and canals on the site and along the maintenance roads as well as the upland areas outside of the agricultural fields.

4.3.3 Seasonal Wetland

The depressional seasonal wetlands on the site support hydrophytic vegetation. Depressional seasonal wetlands are depressions within the topography that inundate or saturate for short periods of time following intense rains but do not maintain seasonal aquatic or saturated soils conditions for durations long enough for colonization by perennial, obligate plant species. As such, plant species in seasonal wetlands are generally of two types: species that can tolerate short periods of inundation but have not adapted to withstand sustained aquatic or saturated soils conditions, and short-lived (primarily annual) species that take advantage of ephemeral aquatic and/or saturated soils conditions. Plant species observed occurring within the seasonal wetlands on the site and in the associated utility alignments include Italian ryegrass, Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), vernal pool buttercup (*Ranunculus bonariensis* var. *trisepalus*) and nutsedge (*Cyperus esculentus*). The depressional seasonal wetlands are concentrated in the northern and central portions of the site.

4.3.4 Seasonal Marsh

Cattail alliance occurs throughout the state of California in brackish, alkali or freshwater marshes from sea level to approximately 6,500 feet above MSL. Typically, cattail alliance occurs in intermittently or permanently flooded wetlands, such as the depressional perennial marsh in the northwestern portion of the site. The diagnostic species of this vegetation alliance is cattail (*Typha latifolia*), which is a hydrophytic species. Associates vary widely depending on length of inundation/saturation during the year as well as seasonal temperatures and water chemistry. On the site, sand bar willow (*Salix exigua*) and smartweed (*Polygonum* sp.) are common associates of this alliance. This vegetation alliance also occurs within the depressional seasonal marsh located along the eastern site boundary.

4.3.5 Perennial Marsh

The depressional perennial marshes on the site support hydrophytic vegetation. Depressional perennial marsh is located in the northwestern portion of the site within the center of the equestrian track. The marsh is supplied by a ditch which conveys water into the marsh via a subsurface conveyance feature and culverts. A review of historical photographs indicates that this feature was created on the site as part of the equestrian track design and/ or maintenance function. The dominant tree species in the marsh, which appears to have been red willow (*Salix laevigata*), had been recently cut down prior to conducting the wetland delineation. Sand bar willow is common along the boundary and within the margins of this feature. Emergent aquatic plant species such as cattail and floating aquatics such as duckweed (*Lemna* sp.) and knotweed also occur in this area. Dense interspersed stands of Himalayan blackberry (*Rubus discolor*) occur with regular frequency along the boundary of this feature, as well.

4.4 Classification of Waters of the United States

As discussed previously in section 2.0, jurisdictional waters of the U.S. are classified into multiple types based on topography, edaphics (soils), vegetation and hydrologic regime. Primarily, the Army Corps of Engineers establishes two distinctions: wetland and non-wetland waters of the U.S. Non-wetland waters are commonly referred to as other waters. Potential jurisdictional wetland types mapped within the site include the following: depressional seasonal wetland, depressional seasonal marsh and depressional perennial marsh.

Potential other waters of the U.S. delineated within the site include the following: ditch/canal. In addition, the ponds on the site were identified as excavated in uplands and interpreted as potentially non jurisdictional features. A description of all of the features delineated within the site is provided in the following sections.

4.4.1 Depressional Seasonal Wetland

A total of **4.68** acres of depressional seasonal wetland have been delineated on the site. Depressional seasonal wetlands are defined by a hydrologic regime characterized by saturation rather than inundation. Depressional seasonal wetlands were identified on the site as topographic depressions with a hydrologic regime characterized by saturation and capable of supporting hydrophytic plant species and hydric soils. Plant species in depressional seasonal wetlands are adapted to withstand short periods of saturation or saturated soils conditions but will not withstand prolonged periods of inundation, as is common in vernal pools. The depressional seasonal wetlands on the site support wetland soils, vegetation, and hydrology, and would likely be regulated by the Corps. Depressional seasonal wetlands are located in the northern central portion of the site (**Figure 3**).

4.4.2 Depressional Seasonal Marsh

A total of **0.31-**acre of depressional seasonal marsh has been delineated on the site. Depressional seasonal marshes are wetlands that are seasonally inundated or saturated, but inundation/saturation persists through the majority of the warm season. The persistence of inundation/saturation into the warm season permits the growth of primarily perennial herbaceous plant species capable of withstanding extended periods of inundation or saturated soil conditions. In the Great Central Valley, these features are typically located on the fringes of naturally occurring or artificially created impoundments, such as ponds or reservoirs. These features may also be associated with slow moving riverine systems where natural and/or artificial flows persist into the warm season. The depressional seasonal marsh on the site exhibits wetland characteristics.

4.4.3 Depressional Perennial Marsh

A total of **1.34** acres of depressional perennial marsh have been delineated on the site. Depresional perennial marshes can occur as the result of natural and/or artificial water flows associated with agricultural or residential water uses. Depressional perennial marshes are dominated by inundation. Typically, depressional perennial marshes remain inundated or saturated throughout the year. The persistence of inundation/saturation throughout the year permits the growth of warm-season wetland grasses and perennial herbaceous plant species. Within the Central Valley, depressional perennial marshes typically occur in association with the lowland terminus of local riverine watersheds or as the result of artificial excavation activities in low lying areas exhibiting historic hydric soils conditions, often resulting in artificially created impoundments, such as ponds or reservoirs.

The depressional perennial marsh is located within the abandoned equestrian racetrack in the northwestern portion of the site. It exhibits wetland characteristics and is connected via a series of culverts to a network of ditches/canals on the site which are connected to jurisdictional waters (Sacramento River) off site. The depressional seasonal marsh is therefore presumed to be a Corps jurisdictional wetland.

4.4.4 Ditch/Canal

A total of **11.64** acres of ditch/canal have been delineated on the site. Non-tributary water conveyance features excavated in uplands and constructed for the transport and distribution of groundwater between agricultural fields are not jurisdictional features unless the Corps determines and claims jurisdiction on a case-by-case basis. Water conveyance features excavated in uplands and constructed for transport and distribution of surface water between agricultural fields may be jurisdictional features, specifically if they are tributary to known waters of the U.S.

An additional **0.72** acre of ditches/canals was delineated on the site and are not connected to any other water conveyance feature on or off of the site. At no time was standing or flowing water observed within the interior remnant ditches on the site. As a result, these features or a portion or portions thereof may be considered non-jurisdictional by the Corps. However, the Corps reviews these situations on a case-by-case basis. The ditches/canals are located throughout the interior of the site and along the eastern, western and southern site boundaries. Because of the lack of connectivity, we have identified these features as non-jurisdictional.

4.4.5 Excavated pond

A total **0.34-**acre of excavated pond has been delineated on the site. There are two excavated ponds in the northern-central portion of the site. Ponds are typically the result of the deliberate impoundment of water through artificial damming. When stock ponds occur as the result of the construction of artificial impoundment features that restrict or stop the flow of jurisdictional waters of the U.S., the resulting pond becomes jurisdictional to the limits of the ordinary high water mark or wetland boundary. Conversely, ponds wholly excavated in uplands and supplied by surface run off or groundwater are not jurisdictional features. The ponds on the site are excavated and are not the result of the impoundment of a natural drainageway. Nor are the excavated ponds tributaries to or from any waters of the U.S. The hydrology of the ponds is supplied by seasonal precipitation. Therefore, the Corps will not likely assert jurisdiction of these features.

Table 1 below provides acreage per class and summarizes the total acreage of wetlands and waters on the site.

Table 1 — Waters of the U.S: Acreage According to Feature

CLASS	TOTAL ACREAGE	JURISDITIONAL	NON-JURISDITIONAL
Depressional Seasonal Wetland	**4.68**	**4.68**	**0.0**
Depressional Seasonal Marsh	**0.31**	**0.31**	**0.0**
Depressional Perennial Marsh	**1.34**	**1.34**	**0.0**
Ditch/Canal	**12.36**	**11.64**[1]	**0.72**
Excavated Pond	**0.34**	**0**	**0.34**
TOTAL	**19.03**	**17.97**	**1.06**

[1] Ditches and canals may not be jurisdictional.

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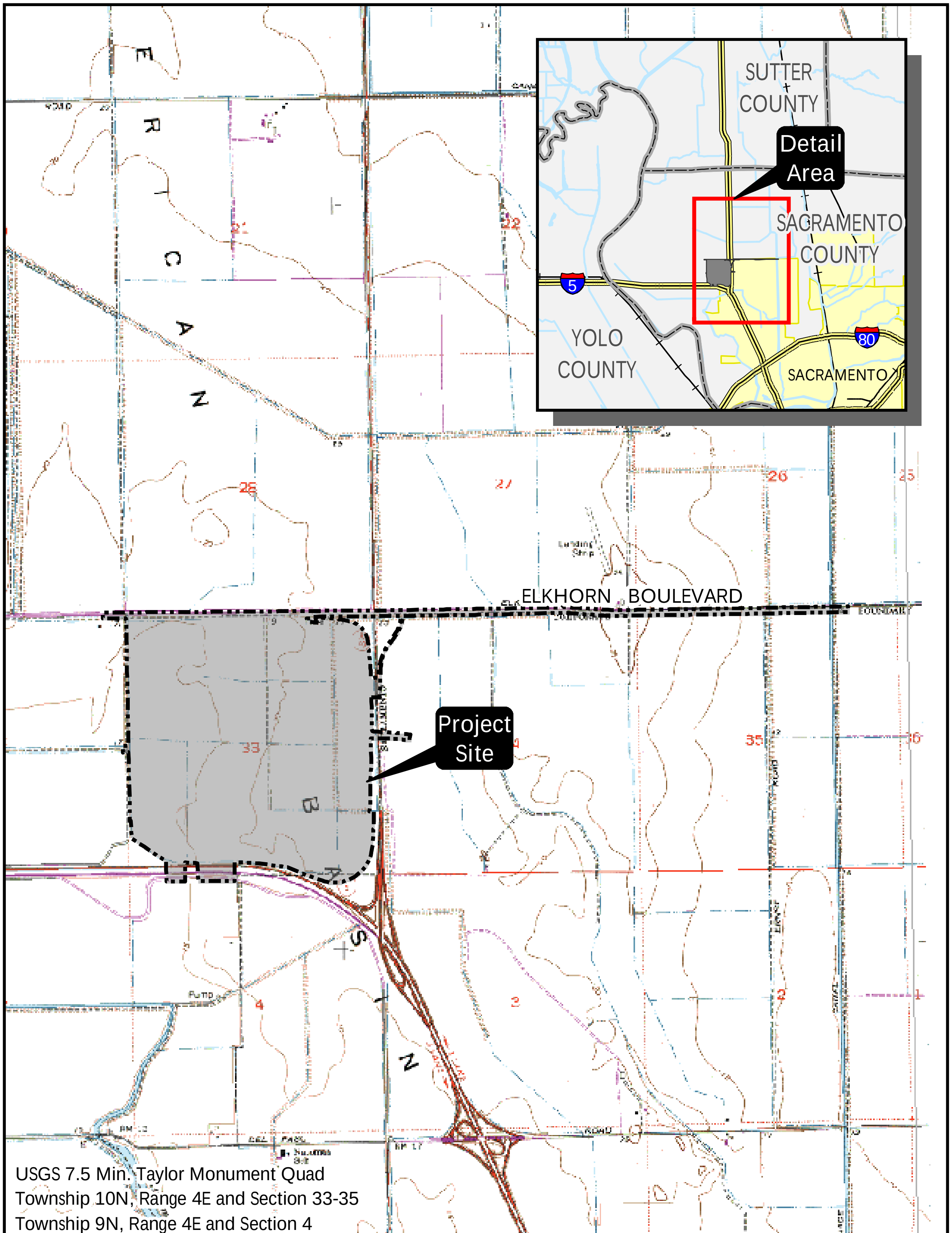
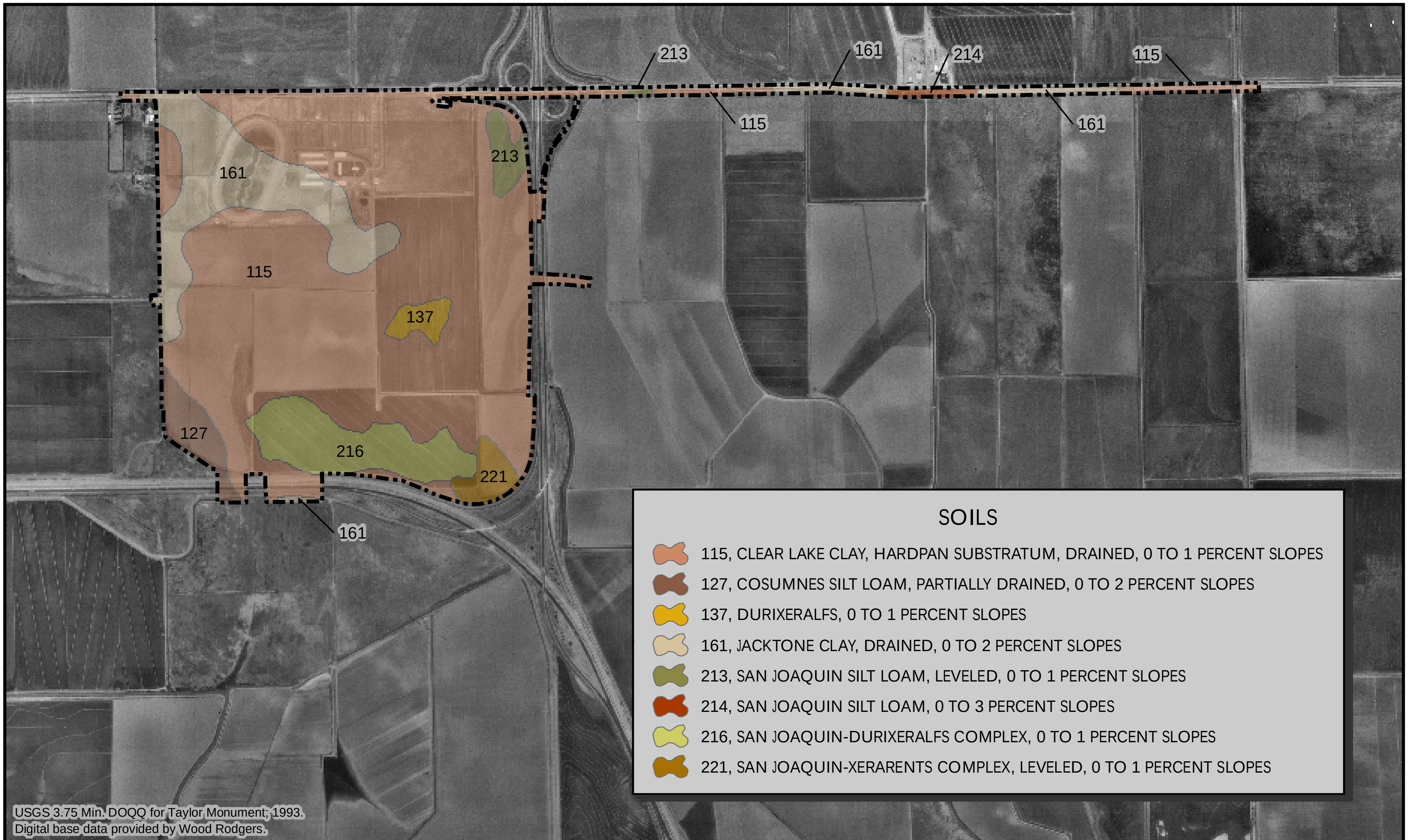


SITE AND VICINITY

FOOTHILL ASSOCIATES ENVIRONMENTAL CONSULTING • PLANNING LANDSCAPE ARCHITECTURE	N	0 1500 3000 SCALE IN FEET	Drawn By: AH Date: 10/17/05	FIGURE 1

GREENBRIAR

site_and_vicinity_101705.mxd



SOILS

FOOTHILL ASSOCIATES
ENVIRONMENTAL CONSULTING • PLANNING
LANDSCAPE ARCHITECTURE

N

0 2000 4000
SCALE IN FEET

Drawn By: AH
Date: 10/17/05

FIGURE 2

GREENBRIAR

soils_101705.mxd

INDIVIDUAL WOUS FEATURE ACREAGES

POTENTIAL JURISDICTIONAL

DSW	
LABEL	*ACRES**
1	0.007
2	0.036
3	0.008
4	0.012
5	0.051
6	0.043
7	0.006
8	4.498
52	0.001
53	0.004
54	0.009
55	0.005
SUBTOTAL	4.680

DSM	
LABEL	*ACRES**
9	0.062
10	0.009
38	0.104
39	0.026
40	0.020
41	0.020
42	0.022
43	0.025
44	0.021
45	0.004
SUBTOTAL	0.313

DPM	
LABEL	*ACRES**
11	1.343

DITCH	
LABEL	*ACRES**
12	0.172
13	0.065
14	0.336
15	0.004
16	0.005
17	0.012
18	0.041
19	0.393
20	0.086
21	0.493
22	0.018
23	0.003
24	0.753
25	0.345
26	1.625
27	0.041
28	0.746
29	1.430
30	0.029
31	0.078
32	0.142
33	0.050
34	0.149
35	3.624
36	0.091
37	0.017
58	0.552
59	0.344
SUBTOTAL	11.644

DITCH	
LABEL	*ACRES**
46	0.383
47	0.005
48	0.150
49	0.112
56	0.008
57	0.008
60	0.024
61	0.003
62	0.031
SUBTOTAL	0.724

POND	
LABEL	*ACRES**
50	0.078
51	0.258
SUBTOTAL	0.336

TOTAL**	**19.03**

*Individual acreage reported to 3 significant figures. Digital GIS data file provides area in square feet as well as acres.
**Based on sum of subtotals at 2 significant figures.

JURISDICTIONAL WATERS OF THE U.S. CLASSIFICATION	ACREAGE	NON JURISDICTIONAL ACREAGE CLASSIFICATION	ACREAGE	TOTAL ACREAGE
DEPRESSIONAL WETLANDS				
Seasonal Wetland	4.68	– – – – – – – – – – – – – – – –		4.68
Seasonal Marsh	0.31	– – – – – – – – – – – – – – – –		0.31
Perennial Marsh	1.34	– – – – – – – – – – – – – – – –		1.34
OTHER WATERS OF THE U.S.				
Ditch/Canal	11.64	Ditch/Canal	0.72	12.36
– – – – – – – – – – – – – – – – – – – –		Excavated Pond	0.34	0.34
TOTAL	17.97	TOTAL	1.06	19.03

OTHER FEATURES

- Data Points
- Direction of underground flow
- Culvert
- Off-Site Ditch/Canal
- Site Boundary

NOTES

- Wetland delineation subject to U.S. Army Corps of Engineers verification.
- Digital base data provided by Wood Rodgers. Contour interval is 1 foot or less.
- Eastern countours generated from 30M DEM, interval is 1 foot.
- The Hydrologic Unit Code for this site is 18020109.
- This wetland delineation utilizes the Corps' 1987 three-parameter methodology to delineate jurisdictional waters of the U.S.
- Wetlands and other waters of the U.S. were mapped using a Trimble GPS Global Positioning System).

0 400 800
SCALE IN FEET

GREENBRIAR

WETLAND DELINEATION

FOOTHILL ASSOCIATES
ENVIRONMENTAL CONSULTING • PLANNING
LANDSCAPE ARCHITECTURE

FIGURE 3

DATE: 04/20/05 FILE NAME: wetland_delineation_100505.mxd
REVISION: 10/06/05 DRAWN BY: DBV/BF/AH
DELINEATED BY: CJS, RHB, BCM

PROJECT NAME: Greenbriar FILE NAME: Wetland_Delineation_100605.MXD DATE: 10/06/05

Appendix A — Contact Information

Client Contact Information:

Niki Doan
AKT Development Corporation
7700 College Town Drive, Suite 101
Sacramento, CA 95826 -2397

Delineation Conducted by:

Brian Mayerle, Biologist
Cristian Singer, Botanist
Foothill Associates
655 Menlo Drive, Suite 100
Rocklin, CA 95765-3718

Appendix B — Routine Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Taxonomy (Subgroup): N/A

Drainage Class: N/A
Field Observations
Confirm Mapped Type? ○ Yes ○ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

Approved by HQUSACE 3/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
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VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Associate Plant Species	Stratum	Indicator
1.	Cynodon dactylon 50%	HERB	FAC	9.			
2.	Paspalum dilatatum 35%	HERB	FAC	10.			
3.	Cyperus sp. 15%	HERB	FACW	11.			
4.	Rumex sp. <1%	HERB	FACW	12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- ☑ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☑ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name (Series and Phase): gravel/fill

Taxonomy (Subgroup): N/A

Drainage Class: N/A

Field Observations Confirm Mapped Type? ○ Yes ○ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

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- ☐ Histosol
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- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No

Wetland Hydrology Present? ○ Yes ○ No

Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

Approved by HQUSACE 3/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523	Date: 01/26/2005
Applicant/Owner: AKT Development Corporation	County: Sacramento
Investigator: Cristian Singer	State: California

Do Normal Circumstances exist on the site?	○ Yes	○ No	Community ID: UPL
Is the site significantly disturbed (Atypical Situation)?	○ Yes	○ No	Transect ID: 1
Is the area a potential Problem Area? (If needed, explain on reverse.)	○ Yes	○ No	Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
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Percent of Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

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Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
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- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
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- ☐ Organic Streaking in Sandy Soils
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- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
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Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
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Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

☑ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☑ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
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Secondary Indicators (2 or more required):
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Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
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Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

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- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
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Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
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- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

☑ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☑ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

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- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
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5.			13.		
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7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

☑ Recorded Data (Describe in Remarks): ☐ Stream, Lake, or Tide Gauge ☑ Aerial Photographs ☐ Other ☐ No Recorded Data Available Field Observations: Depth of Surface Water: N/A (in.) Depth to Free Water in Pit: N/A (in.) Depth to Saturated Soil: N/A (in.)	Wetland Hydrology Indicators: Primary Indicators: ☐ Inundated ☐ Saturated in Upper 12 Inches ☐ Water Marks ☐ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns in Wetlands Secondary Indicators (2 or more required): ☐ Oxidized Root Channels in Upper 12 Inches ☐ Water-Stained Leaves ☐ Local Soil Survey Data ☐ FAC-Neutral Test ☐ Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523	Date: 01/26/2005
Applicant/Owner: AKT Development Corporation	County: Sacramento
Investigator: Cristian Singer	State: California

Do Normal Circumstances exist on the site?	○ Yes	○ No	Community ID: UPL
Is the site significantly disturbed (Atypical Situation)?	○ Yes	○ No	Transect ID: 1
Is the area a potential Problem Area? (If needed, explain on reverse.)	○ Yes	○ No	Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

☑ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Gauge
- ☑ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Taxonomy (Subgroup): N/A

Drainage Class: N/A
Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523
Applicant/Owner: AKT Development Corporation
Investigator: Cristian Singer

Date: 01/26/2005
County: Sacramento
State: California

Do Normal Circumstances exist on the site? ○ Yes ○ No
Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No
Is the area a potential Problem Area? ○ Yes ○ No
(If needed, explain on reverse.)

Community ID: UPL
Transect ID: 1
Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
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5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Taxonomy (Subgroup): N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
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- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523
Applicant/Owner: AKT Development Corporation
Investigator: Cristian Singer

Date: 01/26/2005
County: Sacramento
State: California

Do Normal Circumstances exist on the site? ○ Yes ○ No
Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No
Is the area a potential Problem Area? ○ Yes ○ No
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Community ID: UPL
Transect ID: 1
Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
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Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- ☑ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☑ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ☐ Oxidized Root Channels in Upper 12 Inches
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- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
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Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
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HYDROLOGY

- ☑ Recorded Data (Describe in Remarks):
  - ☐ Stream, Lake, or Tide Gauge
  - ☑ Aerial Photographs
  - ☐ Other
- ☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
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- ☐ Other (Explain in Remarks)

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SOILS

Map Unit Name (Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations Confirm Mapped Type? ○ Yes ○ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
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- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
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- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	○ Yes	○ No
Wetland Hydrology Present?	○ Yes	○ No
Hydric Soils Present?	○ Yes	○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
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3. Cyperus sp. 15%	HERB	FACW	11.		
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Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

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HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ◯ Yes ◯ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ◯ Yes ◯ No
Wetland Hydrology Present? ◯ Yes ◯ No
Hydric Soils Present? ◯ Yes ◯ No

Is this Sampling Point Within a Wetland? ◯ Yes ◯ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523 Applicant/Owner: AKT Development Corporation Investigator: Cristian Singer	Date: 01/26/2005 County: Sacramento State: California
Do Normal Circumstances exist on the site? ○ Yes ○ No Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No Is the area a potential Problem Area? ○ Yes ○ No (If needed, explain on reverse.)	Community ID: UPL Transect ID: 1 Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
5-16	N/A	none	none	none	rock

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
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- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: North Natomas 523
Applicant/Owner: AKT Development Corporation
Investigator: Cristian Singer

Date: 01/26/2005
County: Sacramento
State: California

Do Normal Circumstances exist on the site? ○ Yes ○ No
Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No
Is the area a potential Problem Area? ○ Yes ○ No
(If needed, explain on reverse.)

Community ID: UPL
Transect ID: 1
Plot ID: N/A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Associate Plant Species	Stratum	Indicator
1. Cynodon dactylon 50%	HERB	FAC	9.		
2. Paspalum dilatatum 35%	HERB	FAC	10.		
3. Cyperus sp. 15%	HERB	FACW	11.		
4. Rumex sp. <1%	HERB	FACW	12.		
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7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

HYDROLOGY

- [x] Recorded Data (Describe in Remarks):
  - [ ] Stream, Lake, or Tide Gauge
  - [x] Aerial Photographs
  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Taxonomy (Subgroup): N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	N/A	none	none	none	gravel, rock (approx1-3")
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- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

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Date: 01/26/2005
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Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No
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Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100 %

Remarks: Hydrophytic vegetation dominant. Most Cyperus sp. are FACW or stronger. Plant identification indeterminate due to phenology. Cyperus sp. is likely Cyperus eragrostis based on habit, etc.. Applied indicator status of C. eragrostis.

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  - [ ] Other
- [ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

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Wetland Hydrology Indicators:

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- [ ] Sediment Deposits
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Secondary Indicators (2 or more required):
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- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
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Taxonomy (Subgroup): N/A

Profile Description:

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Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

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Date: 01/26/2005
County: Sacramento
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Do Normal Circumstances exist on the site? ○ Yes ○ No
Is the site significantly disturbed (Atypical Situation)? ○ Yes ○ No
Is the area a potential Problem Area? ○ Yes ○ No
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Community ID: UPL
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Plot ID: N/A

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Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil: N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

Remarks: No primary wetland hydrology indicators present. Fill material present. Aerial photo from 11/04.

SOILS

Map Unit Name
(Series and Phase): gravel/fill

Drainage Class: N/A

Field Observations
Confirm Mapped Type? ○ Yes ○ No

Taxonomy (Subgroup): N/A

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
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Hydric Soil Indicators:

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- ☐ Sulfidic Odor
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- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
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- ☐ Other (Explain in Remarks)

Remarks: Hydric soil indicators not present. Naturally developed soil is lacking. Field observations do not confirm mapped unit name. Area is underlain with gravel/rock associated with past land uses.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ○ Yes ○ No
Wetland Hydrology Present? ○ Yes ○ No
Hydric Soils Present? ○ Yes ○ No

Is this Sampling Point Within a Wetland? ○ Yes ○ No

Remarks: Does not meet the three criteria; upland (UPL).

DELINEATION OF WATERS OF THE UNITED STATES
SUPPLEMENTAL REPORT

Delineation of Waters of the United States

Supplemental Report

Regulatory #200500572

Greenbriar ±577-Acre Site and Associated Utility Alignments
Sacramento County, California

Prepared for: U.S. Army Corps of Engineers

Contracted By: AKT Development Corporation

February 27, 2006

Submitted by:

FOOTHILL ASSOCIATES

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1.0 INTRODUCTION

In response to the December 6, 2005 letter from the U.S. Army Corps of Engineers (Corps), this report provides supplemental information to the site's initial wetland delineation report, dated November 3, 2005, prepared by Foothill Associates. This report specifically addresses atypical situations versus normal circumstances on the site and includes three-parameter data gathered for the 36 Corps-requested data points along with updated three-parameter data for sample points 4A-10, which were initially evaluated as part of the site's original wetland delineation report. Additional data points were evaluated as warranted based on site conditions at the time of the field surveys, for example, to determine the wetland or upland status of uncertain areas. Based on the re-evaluation of the site, a revised wetland delineation map has been prepared and included in this report.

2.0 METHODOLOGY

2.1 Site-Specific References

Available information pertaining to the natural resources of the region was reviewed. All references reviewed for this delineation are listed in Section 4.0 of this report. Pertinent site-specific reports and general references utilized concurrent with the delineation include the following:

- Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual*. U.S. Army Corps of Engineers Waterways Experiment Station. Vicksburg, MS;
- GretagMacbeth. 2000. *Munsell Soil Color Charts*. New Windsor, NY;
- Hickman, James C. 1993. *The Jepson Manual: Higher Plants of California*. University of California Press, Berkeley, CA;
- Reed, P.B., Jr. 1988. *National List of Plant Species That Occur in Wetlands: California (Region O)*; U.S. Fish & Wildlife Service;
- USDA, NRCS (Natural Resource Conservation Service). 1993. *Soil Survey of Sacramento County, California*. USDA, NRCS, in cooperation with the Regents of the University of California (Agricultural Experiment Station); and
- USDA, NRCS. 2003. *Field Indicators of Hydric Soils in the United States*, Version 5.01. G.W. Hurt, P.M. Whited, and R.F. Pringle (Eds). USDA, NRCS in cooperation with the National Committee for Hydric Soils. Fort Worth, TX.

2.2 Field Methodology

The Corps 1987 three-parameter (vegetation, hydrology, and soils) methodology to delineate jurisdictional waters of the U.S was utilized during the field surveys. This methodology requires the collection of data on soils, vegetation, and hydrology at several locations to establish the jurisdictional boundary of wetlands. In addition, the site was re-evaluated according to atypical situation methodology according to the Corps' request.

Field surveys of the site were conducted by Foothill Associates on January 20 and 24, 2006; and February 13, 14, and 22, 2006. Each data point was evaluated to determine the composition and identification of dominant plant species. The indicator status of all dominant plant species (as determined by the U.S. Fish and Wildlife Service National List of Plant Species that Occur in Wetlands: 1988 California (Region 0)) was applied and evaluated as part of the vegetation assessment portion of the wetland determination process. The plant community within a five-foot radius surrounding each data point was evaluated to determine dominant vegetation. Given the herbaceous vegetation stratum within the fields and the fact that the surveys were conducted near the beginning of the growing season, not all of the vegetation on the site was readily identifiable. All dominant species within each data point were keyed out to the extent possible. The state of the vegetation growth did not bias the results of the delineation in terms of which areas were identified as wetlands. The results were consistent under both normal and atypical methodologies. Any inaccuracies did not affect the results of this wetland delineation.

A soil pit was dug to a depth of 16-20 inches and the soil profile was examined for wetness characteristics. Observations were made and recorded for both primary and secondary wetland hydrology indicators, if present. In addition to sampling at the locations requested by the Corps, routine determination data points were collected in other areas of the site. The location of each data point is depicted in **Figure 2** and corresponding routine wetland determination data forms are provided in **Appendix B**.

As part of the fieldwork, all previously mapped ditches were re-inspected to determine the surface hydrological connection, if any, between the ditches on the site and their jurisdictional status was re-evaluated accordingly. Representative ground-level photographs on the site are included in **Appendix A**.

2.3 GPS Data Integration

All data point locations and boundaries of wetlands and other waters of the U.S. within the site were surveyed and mapped with a Trimble GeoXT GPS (Global Positioning System) hand-held unit. This is a mapping-grade GPS unit capable of real-time differential correction and sub-meter accuracy. The GPS data were downloaded from the unit and differentially corrected utilizing Trimble Pathfinder Office software and appropriate base station data, and then converted to ESRI ® shape file format. Data were exported to the Geographic Information System (GIS) software in the State Plane coordinate system (NAD 83) with units as "survey feet." Within the GIS, data were edited and linear features were built into polygons using recorded width information. All wetland shape files were merged to create a single wetland file with calculated acreages. These results are presented in **Figure 2**.

3.0 RESULTS

3.1 Study Area Description, Land Use

3.1.1 Study Area Location

The ±577-acre site and associated utility alignments are located in northwestern Sacramento County, approximately two miles southeast of the Sacramento International Airport and two miles northeast of Sacramento River. The site is bound by Interstate 5 on the south, State Highways 70/99 on the east, and Elkhorn Boulevard on the north. The utility alignments include areas along the south edge of Elkhorn Boulevard, east to Natomas Boulevard and the east edge of the site, south along State Route 99. The site is bound on the west by rural residences and agricultural lands. The site is located within Townships 9 and 10 North, Range 4 East and occupies portions of sections 4 and 33 of the U.S.G.S. Taylor Monument 7.5' quadrangle map (**Figure 1**).

3.1.2 Existing and Historic Land Use

With the exception of a small area in the northern portion of the site, the entire site is currently cultivated with dry farmed wheat. A portion of the site was in rice cultivation until 2002. A horse race track and an irrigated polo field were present in the northern portion of the site from approximately 1980 to the early 2000s. For several years the horse ranch subleased the northwest corner of the property to a highway construction company, who stored equipment there. For at least the last 20 years, the remainder of the property outside the horse ranch area has been in agricultural use (rice, sugar beets, wheat).

3.1.3 Atypical Situation and Normal Circumstances

The site was evaluated as having normal circumstances because the vegetation conditions that were observed reasonably represent normal circumstances for the hydric soils and wetlands hydrology on the site. This is because the fields were seeded with wheat, an upland species, prior to the onset of the rainy season. Because wheat will not grow in wetlands as it cannot withstand wetland hydrology, the areas in which wheat has germinated and grown reflect non-wetland conditions. Since our observations were made during the normal wet period of the growing season, we were able to observe the vegetation before the planted community began to monopolize the site as we would expect to happen later during the year. We did observe a sorting of vegetation with wheat being either absent or not dominant from the areas that otherwise clearly had wetlands characteristics.

As requested by the Corps, we also evaluated the site as an atypical site. For the atypical evaluation, we were unable to determine what vegetation would have been present absent the agriculture use of the land (since that first took place over 60 years ago and appears to be relatively continuous since then), so we did a two-parameter delineation for the atypical evaluation. For each data point, the atypical evaluation results in the same wetland determination as the normal circumstances assessment revealed.

3.2 Vegetation

The vegetation assemblages and habitat types occurring on the site include agricultural cropland, depressional seasonal wetland, farmed wetland, and depressional seasonal marsh

3.2.1 Agricultural Cropland

As previously mentioned, nearly the entire site is currently cultivated with dry farmed, or non-irrigated, wheat. While wheat vastly dominates all other herbaceous vegetation on the site, other immature grasses were emerging within some of the data points. Since most of the non-wheat vegetation was observed prior to their flowering period and not readily identifiable, these species were keyed out to the extent possible. Aside from the wheat, the dominant herbaceous species observed within the data points are most likely annual bluegrass (*Poa annua*), Mediterranean barley (*Hordeum marinum*), ryegrass (*Lolium multiflorum*), and bur clover (*Medicago polymorpha*).

3.2.2 Seasonal Wetland

The depressional seasonal wetlands on the site support hydrophytic vegetation. Depressional seasonal wetlands are depressions within the topography that inundate or saturate for short periods of time following intense rains but do not maintain seasonal aquatic or saturated soils conditions for durations long enough for colonization by perennial, obligate plant species. As such, plant species in seasonal wetlands are generally of two types: species that can tolerate short periods of inundation but have not adapted to withstand sustained aquatic or saturated soils conditions, and short-lived (primarily annual) species that take advantage of ephemeral aquatic and/or saturated soils conditions. Plant species observed occurring within the seasonal wetlands on the site and in the associated utility alignments include Italian ryegrass, Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), vernal pool buttercup (*Ranunculus bonariensis* var. *trisepalus*) and nutsedge (*Cyperus esculentus*). The depressional seasonal wetlands are concentrated in the northern and central portions of the site.

3.2.3 Farmed Wetland

Farmed wetlands on the site are basically seasonal wetlands that occur within agricultural croplands. Since wheat, an upland species, is currently in cultivation on the Greenbriar site, the cropland areas that are functioning as wetland habitat support a predominance of the non-wheat, herbaceous species discussed above for the agricultural cropland community.

3.2.4 Seasonal Marsh

Cattail alliance occurs throughout the state of California in brackish, alkali or freshwater marshes from sea level to approximately 6,500 in elevation. Typically, cattail alliance occurs in intermittently or permanently flooded wetlands, such as perennial marshes. The diagnostic species of this vegetation alliance is cattail (*Typha latifolia*), which is a hydrophytic species. Associates vary widely depending on length of inundation/saturation during the year as well as seasonal temperatures and water chemistry. On the site, sand bar willow (*Salix exigua*) and smartweed (*Polygonum* sp.) are common associates of this alliance. This vegetation alliance also occurs within the depressional seasonal marsh located along the eastern site boundary.

3.3 Classification of Waters of the United States at the Greenbriar Site

Jurisdictional waters of the U.S. are classified into multiple types based on topography, edaphics (soils), vegetation and hydrologic regime. Primarily, the Corps establishes two distinctions: wetland and non-wetland waters of the U.S. Non-wetland waters are commonly referred to as other waters. Potential jurisdictional wetland types mapped within the site include depressional seasonal wetland, farmed wetland, and depressional seasonal marsh. Potential other waters of the U.S. delineated within the site include a portion of the networks of ditches and canals on-site. In addition, the ponds on the site were identified as excavated in uplands and interpreted as non-jurisdictional features. A description of all of the features delineated within the site is provided in the following sections.

3.3.1 Depressional Seasonal Wetland

A total of **0.18** acre of depressional seasonal wetland has been delineated on the site. Depressional seasonal wetlands are defined by a hydrologic regime characterized by saturation rather than inundation. Depressional seasonal wetlands were identified on the site as topographic depressions with a hydrologic regime characterized by saturation and capable of supporting hydrophytic plant species and hydric soils. Plant species in depressional seasonal wetlands are adapted to withstand short periods of saturation or saturated soils conditions but will not withstand prolonged periods of inundation, as is common in vernal pools. Depressional seasonal wetlands are located in the northern-central portion of the site and numbered 21-31 on **Figure 2**.

The depressional seasonal wetlands on the site support wetland soils, vegetation, and hydrology; however, they are isolated features and are exempt from Corps jurisdiction as they do not connect to waters of the United States.

3.3.2 Farmed Wetland

A total of **9.75** acres of farmed wetlands have been delineated on the site. Similar to depressional seasonal wetlands, farmed wetlands are defined by a hydrologic regime characterized by saturation rather than inundation and support wetland soils, vegetation, and hydrology. Farmed wetlands are located in the northern and western portions of the site and numbered 8-10 and 66-68 on **Figure 2**.

Wetlands 8-10 are adjacent to but hydrologically separated from Lone Tree Canal by a berm. These features have been identified in this delineation report as jurisdictional consistent with existing Corps policy and the decision of the Sixth Circuit of the United States Courts of Appeals in *Carabell v. United States*, 391 F.3d 704 (2004). The *Carabell* decision is now under review by the United States Supreme Court. The Supreme Court may reach a different conclusion regarding Corps jurisdiction over adjacent wetlands which may change the results of this delineation.

Wetland number 8 includes both wetland and upland characteristics. While the perimeter of the feature is relatively well defined, the interior portions contain small, irregularly shaped wetland and upland areas and are very difficult to map consistently. In order to determine the amount of wetland acreage encompassed within the feature, four east-west transects (perpendicular to existing cultivation furrows) were walked across the entire width of the feature. At every 25-foot interval along each transect, the determination of either upland or wetland characteristics (e.g., presence/absence of algal matting, wheat-dominated vegetation) were noted. Individual soil pits were not dug for any of the points within these transects. The percentage of all points that showed wetland characteristics was used to calculate the amount of wetland acreage within the mapped feature. Of the 33 points taken along the four transects, 14 showed wetland characteristics. Therefore, only 42 percent of Wetland 8 is a wetland.

Wetlands 66-68 are isolated and are exempt from Corps jurisdiction as they do not connect to waters of the United States.

3.3.3 Depressional Seasonal Marsh

A total of **1.65** acres of depressional seasonal marsh have been delineated on the site. Depressional seasonal marshes are wetlands that are seasonally inundated or saturated, but inundation/saturation persists through the majority of the warm season. The persistence of inundation/saturation into the warm season permits the growth of primarily perennial herbaceous plant species capable of withstanding extended periods of inundation or saturated soil conditions. In the Great Central Valley, these features are typically located on the fringes of naturally occurring or artificially created impoundments, such as ponds or reservoirs. These features may also be associated with slow-moving riverine systems where natural and/or artificial flows persist into the warm season. The depressional seasonal marshes occur in the northern and eastern portions of the site and are numbered 1 and 11-20 on **Figure 2**.

Marsh 1 was identified as a perennial wetland on the original wetland delineation map. This feature received year-round water from the equestrian facility when it was in operation. Given the lack of ponded water within this feature during our February 2006 field surveys and the fact that the equestrian facility is no longer in operation, this feature functions as a seasonal marsh and has been labeled on **Figure 2** accordingly.

3.3.4 Ditch/Canal

A total of **12.37** acres of ditch/canal have been delineated on the site. Non-tributary water conveyance features excavated in uplands and constructed for the transport and distribution of groundwater between agricultural fields are not jurisdictional features unless the Corps determines and claims jurisdiction on a case-by-case basis. Water conveyance features excavated in uplands and constructed for transport and distribution of surface water between agricultural fields may be jurisdictional features, specifically if they are tributary to known waters of the U.S. Under the Corps policies implementing Section 404 of the Clean Water Act, non-tidal agricultural ditches constructed in uplands for the purpose of draining and irrigating agricultural farmland are normally non-jurisdictional. Based on this long-standing policy, the majority of agricultural ditches on the Greenbriar site are non-jurisdictional.

As stated in the earlier wetland delineation submitted, the site is approximately two miles northeast of the Sacramento River in the vicinity of the former Bush Lake. Large-scale flood control projects in the 1930s and demand for agricultural production in the region resulted in construction of a complex system of canals and ditches constructed to maximize water conveyance and storage. This system drained the area well prior to enactment of the Clean Water Act. On-site, the natural hydrologic regime was altered to facilitate agricultural production prior to 1937.

Lone Tree Canal is physically connected to the Western Drainage canal via a series of culverts, and the Western Drainage Canal is tributary to the Sacramento River. The Final Natomas Habitat Conservation Plan (2003) identified and described the ditches and canals along the western, southern, and eastern site boundary as part of the water drainage system, and the ditches within the interior site boundary are identified as part of the water delivery system. This system of irrigation and drainage ditches fed and drained the site for agricultural purposes. Water pumped through the irrigation ditches from a lift station located approximately half a mile north of the site artificially irrigated the site until 2003 when water to the site was shut off.

The original flood control structures in the Natomas region were constructed in the 1910s. These structures significantly changed the areas hydrologic regime. Subsequently, the system of irrigation canals and drainage ditches were constructed by the end of the 1930s to supply water for agricultural production and to drain excess water from fields. All of this occurred well prior to the enactment of the Clean Water Act in 1972. According to Corps policy and relevant case law, these conditions constitute the baseline environmental conditions and must be taken into account when determining jurisdiction over sites in this region. By 1972, virtually all of the Greenbriar site existed as uplands.

The irrigation ditches and the drainage ditches constructed on the site were constructed for the purpose of agricultural production. Since at least the 1930s, much of the Greenbriar site has been devoted to rice production. Crops continue to be grown on-site to this day. Rice was farmed on the site until as recently as 2004. Wheat, an upland crop, was planted for the 2005 growing season and again for the 2006 growing season.

As artificial irrigation of the site is no longer needed to grow rice, water delivery to the site from the pump station to the north has ceased. The on-site irrigation ditches are now dry. The site's natural hydrology supports the growth of wheat on the site. The underlying purpose and the current condition of the on-site irrigation ditches indicate that Ditches 32, 34-35, 37-40, and 42-56 are not subject to Corps jurisdiction.

There are isolated irrigation ditches on the site. These ditches were man-made and constitute remnants of artificial conveyance facilities associated with agricultural practices on site. They are not functionally connected by natural flow to Lone Tree Canal, the West Drainage Canal or the Sacramento River. At no time has standing or flowing water been observed in these interior, remnant ditches that are classified as part of a water delivery system. The isolated irrigation ditches ought to be exempt from Corps jurisdiction as they do not connect to waters of the United States. These non-jurisdictional irrigation ditches include Ditches 33, 36, and 41. Similarly, other on-site or roadside ditches with no connection to waters of the United States, including Ditches 57-63 are non-jurisdictional.

Other drainage ditches on the site that connect with Lone Tree Canal merely collect excess surface water from the site. Lone Tree Canal and other on-site drainages that eventually connect to the Sacramento River by way of Lone Tree Canal would be jurisdictional if they became tidal or extended the ordinary high water mark (OHWM). We understand that the exemption does not apply to a drainage ditch that extends the OHWM of a tributary otherwise subject to regulation.

Lone Tree Canal (Ditches 3, 4, and 6) is likely a jurisdictional waters of the United States. This OHWM extends from Lone Tree Canal to other on-site drainage ditches with which it connects on site. These drainage ditches and any connecting irrigation ditches are jurisdictional to the extent of the OHWM or to the extent of adjacent wetlands. Ditches 5 and 7 connect with Lone Tree Canal and extend its OHWM. Ditch 7 extends the OHWM approximately 23 feet east from the culvert under I-5. Ditch 5 extends the OHWM approximately 11 feet east from its connection with Lone Tree Canal. Ditch 2 also extends the OHWM of Lone Tree Canal; however, because of its connection with Seasonal Marsh 1, it extends the Corps jurisdiction from Lone Tree Canal to the boundaries of the seasonal marsh.

Wetlands adjacent to jurisdictional waters of the United States extend the Corps' jurisdiction. However, the Corps lacks jurisdiction over on-site wetlands that are adjacent to exempt ditches. The jurisdictional ditches on the Greenbriar site include Lone Tree Canal (consisting of Feature 3, 4, and 6) and connecting drainage ditches 2, 5, and 7. Only wetlands adjacent to these features may be subject to Corps jurisdiction. Therefore, on-site wetlands that may be jurisdictional include Seasonal Marsh 1 and Farmed Wetlands 8-10. The remainder are non-jurisdictional based on their isolation from jurisdictional waters of the United States.

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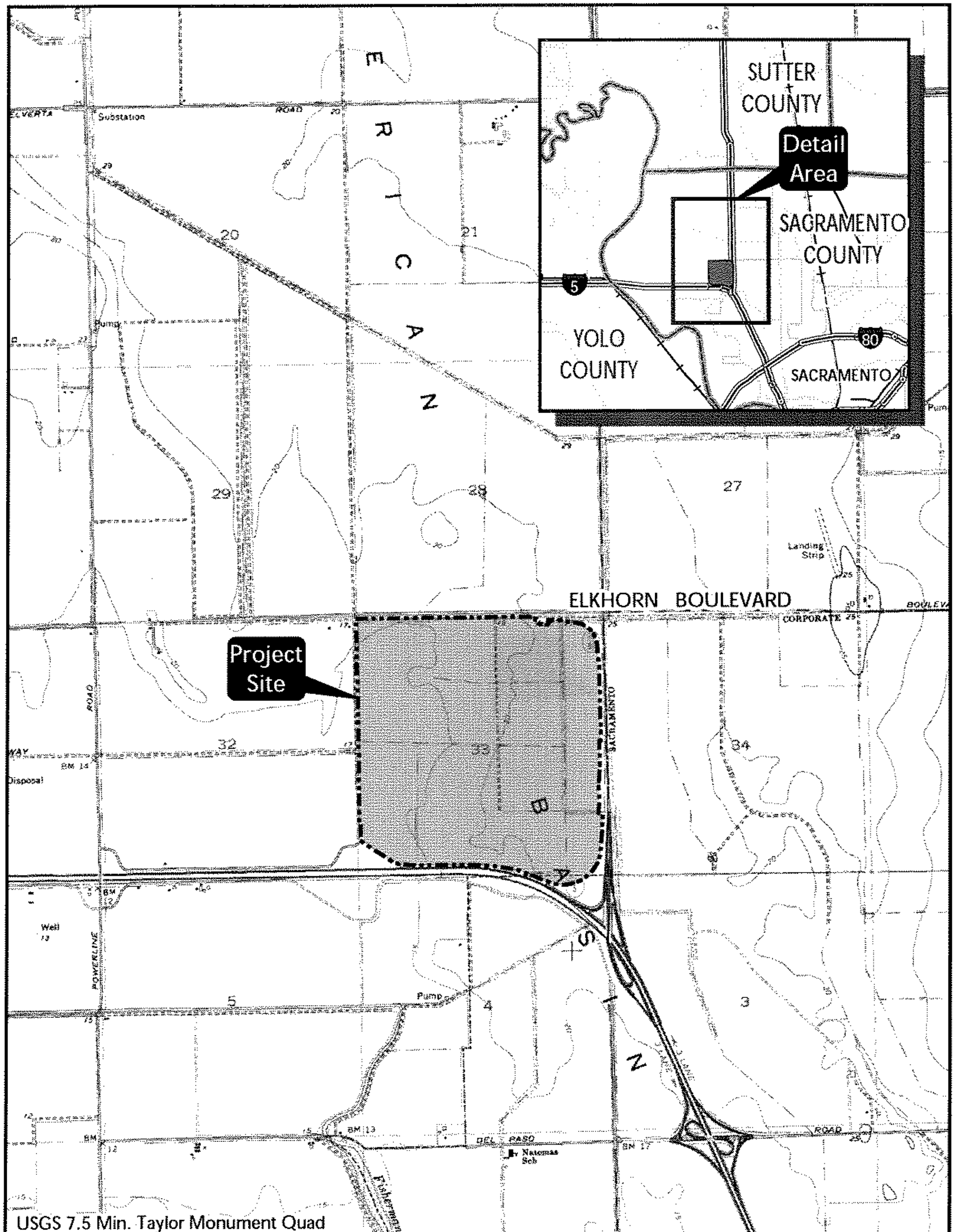
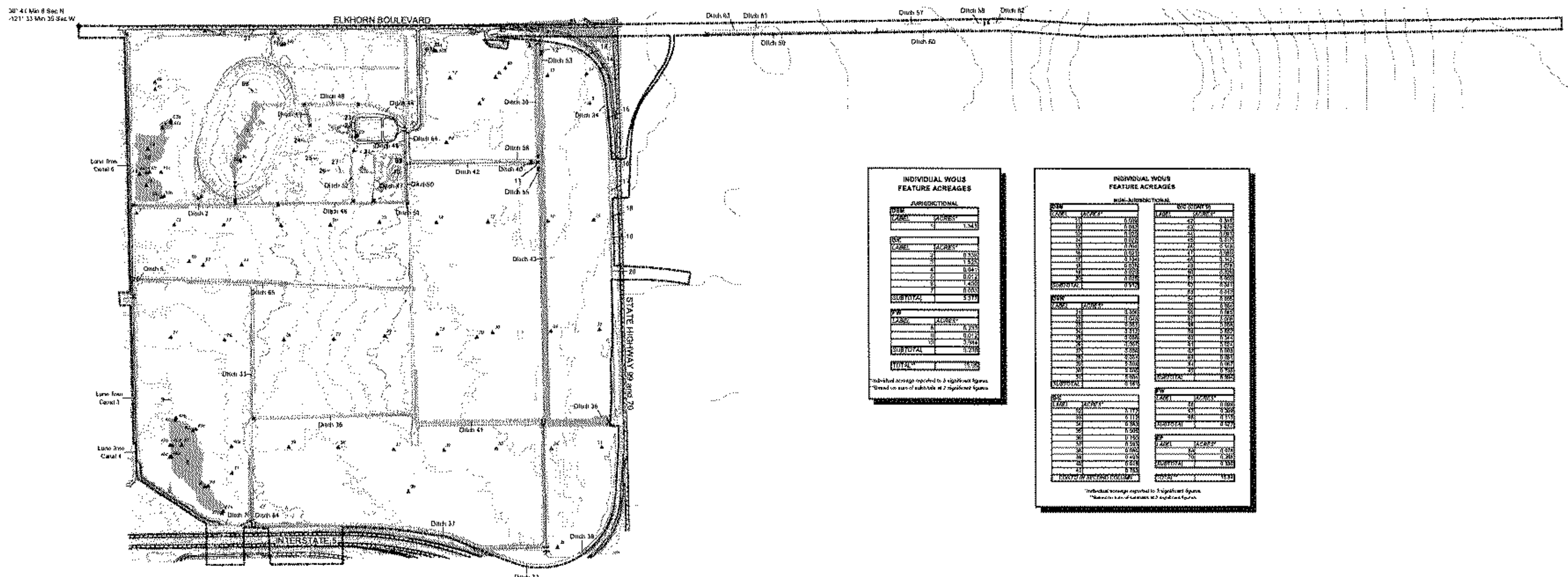


SITE AND VICINITY

FOOTHILL ASSOCIATES ENVIRONMENTAL CONSULTING • PLANNING LANDSCAPE ARCHITECTURE	N	0 1500 3000 SCALE IN FEET	Drawn By: AH Date: 12/01/04	FIGURE 1

NORTH NATOMAS 523

site_and_vicinity_v9.mxd



INDIVIDUAL WOUS FEATURE ACREAGES

JURISDICTIONAL

DBM	
LABEL	ACRES*
1	1.343

DC	
LABEL	ACRES*
2	0.32[illegible]
3	1.52[illegible]
4	0.041
5	0.012
6	1.450
7	0.003
SUBTOTAL	3.3[illegible]

FW	
LABEL	ACRES*
8	[illegible]
9	0.012
10	[illegible]
SUBTOTAL	[illegible]

TOTAL**	[illegible]

*Individual acreage reported to 3 significant figures.
**Based on sum of subtotals at 2 significant figures.

INDIVIDUAL WOUS FEATURE ACREAGES

NON-JURISDICTIONAL

SM	
LABEL	ACRES*
[illegible]	[illegible]
SUBTOTAL	[illegible]

SW	
LABEL	ACRES*
[illegible]	[illegible]
SUBTOTAL	[illegible]

DC	
LABEL	ACRES*
[illegible]	[illegible]
TOTALS OF SECOND COLUMN	[illegible]

DC (CONT'D)	
LABEL	ACRES*
[illegible]	[illegible]
SUBTOTAL	[illegible]

FW	
LABEL	ACRES*
[illegible]	[illegible]
SUBTOTAL	[illegible]

EP	
LABEL	ACRES*
[illegible]	[illegible]
SUBTOTAL	[illegible]

TOTAL**	[illegible]

*Individual acreage reported to 3 significant figures.
**Based on sum of subtotals at 2 significant figures.

JURISDICTIONAL WATERS OF THE U.S. CLASSIFICATION	ACREAGE	NON JURISDICTIONAL CLASSIFICATION	ACREAGE	TOTAL ACREAGE
DEPRESSIONAL WETLANDS				
Seasonal Marsh	1.34	Seasonal Marsh	0.31	1.65
Seasonal Wetland	N/A	Seasonal Wetland	0.18	0.18
OTHER WATERS OF THE U.S.				
Ditch/Canal	3.38	Ditch/Canal	8.98	12.37
Farmed Wetland	9.23	Farmed Wetland	0.52	9.76
Excavated Pond	N/A	Excavated Pond	0.34	0.34
TOTAL	13.95	TOTAL	10.34	24.29

OTHER FEATURES

- Data Points
- Direction of underground flow
- Culvert
- Off-Site Ditch/Canal
- Site Boundary

NOTES

- Wetland delineation subject to U.S. Army Corps of Engineers verification
- Digital base data provided by Wood Rodgers. Contour Interval is 1 foot of less
- Exhibit contours generated from SIMDEM, interval is 1 foot
- The Hydrologic Unit Code for this site is 18020109
- Wetlands and other waters of the U.S. were mapped using a Trimble GPS Global Positioning System

0 400 800
SCALE IN FEET

FIGURE 2

GREENBRIAR

WETLAND DELINEATION

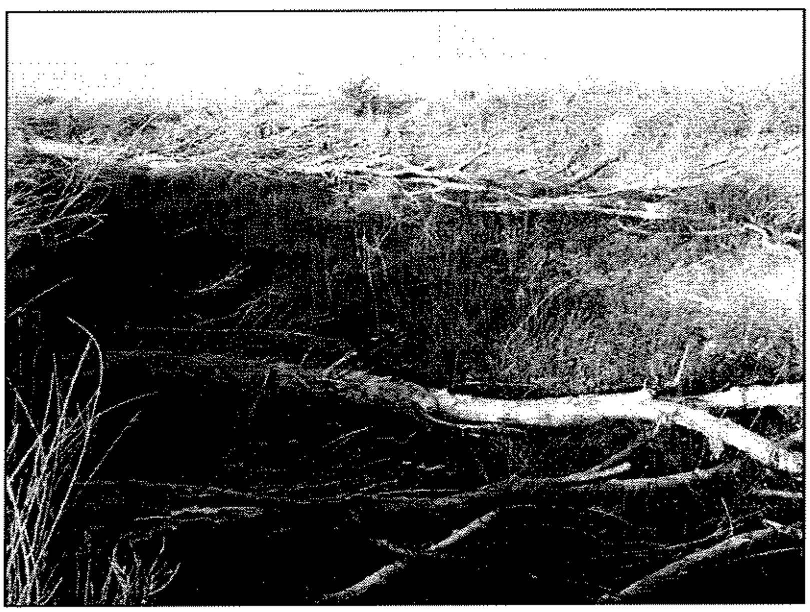
FOOTHILL ASSOCIATES
ENVIRONMENTAL CONSULTING • PLANNING • LANDSCAPE ARCHITECTURE
© 2005

DATE	04/2005	FILE NAME	wetland_delineation_ [illegible]
REVISION	[illegible]	DRAWN BY	[illegible]
		DELINEATED BY	[illegible]

FINAL SUBMITTED

Appendix A — Ground-Level Photographs

Greenbriar
Seasonal Marsh #1 — Northern Portion
Photo Date: February 22, 2006



Greenbriar
Seasonal Marsh #1 — Central Portion
Photo Date: February 22, 2006

GROUND-LEVEL PHOTOGRAPHS

FOOTHILL ASSOCIATES ENVIRONMENTAL CONSULTING • PLANNING • LANDSCAPE ARCHITECTURE	PAGE 1 OF 10	Appendix A

Greenbriar
Seasonal Marsh #1 — Southern Portion
Photo Date: February 22, 2006

Greenbriar
Seasonal Marsh #1 — Southern End
Photo Date: February 22, 2006

GROUND-LEVEL PHOTOGRAPHS

FOOTHILL ASSOCIATES ENVIRONMENTAL CONSULTING • PLANNING • LANDSCAPE ARCHITECTURE	PAGE 2 OF 10	Appendix A

APPENDIX P

ANALYSIS OF EFFECTS ON THE NATOMAS BASIN HABITAT CONSERVATION PLAN REPORT

Greenbriar Development Project
Sacramento, California

Analysis of Effects on the Natomas Basin Habitat Conservation Plan Report

Prepared for:

City of Sacramento
Environmental Planning Services

July 19, 2006

EDAW

Greenbriar Development Project
Sacramento, California

Analysis of Effects on the Natomas Basin Habitat Conservation Plan Report

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July 19, 2006

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This Analysis of Effects on the Natomas Basin Habitat Conservation Plan Report (effects analysis) (EDAW 2006) is an evaluation of the effects on each species covered by the Natomas Basin Habitat Conservation Plan (NBHCP), on the conservation strategy of the NBHCP, on specific conservation measures, and consequently on attainment of the NBHCP's goals and objectives as a result of implementing the proposed Greenbriar project. The U.S. Fish & Wildlife Service (Service) and the California Department of Fish & Game (Department) approved the NBHCP in the summer of 2003. The NBHCP establishes the overall conservation program for the development of a 17,500 acre-portion of the Natomas Basin. The Greenbriar site is located within the boundaries of the NBHCP plan area, but is not within an area permitted for development. This Effects Analysis is being released for public review in conjunction with the *Greenbriar Development Project Sacramento, California: Draft Environmental Impact Report* (DEIR) (EDAW 2006) because the EIR contains an evaluation of the Greenbriar project's effects on biological resources for purposes of CEQA review, as well as the evaluation of the project's effects on the NBHCP.

The Effects Analysis is organized in the following way:

- Section 1, Introduction
- Section 2, Evaluation Approach
- Section 3, Greenbriar Project's Alteration of Population and Habitat Attributes
- Section 4, Potential Effects of the Greenbriar Project on Covered Species
- Section 5, Potential Effects on the Conservation Strategy of the NBHCP
- Section 6, Potential Effects of the Greenbriar Project on NBHCP Goals and Objectives
- Section 7, Cumulative Effects
- Appendix A, Consistency of Greenbriar Project and NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts
- Appendix B, Change in Natomas Basin Land Cover in 2001–2004

ES.2 OVERVIEW OF GREENBRIAR PROJECT

As currently proposed, the Greenbriar project would:

- Develop 546 acres at the Greenbriar site;
- Avoid and preserve an on-site corridor (of 31 acres) along Lone Tree Canal;
- Create or enhance, preserve, and manage in perpetuity two proposed off-site reserves — the Natomas 130 and Spangler properties (with a combined acreage of 266 acres).

As designed, the proposed project includes a package of measures to avoid, minimize, and mitigate impacts from the proposed development. In addition, the City of Sacramento, through the CEQA process, has proposed mitigation measures to reduce further the adverse effects of the proposed project. (Throughout this Effects

Analysis, "mitigation" refers to the measures proposed by the City of Sacramento in the Draft EIR for the Greenbriar project [City of Sacramento July 2006].) With the DEIR mitigation, the project's avoidance, minimization, and mitigation measures include:

- Avoidance of a 31 acre (250-foot wide) corridor along Lone Tree Canal;
- Measures to reduce or offset effects on the Lone Tree Canal corridor including barriers/fencing, creation of marsh habitat along the canal corridor, design of canal crossings to minimize obstacles to giant garter snake movement, and an assurance that aquatic habitat would be maintained in this section of the canal;
- Funding to manage the Lone Tree Canal corridor in perpetuity;
- Measures to avoid and minimize construction-related effects on covered species; and
- Creation or enhancement, preservation, and management in perpetuity of 315 acres of high quality habitat in addition to the corridor conserved along Lone Tree Canal.

ES.3 SUMMARY OF FINDINGS

To evaluate the proposed project's effects on the effectiveness of the NBHCP, this effects analysis performed an extensive analysis of the project's potential effects on the future condition of the Natomas Basin. This analysis used the 2001 land cover data that represents baseline conditions of the NBHCP, and also considered 2001–2004 changes in land cover, and 2005 conditions. Interpretations of the project's effects on the NBHCP were based on the sum of anticipated effects on the viability of populations of covered species using the Natomas Basin, on the effectiveness of the NBHCP's conservation strategy, and on attainment of the goals and objectives of the NBHCP.

Although the proposed project would cause a variety of adverse and beneficial effects, overall, the proposed project (with the DEIR mitigation) would not reduce the viability of covered species, the efficacy of the NBHCP conservation strategy, or adversely affect attainment of the NBHCP goals and objectives. In part, it would have this outcome because its conservation strategy includes a substantial investment in the creation, enhancement, and management in perpetuity of high quality habitat on the preserved land, and in the avoidance, minimization, and mitigation of effects on the Lone Tree Canal corridor. For most covered species, the increased habitat values on preserved lands offset the habitat values lost as a result of development at the Greenbriar site, and thus prevent a net loss in resources in the Natomas Basin for these species. The conservation of the Lone Tree Canal corridor, while costly and resulting in a small reserve that will be costly to manage, is essential for maintaining connectivity of aquatic habitat and movement of giant garter snakes between the southern and central Natomas Basin; without this connectivity, the effectiveness of the NBHCP's conservation strategy would be reduced.

The project's adverse and beneficial effects on the viability of populations of covered species using the Natomas Basin, on the effectiveness of the NBHCP's conservation strategy, and on attainment of the goals and objectives of the NBHCP are summarized in the following sections of text.

ES 3.1 Effect On Population Viability of Covered Species

The Greenbriar project would not affect five of the 15 animal species covered by the NBHCP: California tiger salamander, western spadefoot toad, vernal pool fairy shrimp, vernal pool tadpole shrimp, and midvalley fairy shrimp. None of these vernal pool-associated species are known from the vicinity of the Greenbriar or proposed reserve sites, nor does suitable habitat occur in the vicinity of these sites.

The project is also unlikely to affect valley elderberry longhorn beetle (VELB) because VELB is not known from the vicinity of the Greenbriar or proposed reserve sites, and riparian habitat that might contain elderberry bushes is only present at and in the vicinity of the proposed Natomas 130 reserve; also, in the future, riparian habitat may recover and persist in the proposed reserve along Lone Tree Canal; preservation of these sites was considered unlikely to benefit VELB.

The Greenbriar project would cause a variety of beneficial and adverse effects on populations of nine species covered by the NBHCP. For these species, the overall effect on population viability is summarized below.

Three of these species are birds that do not nest in the Natomas Basin but forage in the Basin in winter or during migration: Aleutian Canada goose, white-faced ibis, and bank swallow. Based on 2001 land cover, the Greenbriar project (with the DEIR mitigation) would decrease the acreage of foraging habitat available for these species in the Natomas Basin by 1–3% and would preserve and enhance 0–2% of the foraging habitat in the Basin. Because the size of these populations is not limited by the availability of foraging habitat in winter, or during migration, and the Greenbriar project would not substantially alter the availability of such foraging habitat, the project's effect on foraging habitat would be unlikely to alter the viability of these populations. The project would also increase the acreage of nesting habitat for white-faced ibis, and this could increase the likelihood of white-faced ibis establishing a nesting colony in the Natomas Basin; while not discounted, this effect was not considered likely.

The Greenbriar project would cause both adverse and beneficial effects on burrowing owl and loggerhead shrike populations in the Natomas Basin, but effects due to the project would be insufficient to alter the viability of these populations. Based on 2001 land cover, the project would preserve approximately 345 and 141 acres of shrike and owl habitat, respectively, and this beneficial effect would at least partially offset the project's adverse effects on these species. Adverse effects would include a net loss of 141 acres of habitat for the shrike, and for both species a loss of occupied habitat, habitat fragmentation, and probably some increased mortality and habitat degradation adjacent to the Greenbriar site. However, the project's effects would be small relative to the quantity of habitat that would remain in the Natomas Basin (for example, the project would eliminate 1% of shrike habitat), and the Natomas Basin represents only a small portion of the habitat for and population of these species in the Central Valley; thus, the project is unlikely to measurably alter the viability of the loggerhead shrike and burrowing owl populations using the Natomas Basin.

The project (with the DEIR mitigation) could cause a small adverse or beneficial effect on tricolored blackbird use of the Natomas Basin, but in either case this effect is unlikely to alter the viability of the tricolored blackbird population using the Natomas Basin. Based on 2001 land cover, the Greenbriar project would increase the quantity of nesting habitat in the Natomas Basin (by 201 acres or about 9%), but would decrease the quantity of foraging habitat (by 598 acres or about 3%). This loss of foraging habitat would be partially (but not fully) offset by the preservation and enhancement of 135 acres of foraging habitat. Although currently, nesting habitat is more limited than foraging habitat in the Natomas Basin, under the future condition much more nesting habitat will exist, and thus the additional nesting habitat that would be provided by the project may not affect the tricolored blackbird population more than the loss of foraging habitat that would also result. However, because the project would only cause a small beneficial or adverse effect on tricolored blackbird use of the Natomas Basin, and because the Natomas Basin accounts for only a small portion of the habitat for and population of tricolored blackbird in the Central Valley, the Greenbriar project is unlikely to alter the viability of the tricolored blackbird population using the Natomas Basin.

The project with the mitigation proposed in the DEIR would result in both adverse and beneficial effects on the Swainson's hawk population nesting and foraging in the Natomas Basin, but these effects would be insufficient to alter the population's viability. Adverse effects would include a reduction in the total acreage of foraging habitat under the future condition (by 222 acres or 2%), fragmentation, and possibly degradation of habitat near the Greenbriar site, and a reduction in habitat available to hawks nesting at reserves near the Greenbriar site. Beneficial effects would include an overall increase in the acreage of high quality habitat, enhancing and preserving habitat within a mile of TNBC reserves, and possibly contributing to the connectivity of foraging habitat adjacent to proposed reserves and the mitigation site required by mitigation measure 6.13-2 of the DEIR.

Overall, the project would have a neutral effect. This interpretation is based on the USFWS interpretation of effects on Swainson's hawk due to the NBHCP (USFWS 2003). The availability of foraging habitat during April–August (the nesting period) is considered to limit the abundance and reproductive success of Swainson's hawk in the Natomas Basin (CH2M HILL 2003, USFWS 2003). Based on the methods used by CH2M HILL (2003) to evaluate availability of foraging habitat, the enhancement of habitat at the proposed reserves and mitigation sites would increase the availability of foraging habitat during these months. Using an alternative analysis developed by EDAW, this effects analysis estimated that during April–June the increase in foraging habitat values at the proposed reserve and mitigation sites would be about 6% greater than the habitat values lost by development at the Greenbriar site; during July–August, foraging values would not be fully offset, but foraging habitat values would be higher within the Natomas Basin as a whole at this time because of the harvesting of crops. Thus, based on these analyses, the project would not be expected to reduce the number of hawks nesting in the Natomas Basin or their reproductive success.

The project would cause both adverse and beneficial effects on the populations of giant garter snake and northwestern pond turtle that use canals, wetlands, and rice in the Natomas Basin; overall, the project would not adversely affect these populations. Beneficial effects would include preserving, creating, and enhancing habitat at the reserve sites, preserving and enhancing a 250-foot wide corridor along a portion of Lone Tree Canal, and contributing to the connectivity of habitat and existing TNBC reserves adjacent to or near the proposed reserves. Adverse effects would include a reduction in the total acreage of habitat by 204 acres, and possibly degradation of habitat near the Greenbriar site and reduced connectivity along Lone Tree Canal as a result of increased human disturbance and predation (which would result from narrowing the corridor of land along Lone Tree Canal, and placing residential development adjacent to it). The DEIR mitigation would reduce these adverse effects and ensure that connectivity of giant garter snake habitat was conserved along Lone Tree Canal at the Greenbriar site. For example, to minimize risks to connectivity due to human disturbance and predation, the DEIR mitigation includes requirements for fencing and barriers, and the creation of habitat along the canal.

The loss of habitat acreage would be offset by the increased habitat quality resulting from the preservation of habitat, and conversion of rice to marsh. The project (with the DEIR mitigation) also would conserve connectivity and habitat for giant garter snake along the affected section of Lone Tree Canal, which is an important waterway connecting the southern and central Natomas Basin, and proposed reserves would contribute to connectivity of habitats and reserves in the southern and central Basin.

Of the seven plant species covered by the NBHCP, the Greenbriar project would not affect the five vernal pool-associated species because these species are not known to occur in the vicinity of the Greenbriar or proposed reserve sites, nor is suitable habitat present at or near these sites. These plant species are: Boggs Lake hedge-hyssop, Sacramento Orcutt grass, slender Orcutt grass, Colusa grass and legenere. The other two covered plant species (delta tule pea and Sanford's arrowhead) are not known to occur at the Greenbriar or the proposed reserve sites, but suitable habitat for these species does occur at or near some of these sites, which have not been surveyed for these species. Overall, the project would increase the acreage of suitable habitat for these species (i.e., marsh and canal habitats) in the Natomas Basin. Nonetheless, because these species are not known to occur in the Natomas Basin, the project probably would not alter the viability of any of their populations.

ES 3.2 EFFECTS ON THE CONSERVATION STRATEGY OF THE NBHCP

The Greenbriar project (with the *DEIR* mitigation) would not reduce the effectiveness of the NBHCP's conservation strategy. In Section IV.C.1 (pages IV 5-15), the NBHCP describes the basis of the key components of the NBHCP's conservation strategy and how these components provide effective mitigation for 17,500 acres of urban development. These components are:

- basis for 0.5 to 1 mitigation ratio (Section IV.C.1.a),
- preparation of site specific management plans (Section IV.C.1.b),
- buffers within the reserve lands (Section IV.C.1.c),

- connectivity (Section IV.C.1.d),
- foraging habitat (Section IV.C.1.e), and
- 2,500-acre/400-acre minimum habitat block size requirements (Section IV.C.1.f).

In describing the basis for the 0.5:1 mitigation ratio, the NBHCP states that the ratio mitigates the impacts of the incidental take authorized under the NBHCP because much of the land to be developed does not provide habitat or provides only marginal habitat, and because the TNBC-managed reserves will provide habitat of higher quality than the eliminated habitat. Because the Greenbriar project would not alter the habitat value of land authorized for development under the NBHCP, and would not adversely affect the habitat value of TNBC reserves established under the NBHCP, the project would not affect the basis for the 0.5:1 mitigation ratio of the NBHCP. Although the project would result in the conversion of agricultural land and open space to urban development on an additional 546 acres of land in addition to the 17,500 acres of permitted development under the NBHCP, with the proposed mitigation, this conversion to urban development would result in a minimal change to the conditions in which the NBHCP conversation strategy is being implemented.

The Greenbriar site is not adjacent to existing TNBC reserves, and thus would not alter the effectiveness of the buffers within these reserve lands. Also, because under the future condition of the Natomas Basin resulting from the NBHCP, the Greenbriar site would already be bordered by urban development, highways or major roads on all sides, development of the Greenbriar site could cause only very limited effects on the effectiveness of buffers within future reserves, even if reserves were established on adjacent land to the north or southwest (i.e., adjacent land that would not be developed under the future condition of the Natomas Basin).

The development and reserves resulting from the Greenbriar project would, however, need to be considered in the development of site-specific management plans for existing and future reserves in their vicinity. Although the loss of raptor habitat at the Greenbriar site would be mitigated, there would still be less foraging habitat in the vicinity of some sites as a result of the project, which could alter site-specific plans. Also, the proposed reserves would provide additional options for management and future acquisitions that could alter the management plans of nearby TNBC reserves.

Overall, the project with the DEIR mitigations would not reduce connectivity of reserves or habitats within the Natomas Basin. The proposed reserve and mitigation sites would probably improve connectivity of habitats and TNBC reserves, and potential adverse effects on Lone Tree Canal would be minimized by measures included in the project design and additional mitigation measures in the DEIR. A comprehensive set of measures would be implemented to both reduce the project's effects on and to enhance the habitat in a 250-foot wide corridor along the Lone Tree Canal, which would provide garter snake habitat connectivity. These measures would prevent the project from reducing the connectivity of canal habitats and TNBC reserves, and also would prevent the project from subdividing the Basin's giant garter snake population into two smaller, and thus less viable, populations.

With the DEIR mitigation, the project would not reduce the availability of foraging resources for the Swainson's hawk in the Natomas Basin, and thus not affect reproduction or survival. Based on 2001 land cover, the Greenbriar project, however, would result in a net reduction of 253 acres of upland land cover providing habitat for covered species, it would enhance or create, and preserve, at least 135 acres of upland land cover types (plus 60 acres of upland components of created marshes). As a result, the upland habitats that would result from the project would provide foraging resources during the months of April–August (when Swainson's hawks are nesting in the Basin) comparable to the habitats that would be eliminated by the project. Based on the method CH2M HILL (2003) used to analyze effects of the NBHCP, the acreage of available foraging habitat would be increased by the project; based on the additional analysis conducted by EDAW for this effects analysis, the increase of habitat values resulting from enhancement would be greater than values lost at the Greenbriar site during April–June but not during July–August. Although the loss of values would not be fully offset during July–August, foraging resources increase in the Natomas Basin during those months from the harvesting crops, and therefore, Swainson's hawk is unlikely to be affected. (Both the mitigation and eliminated habitat would be within a mile of nesting habitat that is currently occupied.) By maintaining foraging resources during the critical April–

June period, the Greenbriar project would not compromise the NBHCP Operating Conservation Program, and thus actions such as those listed on pages IV-13 and IV-14 of the NBHCP would not be necessary.

Overall, the project would avoid, minimize and mitigate adverse effects of development by establishing large blocks of preserved habitat. It would enhance and preserve 296 acres of additional habitat adjacent to or near existing TNBC reserves and the *DEIR* mitigation would increase this benefit by requiring the preservation of at least an additional 49 acres of land. The project would adversely affect the preservation of large blocks of habitat by developing existing habitat at the Greenbriar site. Under the future condition of the Natomas Basin, this land would be surrounded by major roads and urban development, and the Greenbriar project includes design measures to preserve the most ecologically important portion of the site, the corridor of land along Lone Tree Canal.

ES 3.3 EFFECTS ON ATTAINMENT OF NBHCP GOALS AND OBJECTIVES

For many of the same reasons that viability of populations and the effectiveness of the NBHCP's conservation strategy would not be reduced, the Greenbriar project would not reduce the likelihood of attaining the goals and objectives of the NBHCP. Below, the overall effect resulting from the project (with the *DEIR* mitigations) is summarized for each goal or objective that could be affected.

Overall Goal 1. *Establish and manage in perpetuity a biologically sound and interconnected habitat reserve system that mitigates impacts on Covered Species resulting from Covered Activities and provides habitat for existing, and new viable populations of Covered Species. (NBHCP, p. I-15)*

The project (with its mitigation) would have an overall beneficial effect on the establishment and management of reserves for the NBHCP. Because the acreage of land in the Natomas Basin that is potentially available and suitable for preservation substantially exceeds the 8,750 acres that will be preserved by the NBHCP, the project would not preclude the preservation of sufficient land to attain the NBHCP's goals and objectives. It would provide reserve lands adjacent to or near existing reserves, increasing the connectivity of habitats and the resources available to covered species using reserves established by the NBHCP; in addition, it would conserve a portion of an important corridor of canal habitat along Lone Tree Canal. The project also would increase opportunities to establish new reserves, particularly to create larger reserves by preserving additional land adjacent to the project's proposed and existing TNBC reserves.

Although the project would cause a net reduction in the acreage of upland and wetland habitats, the preservation and enhancement of habitat by the project would adequately mitigate for its effects on upland and wetland habitats of covered species. Based on 2001 land cover mapping, the Greenbriar project would eliminate 388 acres of rice and 16 acres of canal habitats, but would increase the acreage of marsh by 201 acres, creating a net loss of 204 acres of these wetland land cover types and of the habitats they provide. An acre of marsh, however, provides a greater quantity and variety of habitat than does an acre of rice for several reasons. These reasons include:

- Giant garter snakes primarily use the margins of rice fields, whereas they use the full extent of managed marshes. These marshes are designed to provide open water, foraging habitat, dense cover, basking sites, and refugia in close proximity throughout the marsh. (For example, an acre of managed marsh provides several times the edge habitat than does a rice field.)

- Marshes provide habitat throughout the active period of the snake. Rice fields do not provide habitat during early and mid-spring, and are typically drained before the end of the snake's active period. Thus, for a portion of their active period, giant garter snakes must rely entirely on non-rice habitats. In the Natomas Basin, these habitats are canals and managed marsh. In contrast, managed marshes provide habitat year-round.

- Rice is fallowed periodically, and thus does not provide habitat in all years; in contrast, a managed marsh does provide habitat in all years.

Thus, the additional habitat values provided by the created marsh offsets the habitat values lost in the rice and canal land cover types. In addition, the project would preserve, and manage for its habitat values, the 201 acres of created marsh (i.e., about 1 acre for each acre lost), ensuring the long-term persistence of this habitat. Similarly, based on 2001 land cover, the Greenbriar project would cause a net reduction of 253 acres of upland land cover providing habitat for covered species, but would enhance and preserve 135 acres of upland habitats (plus 60 acres of upland components in created marshes for a total of 195 acres of upland habitat preserved). For most covered species associated with upland habitats, the additional habitat values resulting from this enhancement and preservation would offset the project's reduction of the acreage of upland habitats in the Natomas Basin. For example, during the months of April–August, when Swainson's hawks are nesting in the Basin, the enhancement of upland habitats that would result from the project would provide foraging resources comparable to the habitats that would be eliminated by the project.

As previously described, the potential effects (both adverse and beneficial) that would result from implementing the proposed project (including the DEIR mitigation) would be unlikely to alter the population viability of any of the covered species.

Overall Goal 3. *Preserve open space and habitat that may also benefit local, non-listed and transitory wildlife species not identified within the NBHCP. (NBHCP, page I-16)*

As described under Overall Goal 1 above, the project would have an overall beneficial effect on the TNBC reserve system. Furthermore, the project (with DEIR mitigation) would slightly increase the ratio of habitat preserved to habitat developed in the Natomas Basin by setting aside land at a ratio (0.6:1) that exceeds the 0.5:1 ratio required for development authorized by the NBHCP, and would include more extensive creation, enhancement, and management of habitat. For these reasons, the project (with the DEIR mitigation) would have an overall beneficial effect on the attainment of this goal.

Overall Goal 4. *Ensure that direct impacts of Authorized Development upon Covered Species are avoided or minimized to the maximum extent practicable. (NBHCP, page I-16)*

With the DEIR mitigation, the project would not adversely affect attainment of this goal because it would implement a comprehensive set of measures to avoid and minimize effects on covered species to the maximum extent practicable. The potential direct impacts are comparable to the potential direct impacts of the development authorized by the NBHCP. Thus, the Greenbriar project with the DEIR mitigation would include all of the applicable avoidance and minimization measures included in the NBHCP to avoid and minimize construction-related effects, and several more stringent minimization measures. The project also would include a set of measures to avoid and minimize effects on the Lone Tree Canal corridor. The Greenbriar project also would not alter the effectiveness of any NBHCP conservation measures for avoiding and minimizing the effects of development authorized by the NBHCP.

Overall Objective 1. *Minimize conflicts between wildlife and human activities, including conflicts resulting from airplane traffic, roads and automobile traffic, predation by domestic pets, and harassment by people. (NBHCP, page I-16).*

With the DEIR mitigation, the project would not adversely affect attainment of this objective because it would implement a comprehensive set of measures that would minimize human-wildlife conflicts. These measures include all of the applicable measures that were included in the NBHCP to avoid and minimize construction-related effects and to reduce human-wildlife conflicts, plus additional measures (e.g., fencing and barriers) to reduce human-wildlife conflicts along Lone Tree Canal. The Greenbriar project also would not alter the effectiveness of any NBHCP conservation measures for minimizing human-wildlife conflicts resulting from development authorized by the NBHCP.

Overall Objective 3. *Ensure connectivity between TNBC reserves to minimize habitat fragmentation and species isolation. Connections between reserves will generally take the form of common property boundaries between* *reserves, waterways (primarily irrigation and drainage channels) passing between reserves, and/or an interlinking network of water supply channels or canals. (NBHCP, page I-16)*

The Greenbriar project would cause beneficial and adverse effects on the attainment of this objective through most of these mechanisms; its overall effect, however, would not be adverse. The main beneficial effects would be increased connectivity of habitats and TNBC reserves due to preservation, creation and enhancement of habitat at the project's proposed reserves, two of which are adjacent to or near (i.e., within a half mile of) existing TNBC reserves. Adverse effects would include reducing the foraging habitat within a mile of a TNBC reserve, fragmenting and reducing the connectivity of upland habitats adjacent to the Greenbriar site, and possibly reducing the connectivity of wetland habitats and TNBC reserves because of effects on Lone Tree Canal (despite preserving a corridor along the canal). The DEIR mitigation would reduce these adverse effects by incorporating additional measures to ensure that connectivity along Lone Tree Canal is sustained, and to preserve and enhance foraging habitat within a mile of existing TNBC reserve(s). (The connectivity of upland habitats, however, would still be reduced at the Greenbriar site.) In the absence of an adverse effect on connectivity along Lone Tree Canal, the project would cause only small effects on the attainment of this objective, and most of these effects would be beneficial.

Wetland Species/Habitat Goal/Objective 1. *Acquire, enhance and create a mosaic of wetland habitats with adjacent uplands and connecting corridors to provide breeding, wintering, foraging, and cover areas for wetland species in the Plan Area. (NBHCP, page I-17)*

For wetland land cover (i.e., rice, canal, and ponds and seasonally wet areas), the net reduction in acreage resulting from the development of the Greenbriar site would be offset by creating and managing marsh at the project's proposed reserves. Based on 2001 land cover mapping, the Greenbriar project would eliminate 388 acres of rice and 16 acres of canal habitats, but would increase the acreage of marsh by 201 acres, creating a net loss of 204 acres of these wetland land cover types and of the habitats they provide. An acre of marsh, however, provides a greater quantity and variety of habitat values than does an acre of rice, and thus the additional habitat provided by the created marsh offsets the habitat lost in the rice and canal land cover types. In addition, the project would preserve, and manage for its habitat values, the 201 acres of created marsh (i.e., about 1 acre for each acre lost), ensuring the long-term persistence of this habitat.

The project would not have an overall adverse effect, and might have a beneficial effect on, connectivity of wetland habitats. This overall effect on connectivity of wetland habitats is described under Overall Objective 1 above.

Wetland Species/Habitat Goal/Objective 2. *Provide habitat to maintain, attract and sustain viable populations of the Covered Species. The habitat areas should be configured to encompass natural species migration areas, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)*

The project would enhance and preserve habitat to offset its adverse effects and that would sustain populations of the covered species, and would not alter the population viability of any of the covered species. The habitat enhanced and preserved by the project and the project's effects on the TNBC reserve system are described under Overall Goal 1 above. The project's effect on the viability of each covered species is described under *Effects on Covered Species* above.

Upland Species/Habitat Goal/Objective 1. *Acquire, enhance and create a mosaic of upland habitat types for breeding, foraging, and cover for species dependent on upland habitats. (NBHCP, page I-17)*

Overall, the project would not adversely and could beneficially affect this goal/objective. Because the acreage of upland habitat in the Natomas Basin that is potentially available and suitable for preservation is substantially more than the acreage of upland habitat that would be preserved and enhanced by the NBHCP, and the project would affect only a small percentage of this land, the project would not preclude the preservation of sufficient land to attain the NBHCP's goals and objectives. The project would, however, increase opportunities to establish new and/or larger reserves, which would aid the attainment of this goal/objective.

Upland Species/Habitat Goal/Objective 2. *Ensure reserve land connectivity with travel corridors for upland-dependent species. The habitat areas should encompass grasslands, agricultural croplands, riparian habitats, and shelter and nesting habitat areas (fence rows, clusters of shrubs and small trees), as well as wetland areas to provide a year-round source of water for upland species. The upland areas should be configured to enhance natural species migration, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)*

A moderate level of uncertainty exists regarding the overall effect of the Greenbriar project on this goal/objective. The proposed changes at the Greenbriar site would have an uncertain effect on the movement and dispersal of upland species; also there is uncertainty regarding the project's contributions to connectivity elsewhere in the Basin because the location of the mitigation site that would account for much of upland habitat preserved has not been determined. However, because the project would cause adverse and beneficial effects that are similar in nature and magnitude, and would affect only a small portion of the Basin's land area, the project would have only a small overall effect on the attainment of this goal/objective, whether it was beneficial or adverse.

ES.4 SUMMARY

In summary, the Greenbriar project (with the DEIR mitigation) would not reduce the viability of populations of covered species using the Natomas Basin and would not reduce the effectiveness of the conservation strategy of the NBHCP. It also would have only small effects on the likelihood of attaining any of the goals and objectives of the NBHCP, and for most of these goals and objectives the overall effect would be neutral or beneficial.

1 INTRODUCTION

This section presents the scope of the effects analysis, an overview of the proposed Greenbriar project, and the intended uses of this document. This section also summarizes the organization of the Effects Analysis.

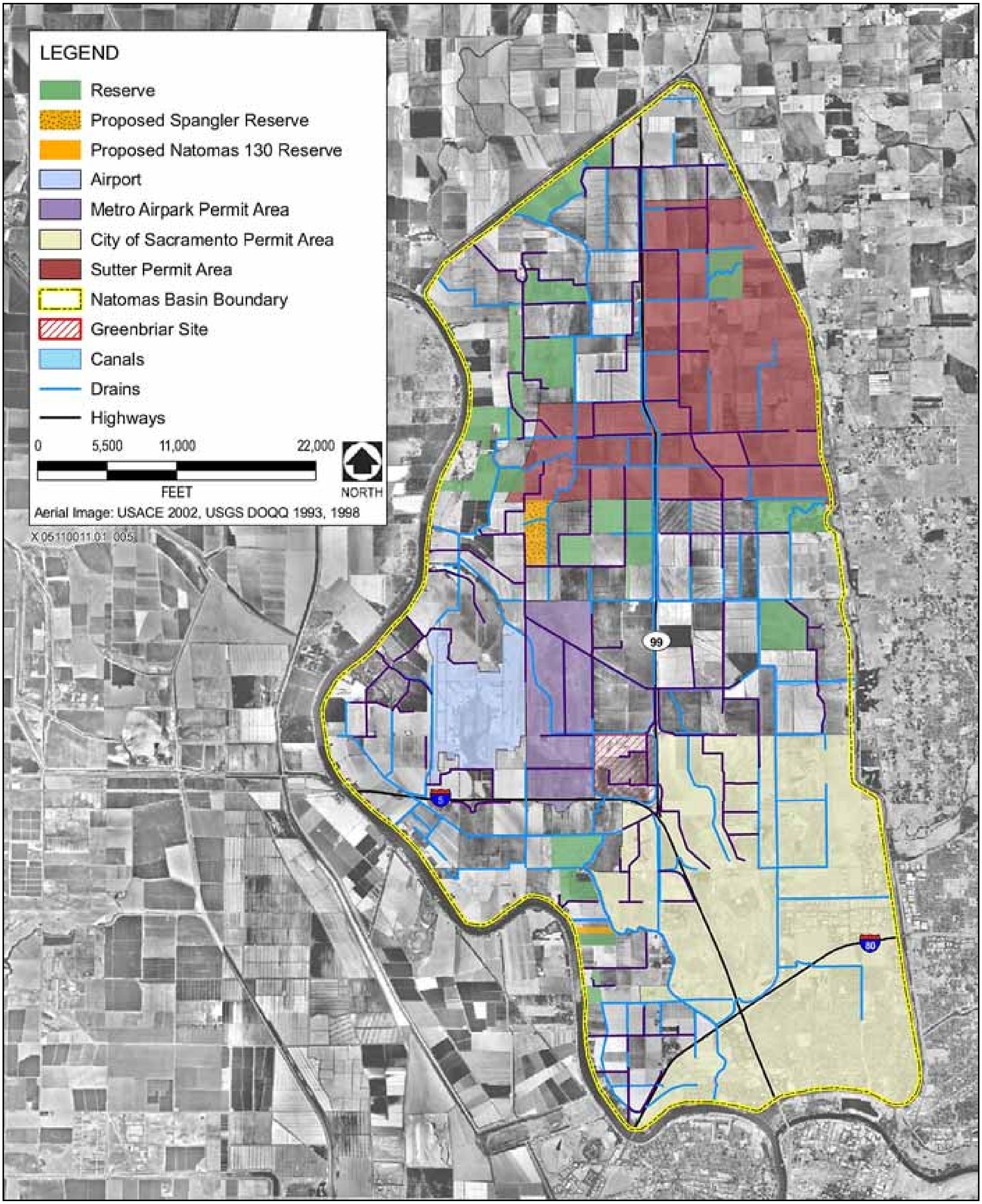
1.1 INTRODUCTION

This analysis of effects of the Greenbriar project on the Natomas Basin Habitat Conservation plan (effects analysis) evaluates the effects of the Greenbriar project on each species covered by the Natomas Basin Habitat Conservation Plan (NBHCP), on the conservation strategy of the NBHCP, and on attainment of the NBHCP's goals and objectives. This project would include development at the Greenbriar site, which is located within the boundaries of the NBHCP plan area, but is not within an area permitted for development. The project also includes establishment of onsite and offsite reserves. The project could affect the population viability of species covered by the NBHCP, the conservation strategy of the NBHCP, or the attainment of the NBHCP's goals and objectives. The purpose of this evaluation is to document the potential effects of the Greenbriar project and evaluate its overall effect on the viability of populations of species covered by the NBHCP and on attainment of the goals and objectives of the NBHCP. Effects on the Metro Air Park Habitat Conservation Plan (MAP HCP) also were considered. However, the MAP HCP was designed to support and follow the regional conservation strategy of the NBHCP; its covered species are a subset of those covered by the NBHCP, and its biological goals and objectives largely represent a subset of the NBHCP's goals and objectives. (In fact, the MAP HCP has been superseded by the 2003 NBHCP.) Thus, the results of this effects analysis also document the project's potential effects on the MAP HCP's covered species and biological goals and objectives. Potential conflicts with and relationships to specific measures of the MAP HCP are also included in this evaluation.

The NBHCP was developed to satisfy the requirements of the Endangered Species Act for a permit for the incidental take of threatened and endangered species. It is intended to minimize and mitigate for the loss of habitat and the incidental take of covered species that could result from urban development and management of reserves in the Natomas Basin. The NBHCP authorizes 17,500 acres of development in the MAP, City of Sacramento, and Sutter County permit areas, and outside of these areas it preserves 8,750 acres in a reserve system surrounded by agricultural lands (Exhibit 1). The reserve system will consist of 4,375 acres of rice, 2,187 acres of created marsh, and 2,187 acres of upland habitat. In this reserve system, land will be managed to enhance its habitat values. The future condition of the Natomas Basin resulting from the NBHCP would provide fewer acres of habitat for covered species than existed in 2001. The U.S. Fish and Wildlife Service (USFWS) considers the reserve system with high quality habitat created by the NBHCP to adequately mitigate and offset the effects of this habitat loss because most of the lost habitat would be of lower quality (USFWS 2003). Consequently, most of the NBHCP's goals and objectives are related to creating a reserve system that provides high quality habitats and is likely to sustain populations of the covered species in the Natomas Basin for the foreseeable future. The NBHCP also includes numerous avoidance, minimization, and mitigation measures to reduce the effects of development on covered species and to ensure the creation and effective operation of the reserve system.

1.2 OVERVIEW OF GREENBRIAR PROJECT

The Greenbriar project would develop the 577-acre Greenbriar site located northwest of the intersection of State Route 99 and Interstate 5 in Sacramento County (Exhibit 2). This site is bordered by agricultural land uses to the north and south, new residential development to the east, and the recently approved Metro Air Park development to the west. As currently proposed, the project would create a residential development with commercial and retail centers, an elementary school, neighborhood parks and a water feature (approximately 39 acres in size). A new east-west roadway, Meister Way, would be constructed through the center of the site. Along this roadway, a new light rail station is proposed to be eventually constructed by Sacramento Regional Transit near the center of the site that would connect the Greenbriar site to the Sacramento International Airport development to the west and to



Source: CH2M HILL, EDAW 2005

Location of Greenbriar Project in the Natomas Basin **Exhibit 1**

Source: CH2M HILL, Ellen Berryman, Sacramento County 2002

Project Boundary and Conservation Easement Locations at the Greenbriar Site **Exhibit 2**

the North Natomas Community to the east across Highway 99 via a new proposed overpass over Highway 99. This development is adjacent to, but outside of, the areas of development permitted by the NBHCP.

Along with this development, the project would preserve, enhance, and create habitat in a 250-foot wide corridor along the site's western edge (occupying approximately 31 acres) and would preserve, enhance, and create habitats off-site at two proposed reserves: the Natomas 130 (30.2 acres, primarily of alfalfa and created marsh with smaller acreages of canal, riparian, and tree grove) and Spangler (235.4 acres, primarily of alfalfa and created marsh with a smaller acreage of canal) reserves.

Preserved lands would become part of reserve system operated by TNBC, or if necessary would be managed by another nonprofit entity. For each reserve, TNBC develops a site-specific management plan, and management activities include habitat management, monitoring, invasive plant control, domestic/feral animal control, and restricting public access and patrolling reserves to enforce restrictions. As part of its management, TNBC also implements a set of measures to avoid and/or minimize take of covered species. These measures are described on pages IV-29 through IV-38 of the NBHCP.

The fee title and an endowment would be provided to TNBC (or if necessary another nonprofit entity) by the project proponent. The endowment would provide for the restoration/enhancement, operation, maintenance, monitoring, and administration of the reserves. For the reserves proposed by the Greenbriar project, a larger endowment fee than that required for NBHCP mitigation may be necessary to provide for the required management. Additional details regarding Greenbriar's funding of these reserves will be developed through the HCP amendment or HCP process together with the development of reserve management plans. The reserve management plans will include details regarding effectiveness monitoring, adaptive management, and a schedule for acquisition of reserve uplands and implementation of all mitigation measures required through the Section 10(a)(1)(B) and Section 2081 permit processes. (For the proposed reserve along Lone Tree Canal, the management plan will include a legal agreement with the Natomas Mutual Water Company regarding vegetation management.) These reserve management plans will form the basis for calculating Greenbriar's endowment fee in consultation with the wildlife agencies.

In addition to the proposed reserves and measures incorporated as part of the proposed Greenbriar project, the City of Sacramento, through the CEQA process, has proposed mitigation measures for the project to reduce further the project's adverse effects. (Throughout this document, "mitigation" refers to these measures proposed by the City of Sacramento in the DEIR, unless otherwise noted as measures incorporated into the Greenbriar project's design.) These DEIR mitigation measures include the preservation of at least an additional 49 acres of land managed to provide high quality Swainson's hawk foraging habitat. This preserved land also would become part of TNBC reserve system. The location of this mitigation land has not yet been determined.

The Greenbriar site is outside of the area permitted for development; thus, the habitat loss, preservation and enhancement resulting from the project is in addition to that permitted by the NBHCP. Consequently, the project would alter the future condition of the Natomas Basin.

1.3 USE OF THIS DOCUMENT

The Greenbriar EIR and Effects Analysis operate in tandem to evaluate the effects of implementation of the Greenbriar project on biological resources. The EIR satisfies the requirements of CEQA partly by considering these effects in light of the NBHCP, IA, and ITP requirements as analyzed in depth in the Effects Analysis (DEIR, Appendix P). The Greenbriar Project is located outside of the 17,500 acre permit area of the NBHCP. The NBHCP, Implementation Agreement, Biological Opinion and ITPs provide that because the NBHCP's Operating Conservation Plan is based upon the City limiting total development to 8,050 acres within the City's Permit Area, approval by the City of future urban development beyond the 8,050 acres or outside of its Permit Area would "constitute a significant departure from the NBHCP's OCP" and would trigger reevaluation of the NBHCP, a new effects analysis, potential amendments and/or revisions to the NBHCP and ITPs, a separate conservation strategy and the need to obtain a new ITP by the Permittee for that additional development, and/or possible suspension or revocation of the City's ITP in the event the City were to violate such limitations without having completed the required reevaluation, and amendments or revisions if necessary, or having obtained a new permit. (See e.g., Implementation Agreement for the NBHCP, Section 3.1.1[a].) As part of this process, Greenbriar intends to file an application for a project-specific HCP.

This EIR evaluates the effects of the Greenbriar project in consideration of the NBHCP, IA and ITP requirements and is based upon an Effects Analysis prepared by the City's EIR consultant with biological resource information provided by Greenbriar's biologists. The purpose of this effects analysis is to support the analysis contained in the EIR and to provide the foundation for the preparation of an amendment to the NBHCP or a new HCP for the addition of the Greenbriar project to the City's permit area.

When the amendment to the NBHCP or new HCP process is initiated with USFWS and CDFG, the Effects Analysis will be reviewed by the USFWS and CDFG through the Section 10(a)(1)(B) and Section 2081 permit processes to assure the Greenbriar project's consistency with federal and state endangered species act requirements and to guide the wildlife agencies in their determinations as to the project's effects on the effectiveness of the NBHCP. Following development of an amendment to the NBHCP or new HCP, the City and/or the Greenbriar project applicant will be required to obtain amended or new ITPs from USFWS and CDFG authorizing incidental take of state and federally listed threatened and endangered species.

If LAFCo approves the proposed annexation of the Greenbriar Project to the City, then the City and/or Greenbriar project applicant will be required to initiate a new HCP or NBHCP amendment process with the wildlife agencies prior to final map approval. USFWS approval of the HCP/NBHCP amendment and issuance of the ITP/ITP amendment will be subject to review under NEPA. The Greenbrier EIR would provide a basis for consideration of environmental impacts under NEPA, and it is intended to provide the environmental information for CDFG action under CEQA. However, CDFG consideration of the HCP/HCP amendment and ITP/ITP amendment could result in subsequent environmental review under CEQA, if CDFG determines, on the basis of substantial evidence in light of the whole record, that there are substantial changes in the project or circumstances in which the project is undertaken, or new information indicates that new or substantially more severe significant environmental effects would occur than were covered in the Greenbriar EIR. Although incidental take would not occur until grading of the site occurs, issuance of the ITPs/amendments will be required prior to final map approval by the City of Sacramento to ensure that any adjustments to the subdivision map approvals (e.g., changes in site design) resulting from the HCP/ITP process occur prior to recordation of a final map.

1.4 ORGANIZATION

This report presents the results of an analysis of the effects of the Greenbriar project (with the DEIR mitigation) on the future condition of the Natomas Basin, and how those changes would affect species covered by the NBHCP and attainment of the NBHCP's goals and objectives.

The Effects Analysis is organized in the following way:

- Section 1, Introduction
- Section 2, Evaluation Approach
- Section 3, Greenbriar Project's Alteration of Population and Habitat Attributes
- Section 4, Potential Effects of the Greenbriar Project on Covered Species
- Section 5, Potential Effects on the Conservation Strategy of the NBHCP
- Section 6, Potential Effects of the Greenbriar Project on NBHCP Goals and Objectives

- Section 7, Cumulative Effects
- Appendix A, Assessment of Avoidance and Minimization of Construction-related Effects and Human-Wildlife Conflicts
- Appendix B, Change in Natomas Basin Land Cover in 2001–2004

2 EVALUATION APPROACH

2.1 OVERVIEW

The Greenbriar project could affect covered species, effectiveness of the NBHCP conservation strategy, effectiveness of specific conservation measures, attainment of NBHCP goals and objectives, or cumulative effects by altering any of several population or habitat attributes. These attributes include:

- Construction-related effects on survival and reproduction,
- Zones with human-wildlife conflicts (i.e., areas adjacent to developed lands and roads),
- Acreage of habitat in Natomas Basin,
- Quality of habitat in the Natomas Basin,
- Connectivity of habitat in Natomas Basin,
- Connectivity of existing TNBC reserves,
- Habitat value of existing TNBC reserves,
- Water availability at TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

For each of these attributes, alterations resulting from the Greenbriar project were analyzed. The findings of this effects analysis of the effects on covered species, effectiveness of the NBHCP conservation strategy, effectiveness of specific conservation measures, and NBHCP goals and objectives was based on the results of the analyses of the above attributes. The methodologies and the bases for the interpretations of effects on covered species and NBHCP goals and objectives are described below. In addition, this analysis of effects on covered species was also based on available information on the distribution of these species in the Natomas Basin and on their ecology.

Analyses of cumulative effects also were based on the results of these analyses together with additional analyses of land cover, and the compilation and review of projects proposed in the Natomas Basin.

2.2 DESCRIPTION OF GREENBRIAR PROJECT

The analysis of the effects of the Greenbriar project is based on a description of the project (including the mitigation measures proposed as part of the project design) that was compiled from multiple sources. The primary source was the Greenbriar Draft Environmental Impact Report (DEIR) (EDAW 2005). Additional information was derived from the draft conceptual mitigation plan for the project (Wildlands, Inc. 2005), Greenbriar Draft Biological Assessment (BA) (Berryman Ecological 2005), and personal communications with project consultants. The draft conceptual mitigation plan describes the proposed Natomas 130 and Spangler reserves, and the proposed on-site reserve along Lone Tree Canal, and the proposed restoration of these areas to provide upland and wetland habitats. This conceptual mitigation plan also evaluated whether the proposed reserve sites met the TNBC's typical conditions for mitigation-land dedication. The draft BA includes proposed avoidance and minimization measures, and a description of the proposed preservation, restoration, and future management of habitat along Lone Tree Canal.

After the conceptual mitigation plan and draft BA were produced, several changes were made to the proposed habitat creation and enhancement at the Natomas 130 and Spangler sites. First, the proposed acreage of restored habitats was changed to 204.2 acres of managed marsh and associated canals (14.2 acres at Natomas 130 created from upland non-rice cropland and 190 acres at Spangler created from rice) and 59.6 acres of upland in alfalfa (14.2 acres at Natomas 130 and 45.4 acres at Spangler). The managed marsh would have 30% upland components. A revised conceptual mitigation plan that reflects these changes is under development. This effects analysis also assumed that development of an HCP for this project would result in mitigation providing habitat values comparable or greater than the proposed acreage of marsh and alfalfa evaluated in this effects analysis.

As indicated by the draft conceptual mitigation plan, and as explicitly required by the DEIR mitigation, the proposed reserves would be dedicated to TNBC, or another entity if necessary, with an endowment sufficient to pay for required restoration and management in perpetuity. The management of these reserves would be as described in sections VI-D, V-B, VI-E, VI-F, and VI-G of the NBHCP (Conservation Plan – Reserve/Management/Site Specific Management Plans; Take Avoidance, Minimization, and Mitigation; and Plan Implementation-Monitoring of the NBHCP, Adaptive Management, Annual Report, respectively) or that comparable management would be developed in consultation with USFWS and incorporated into an HCP for the project. As described in sections VI-D, V-B, VIE, VI-F, and VI-G of the NBHCP, this management would include:

- Development of a site-specific management plan;
- Implementation of measures to reduce take of covered species as a result of restoration and reserve management;
- Implementation of the NBHCP's conservation strategies for covered species on the reserves;
- Management activities that include invasive plant control, domestic/feral animal control, and restricting public access and patrolling reserves to enforce restrictions;
- Compliance and biological effectiveness monitoring; and
- An annual reporting and review meeting to cover progress toward meeting goals, implementation, monitoring, and adaptive management measures.

The dedication of the proposed reserves and their endowments would occur prior to entitlement of the project, and restoration would be initiated within one year of their dedication. Because of their specific management requirements (e.g., having uplands planted in alfalfa), greater proportion of managed marsh, and the potentially high maintenance costs for the small reserve proposed along Lone Tree Canal, this endowment may be greater per acre than the endowment for NBHCP mitigation lands.

Furthermore, in the DEIR, mitigation includes preservation and enhancement of Swainson's hawk foraging habitat, multiple measures to reduce effects on giant garter snake habitat and the snake's use of Lone Tree Canal as a movement corridor, and development and approval of a Habitat Conservation Plan (HCP) for compliance with the federal Endangered Species Act.

The DEIR mitigation for Swainson's hawk foraging habitat (mitigation measure 6.13-2) requires the preservation of an area of habitat that provides habitat values to the species comparable to the habitat eliminated at the Greenbriar site. This DEIR mitigation measure would require preservation of at least an additional 49 acres of land to be enhanced and managed to provide high quality Swainson's hawk foraging habitat. The actual acreage of this mitigation will be determined during development of an HCP for the project (as described in the DEIR), and will depend on the site attributes and future management that determine the level of habitat enhancement (as described in Section 2.3.4 *Quality of Habitat in the Natomas Basin*).

The DEIR mitigation for giant garter snake includes measures to reduce the project's effects on snakes use of Lone Tree Canal as a movement corridor. These measures include:

a. To ensure that the project does not diminish habitat connectivity for giant garter snake between the southwest and northwest zones identified in the NBHCP, approximately 30.6 acres along Lone Tree Canal shall be protected and managed as giant garter snake habitat. This on-site habitat preservation shall protect an approximately 250-foot wide corridor of giant garter snake habitat that includes the canal and approximately 200 feet of adjacent uplands. Uplands within the linear open space/buffer area shall be managed as perennial grassland as described below. Additional aquatic habitat for giant garter snake shall be created along the east bank of Lone Tree Canal by construction and maintenance of a 2.7 acre tule bench. The habitat shall be managed in perpetuity as high-quality habitat for giant garter snake. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared within six months of completion of monitoring for any given year. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP.

b. To ensure that the project does not diminish giant garter snake movement along Lone Tree Canal, all new road crossings of Lone Tree Canal shall be designed to minimize obstacles to giant garter snake movement. The use of culverts under new road crossings on Lone Tree Canal shall be prohibited unless it can be demonstrated that the culverts will not diminish the potential for giant garter snake movement through the section of Lone Tree Canal protected by the setback fence and conservation easement. .

c. Upland giant garter snake habitat within the Lone Tree Canal linear open space/buffer area shall be created and managed to provide cover, basking areas, and refugia during the winter dormant period. Hibernaculae would be constructed at regular intervals by embedding concrete or coarse rock in the bank or in a berm along the Lone Tree Canal corridor to provide additional winter refugia. Upland habitat with the linear open space/buffer areas shall be converted to native perennial grassland and managed, in perpetuity, as perennial grassland habitat.

d. Aquatic habitat shall be maintained throughout the giant garter snake active season in Lone Tree Canal, in perpetuity. This is the legal responsibility and obligation of Metro Air Park property owners (MAP). The MAP HCP includes provisions for maintaining water in the canal such that the basic habitat requirements of the giant garter snake are met. The MAP HCP also provides a road map, through “Changed Circumstances”, to address procedures to follow if water is not being maintained in the canal to meet these requirements. As described in the MAP HCP, the MAP is legally obligated to assure these requirements are met, and financial and procedural mechanisms are included in the MAP HCP to enforce this. It is, therefore, assumed that MAP will provide water to Lone Tree Canal, as required by the MAP HCP and ITP, in perpetuity. It is also assumed that USFWS will use all reasonable means available to it, to enforce this MAP HCP requirement. If water is not provided to Lone Tree Canal by the MAP to meet the habitat requirements of giant garter snake, as required by the MAP HCP, and USFWS exhausts its enforcement responsibilities, the project applicant shall assume the responsibility of providing suitable giant garter snake aquatic habitat throughout the section of Lone Tree Canal protected by the fence and conservation easement. However, as stated herein, the project applicant shall only assume this responsibility if it has been sufficiently demonstrated to the City that USFWS has exhausted all reasonable means to compel MAP to comply with the relevant conditions of the MAP ITP. Specific requirements related to ensuring suitable aquatic habitat in Lone Tree Canal is present, in perpetuity, throughout the giant garter snake active season shall be developed through consultation with DFG and USFWS, and included in the new or amended HCP for Greenbriar, and may include mechanisms, such as installation of a well, to assure water is provided in the canal to meet habitat requirements.

e. A barrier shall be installed between the giant garter snake habitat linear open space/buffer area and the adjacent Greenbriar development to ensure that giant garter snakes do not enter the development area, and to prohibit humans and pets from entering the giant garter snake habitat. The design of this barrier shall be subject to USFWS and CDFG review and approval. The entire length of the barrier, which shall be bordered by yards rather than roadways, shall be maintained on the preserve side by a nonprofit land trust to ensure that vegetation or debris does not accumulate near the barrier and provide opportunities for wildlife and pets to climb over the barrier. On the development side, Covenants, Codes and Restrictions (CCRs) shall prohibit accumulation of vegetation or debris adjacent to the barrier. Chain link fencing shall be placed at both ends of the corridor, with locked gates permitting entry only by RD 1000 and NMWD for channel maintenance, and by the preserve manager for habitat monitoring and maintenance purposes.

f. Specific requirements associated with the barrier shall be developed through consultation with USFWS and DFG, and may include the following and/or other specifications that DFG and USFWS consider to be equally or more effective:

- Adequate height and below-ground depth to prevent snakes or burrowing mammals from providing a through-route for snakes by establishing burrows from one side to the other crossing;
- Constructed using extruded concrete or block construction extending a minimum of 36-inches above ground level;
- Maintenance to repair the barrier and to prevent the establishment of vegetation or collection of debris that could provide snakes with a climbing surface allowing them to breech the barrier;
- A cap or lip extending at least two-inches beyond the barrier's vertical edge to prevent snakes from gaining access along the barrier's top edge; and
- Signage to discourage humans and their pets from entering the area.

g. The Lone Tree Canal linear open space/buffer area shall be protected in perpetuity under a conservation easement and managed to sustain the value of this area for giant garter snake habitat connectivity. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP or following procedures developed in formal consultation with USFWS and DFG and contained in an ESA Incidental Take Permit for the Greenbriar project.

As a result of consultation with the USFWS, the HCP for the Greenbriar project could result in different mitigation than is described in the draft BA, conceptual mitigation plan, or the DEIR. The mitigation described in the DEIR, however, establishes a level of mitigation that will be met or exceeded in the HCP. Thus, the HCP will reduce effects to a comparable or lower level than the mitigation analyzed in this effects analysis.

2.3 METHODOLOGY FOR ANALYZING ALTERATIONS OF POPULATIONS AND HABITATS

2.3.1 CONSTRUCTION-RELATED EFFECTS ON SURVIVAL AND REPRODUCTION

Information regarding the presence of covered species or potentially suitable habitat for these species at the Greenbriar site and adjacent lands was derived from the Greenbriar Draft Environmental Impact Report (DEIR) (EDAW 2005), Greenbriar Draft Biological Assessment (BA) (Berryman Ecological 2005), and a draft conceptual mitigation plan for the project (Wildlands, Inc. 2005). These documents, in turn, were based on site assessments by wildlife biologists and compilation and analysis of the best available data.

Each species was considered to be either likely, possibly, or not affected by construction-activities based on evidence of its presence and of the presence of potentially suitable habitat. Species documented recently (i.e., in the past 5 years) at or adjacent to the Greenbriar or proposed reserve sites were considered to still be using suitable habitat at that site; these species were considered likely to be affected by construction-related activities. The land area considered adjacent to the Greenbriar or proposed reserve sites differed among species according to their ecology (i.e., their territory and home range sizes, daily and seasonal movements, and their susceptibility to disturbance).

Species not recently documented at or adjacent to the Greenbriar site, but for which potentially suitable habitat has been documented at or adjacent to the site, were considered potentially present and thus individuals of those species may be affected by construction activities. (These species were considered potentially present because surveys performed to date have not been adequate to determine absence of these species.)

Species not recently documented at or adjacent to the Greenbriar site, and for which no potentially suitable habitat was located on or adjacent to the site, were considered to not be affected by construction activities.

For species likely to be or possibly affected by construction-related activities, the avoidance and mitigation measures proposed for the Greenbriar project were evaluated. The extent of construction-related effects is reduced through appropriate avoidance and minimization measures. Where combinations of construction activities and affected species and habitats would be similar to those addressed by the NBHCP, this analysis considered the applicable avoidance and minimization measures in the NBHCP (Chapter V) that address construction-related effects to be a complete set of appropriate (and feasible) avoidance and minimization measures for comparable effects potentially caused by the Greenbriar project. Thus, a table of measures in the NBHCP was compiled, measures applicable to the project were identified, and inclusion of each measure in the project and its mitigation was evaluated based on the content of the BA and DEIR for the project. This table was used in evaluating the project's effects on attainment of NBHCP goals and objectives that address the implementation of avoidance and minimization measures. The analysis also considered the need for different measures to address effects that would be likely and that would differ from those addressed by the NBHCP, and the potential for the Greenbriar project to alter the efficacy of the NBHCP measures (Appendix A).

2.3.2 Zones with Human-Wildlife Conflicts

Considerable conflicts between wildlife use and human activities (e.g., animal-vehicle collisions, harassment and predation by pets, degradation of water quality) normally occur in habitat areas adjacent to developed land uses and major roads. These effects diminish with distance, but the distance at which they are no longer significant is debatable.

In this document, the widths used to evaluate human-wildlife conflicts, alterations of vegetation and other habitat conditions, habitat fragmentation, and effects on existing reserves, were based on the ecological literature regarding effects on habitat adjacent to developed land uses and roads, and on the distances used in previous analyses related to the NBHCP or incorporated into the NBHCP itself, The effects of developed land uses on adjacent land diminish with distance. The different types of effects, however, extend different distances onto adjacent land; these distances can be from tens to thousands of feet, and differ not only among mechanisms but among sites as well (because of variation in site attributes such as the presence of barriers and the quantity of impervious surfaces). Thus, in a regional analysis, the use of a specific width only indicates the area within which effects of adjacent developed land are often sufficient to alter habitats.

In the GIS-based evaluations, two widths were used, 800 feet and one mile. The 800-foot width was used in evaluating zones where increased human disturbance, predation from cats and dogs, vehicle collisions, dumping, and alterations to soils, hydrology and vegetation were likely to occur. The one-mile width was used in evaluating the effects on foraging habitat for animals with large home ranges, such as raptors. Both widths are consistent with the ecological literature regarding these effects and the ecology of species in the Natomas Basin, and were previously used in comparable analyses supporting the NBHCP.

The Greenbriar project could cause human-wildlife conflicts in this zone by altering the acreage in the zone (because of an altered perimeter of development) or by altering the intensity of wildlife-human conflicts (because of the avoidance and minimization measures implemented or a change in land cover types in this zone). Change in the extent of the 800-foot wide zone was calculated from the acreage in this zone around the MAP, City of Sacramento and Sutter County permit areas for urban development from the Final NBHCP (City of Sacramento et al. 2003) and around these permit areas plus a developed Greenbriar site. Changes to the intensity of wildlife-human conflicts in the 800-foot wide zone were assessed by calculating changes in land cover types within these zones and by comparing the project's avoidance and minimization measures with those in the NBHCP that address these conflicts. An increase in land cover providing higher quality habitat (or land cover more sensitive to human disturbance) would increase human-wildlife conflicts, while a decrease in such land cover types would reduce human-wildlife conflicts. Similarly, a less comprehensive or stringent set of measures would increase the intensity of conflicts, while a more comprehensive or stringent set of measures would reduce the intensity of conflicts. Any reduction in the efficacy of specific NBHCP measures addressing human-wildlife conflicts also could increase conflicts; potential effects on the efficacy of these measures were evaluated in Appendix A.

2.3.3 ACREAGE OF HABITAT IN THE NATOMAS BASIN

A major component of the effects analysis in the NBHCP was an analysis of change in habitat acreage. For each covered species, the NBHCP analyzed the habitat that was available under baseline conditions and that would be available in the expected future condition of the Natomas Basin. The NBHCP documented baseline land cover in the Natomas Basin as of 2001. The data sources and methods used to do so are described in *Natomas Basin Conservation Plan Impacts to Proposed Covered Species* (CH2M HILL 2002) that was attached to the Final NBHCP as Appendix H. The Natomas Basin covers approximately 53,538 acres. The future condition evaluated was the result of developing an additional 17,500 acres of this land in the MAP, City of Sacramento, and Sutter County permit areas and establishing an 8,750–acre reserve system in the Natomas Basin outside of those permit areas. For each covered species, changes in habitat acreages were derived from the changes in the acreage of land cover types by identifying those land cover types that provide habitat for that species. Additional analyses were performed for Swainson’s hawk that included assessment of changes in habitat within 1 mile of existing reserves and nests, quality of foraging habitat, and seasonal availability of foraging habitat.

The Greenbriar project would alter these future conditions by developing additional land and by preserving and enhancing additional land as part of the TNBC reserve system. Thus, for this project’s effects analysis, for each covered species, the future condition of the Natomas Basin with the NBHCP and the Greenbriar project was compared to the future condition analyzed in the NBHCP and to the 2001 NBHCP baseline. For the Greenbriar and proposed reserve sites, these comparisons were based primarily on 2001 land cover to be consistent with and comparable to the NBHCP’s effects analysis, and because 2001 conditions were used as the NBHCP baseline. These comparisons allow assessment of both the extent of future habitat under the future condition resulting from the NBHCP and under the future condition resulting from the NBHCP plus the Greenbriar project. These were GIS-based analyses. The land cover GIS data layer developed for the NBHCP was the data source for land cover. This was the available land cover data most applicable to this analysis.

Effects based on 2005 land cover were also quantified and considered. This was done by using aerial photography to update the land cover mapped in 2001 in a manner consistent with the 2001 mapping. This mapping used different criteria and was at a coarser scale than some of the land cover mapping in the BA and DEIR (which was based in part on site surveys by biologists). These differences did not lead to different conclusions regarding the efficacy of mitigation for the project’s effects.

Land cover mapped by Jones & Stokes was also considered in our analyses (Jones & Stokes 2005; Jones & Stokes, unpublished data) (Appendix B). This mapping used different land cover classification and mapping methods from the 2001 mapping by CH2M HILL, which limited its applicability to this analysis. Nonetheless, a crosswalk between the CH2M HILL and Jones & Stokes land cover types was developed and a common classification was derived; after reclassifying both data sets, EDAW estimated land cover changes during 2001–2004, and used the results to assess overall changes in land cover, implementation of NBHCP conservation strategies on TNBC reserves, stability of agricultural land uses, and fallowing of rice in anticipation of development. This analysis is presented in Appendix B. Its results also were used in the cumulative effects analyses in Section 7 *Cumulative Effects*.

This assessment indicated that land cover changes since 2001 have occurred primarily within the MAP, City of Sacramento, and Sutter County permit areas for urban development, and at TNBC reserves; the primary land cover changes outside of these areas were an increase in the acreage of rice, a substantial decrease in the acreage of non-rice crops and a corresponding increase in the acreage of fallowed and abandoned cropland. It did not indicate that fallowing of rice in anticipation of development was occurring. Although the dramatic changes in non-rice crop and idle cropland acreages affect the acreage of available habitat for just two covered species (burrowing owl and Aleutian Canada goose), they do illustrate that availability of agricultural habitats can change rapidly in the Natomas Basin; they also indicate that estimates of future availability of agricultural habitats in the NBHCP and in this report represent approximations based on assumptions that may not occur (i.e., that current patterns of agricultural land use are representative of future patterns).

Other GIS data layers used in the analyses included the locations of canals and drains, and the boundaries of the Natomas Basin, NBHCP permit areas, and of the Greenbriar and proposed reserve sites. In our analyses, canal habitats were analyzed differently than in the Final NBHCP. In the Final NBHCP, canals and drains were assigned to four categories (I-IV) based on the width of habitat they provided; of these, only category I canals were included in the land cover layer and categories II-IV were estimated separately. In contrast, we included all habitat along category I-IV waterways in the canal land cover type, Because these canal acreages were included in the canal land cover type in our analyses, the future acreages of land cover types differ somewhat from those presented in the NBHCP.

To assess the future condition of the Natomas Basin with the Greenbriar project, several assumptions were made regarding changes in land cover. These assumptions included the following.

- All land in the MAP, City of Sacramento, and Sutter County permit areas was assumed to be developed, or otherwise no longer providing habitat for covered species.

- Land at the Greenbriar site was assumed to be developed, or otherwise no longer providing habitat for covered species, except for a 250-foot wide corridor along the western edge of the Greenbriar site would be preserved. Land in this corridor would be converted to grassland, except for approximately 2.7 acres of tule marsh that would be created, and 1.4 acres of riparian habitat that was mapped in the conserved corridor in 2001 and would presumably recover and persist in the proposed reserve.

- All other areas were treated as in the effects analysis for the NBHCP, except that 8,750 acres (not including the project's proposed reserves) would be incorporated into a reserve system. The reserve system would be approximately 25% managed marsh, 50% rice and 25% upland land cover types. For estimating acreage changes, the managed marsh and rice was considered to come out of the baseline rice acreage.

- Under the future condition, land at the project's proposed reserve sites was assigned to land cover types based on the *Greenbriar Draft Conceptual Habitat Restoration Design* prepared by Wildlands, Inc. (2005), and subsequent revisions by the project applicant. The mitigation land required by Mitigation Measure 6.13-2 of the DEIR was not included in the GIS analysis because its location has not been determined.

- Preserved land would be dedicated to TNBC (or another nonprofit land trust) and an endowment would be provided for the enhancement, operations, maintenance, and administration of preserved land in perpetuity.)

Thus, the future condition that was analyzed assumes that the project, all development proposed under the NBHCP and all associated mitigation would occur, and that current agricultural land uses are representative of future agricultural land uses. These or comparable assumptions were also made in the effects analyses supporting the NBHCP (e.g., sections 3 and 4 of Appendix H of the NBHCP, and Section 2 of Appendix K).

Changes in the acreage of habitat for a covered species were the sum of changes in land cover types providing habitat for that species. The habitat-land cover relationships used in analyses supporting the NBHCP were also applied to analyses for the Greenbriar project. These relationships are summarized in Table 2-1. Vernal pool-associated species were not considered in these analyses because the Greenbriar and proposed reserve sites do not contain vernal pool habitats nor have vernal-pool associated species been documented in the vicinity of these sites.

Also, in addition to these analyses of Basin-wide GIS data sets, we also considered more detailed site-specific information provided in the DEIR, BA, and the most recent TNBC monitoring report (Jones & Stokes 2005).

Table 2-1
Species Habitat-Land Cover Relationships

Species	Land Cover Types																	
	Airport	Alfalfa	Canals	Grassland	Highways	Idle	Non-rice Crops	Oak Groves	Orchards	Other	Pasture	Ponds and Seasonally Wet	Rice	Riparian	Ruderal	Rural Residential	Tree Groves	Urban
Giant garter snake			X									X	X					
Swainson's hawk (N)								X						X			X	
Swainson's hawk (F)		X		X		X	X				X				X			
Burrowing owl		X	X	X		X					X				X			
Loggerhead shrike		X	X	X		X	X	X	X		X	X		X	X	X	X	
Tricolored blackbird (F)		X		X			X				X		X					
Aleutian Canada goose (F)							X				X		X					
White-faced ibis		X	X									X	X					
Bank swallow		X	X	X			X				X	X	X	X				
Valley elderberry longhorn beetle														X				
Northwestern pond turtle			X									X	X	X				
Sanford's arrowhead			X									X						
Delta tule pea			X									X						

2.3.4 QUALITY OF HABITAT IN THE NATOMAS BASIN

Changes in habitat quality can result from changes in land cover, connectivity, adjacent land uses, and the preservation and management of land to enhance its habitat quality, changes in connectivity, and adjacent land uses. In this report, changes in the acreage of land cover types providing different quality habitat and changes in the acreage of land preserved and managed to enhance habitat quality were derived from the analyses of change in habitat acreages described in the preceding section (*Acreage of Habitat in the Natomas Basin*). Changes in habitat quality resulting from changes in connectivity or adjacent land uses were evaluated separately, and these evaluations are described in other sections.

For Swainson's hawk, the quality and seasonal availability of foraging habitat for Swainson's hawk were evaluated in a manner comparable to the effects analysis conducted by CH2M HILL for the NBHCP (CH2M HILL 2003). In addition, based on a quantitative model of the relative value of different foraging habitats, EDAW also analyzed the overall quantity of resources provided by foraging habitat in the Natomas Basin with and without the Greenbriar project. Though based largely on similar interpretations of existing information as the CH2M HILL analyses for the NBHCP, this model was developed by EDAW biologists for this effects analysis.

In the analysis conducted for the NBHCP, crops and other land cover types were placed in high, medium and low categories for habitat value. This was done on the basis of previous research (e.g., Estep 1989, Estep and Teresa 1992). Seasonal availability of prey was considered separately by calculating the "monthly availability of potential foraging habitat." (This analysis of habitat availability was based on the assumption that for row and field crops, prey were only available to hawks at the time of harvest.) Because food resources for Swainson's hawk vary substantially among land cover and crop types, these analyses provided much more information than a simple tabulation of acres of potential foraging habitat. However, these analyses did not produce an estimate of total foraging resources that would indicate the overall change in habitat. Therefore, in addition to applying the same analysis as CH2M HILL conducted for the NBHCP, EDAW also estimated the total food resource potentially provided by foraging habitat.

In the analyses supporting the NBHCP, alfalfa and idle cropland were considered to be high value habitat; sugar beet, tomato, melons, squash and cucumber, beans, wheat, pastures (clover, unspecified or mixed) and ruderal land was considered moderate value habitat; Corn, safflower, onions and garlic, and unspecified row and field crops were considered low quality habitat.

The temporal availability of prey was also considered in an analysis conducted for the NBHCP. In this analysis, prey was considered inaccessible to Swainson's hawk during much of the spring and summer because of the dense (and high) cover of vegetation in cultivated fields. In contrast, crops, such as alfalfa, and other land cover types (e.g., grassland) were considered to provide accessible prey for longer periods because of frequent harvests or the vegetation's growth form. Thus, during the months of April–October, for the different crop types grown in the Natomas Basin, prey was assumed to be accessible only during the months when harvest predominantly occurs. These time periods were June for wheat, July–August for tomato and unspecified crops, August for safflower onions and garlic, September–October for sugar beet, and October for beans, melons, squash and cucumber. (Swainson's hawks have migrated out of the Natomas Basin by October, and thus crops harvested in October do not provide foraging habitat in the NBHCP analysis.) For crops harvested during periods of two months, the total acreage of these crops was divided by two to determine the acreage of foraging habitat available during each of those months. Grassland, ruderal, idle cropland, and pastures (including alfalfa) were considered to provide habitat throughout April–September.

These analyses regarding habitat value and temporal availability were applied to the Greenbriar project. For this analysis, the habitat value of the Greenbriar, proposed reserve, and DEIR mitigation sites was compared with and without the proposed development and proposed habitat creation, enhancement, and preservation.

For these analyses, the habitat value of the Greenbriar, proposed reserve and DEIR mitigation sites without the Greenbriar project was based on the same data sources as the analysis conducted for the NBHCP (i.e., 1993 DWR mapping of croplands and 2001 land cover mapping by CH2M HILL of the entire Natomas Basin).

The habitat value of the Greenbriar, proposed reserve and DEIR mitigation sites with the Greenbriar project was based on an assumed future condition derived from the project description and mitigation measure 6.13-2 of the DEIR for the project. For this assumed future condition, the acreages of habitats at these sites are presented in Table 2-2. For the Greenbriar site, these assumptions were that the 26.5 acres of preserved grassland that would be created and preserved along Lone Tree Canal would be low quality habitat (because of its proximity to development), and that the rest of the site would not provide any habitat for Swainson's hawk. For the proposed off-site reserves, these assumptions were that the 59.6 acres of upland at the Natomas 130 and Spangler sites would be alfalfa (or otherwise managed to provide high quality habitat) and that the 59.5 acres of upland components of created marsh would provide moderate quality habitat.

Mitigation measure 6.13-2 of the DEIR, which requires at least 49 acres of land be preserved, enhanced, and managed in perpetuity to provide high quality foraging habitat for Swainson's hawk so that the project's proposed mitigation plus this DEIR mitigation would provide equal or greater value to the species than the habitat present at the Greenbriar site in 2005. The location(s) and existing land cover of the Swainson's hawk foraging habitat that would be required by mitigation measure 6.13-2 have not been determined; this analysis assumed that the current land cover of the mitigation site(s) that would provide foraging habitat for Swainson's hawk was agricultural land harvested during July–August and providing low quality habitat. As mitigation for the project, it was assumed that this land would be converted to high quality habitat with prey available from April through September. These assumptions represent the minimum acreage at an additional site that would need to be preserved, enhanced, and managed in perpetuity to comply with mitigation measure 6.13-2.

Table 2-2
Habitat Type Acreages Used in Analyses of Effects on Swainson's Hawk Foraging Habitat

Habitat	Greenbriar Site		Proposed Reserves		DEIR Mitigation		Total	
	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project
Alfalfa	-	-	-	59.6		49	-	108.9
Grassland[1]	-	26.5	-	-	-	-	-	26.5
Idle	62.5	-	-	-	-	-	62.5	-
Ruderal	9.2	-	-	-	-	-	9.2	-
Pasture	33.8	-	-	-	-	-	33.8	-
Upland component of marsh	-	-	-	59.5	-	-	-	59.5
Field crop – Moderate quality, harvested September–October	203.7	-	28.4	-	-	-	232	-
Field crop – Low quality, harvested July–August	30.4	-	-	-	49	-	79.4	-

Note: [1] In analysis, this grassland area was considered to be low quality foraging habitat because of its proximity to development.

The EDAW model of Swainson's hawk foraging habitat uses the same current and assumed future conditions as were used for the NBHCP. The range of habitat quality, however, was divided into four categories, rather than three. These ratings changed seasonally for cropland, and a relative quantitative value was assigned to each category so that the total quantity of food resources potentially available could be estimated. The following text describes EDAW's methodology for calculating this estimate.

For each month during April–September, each crop and other land cover type providing foraging habitat was assigned to one of four quality ratings: high, high-moderate, moderate, or low. These ratings are given in Table 2-3. Crops and the other land cover types that provide foraging habitat were assigned these ratings on the basis of prey abundance; the accessibility of prey to the hawk; and on the frequency of harvest, flood irrigation, and other activities that create valuable foraging opportunities for Swainson's hawks, as indicated by the existing literature (Estep 1989, Estep and Teresa 1992). The frequency of harvest, flood irrigation and other activities was considered in rating habitats because of the importance of these activities for hawk foraging. For example, in the radio telemetry study conducted by Estep (1989), approximately half of all Swainson's hawk foraging was associated with harvest, flood irrigation, and other agricultural activities.

Alfalfa combines a high frequency of mowing and irrigation with low vegetation that leave prey accessible to hawks. For these reasons, this land cover type was rated "high" quality.

Grassland, ruderal, idle cropland, upland components of marsh, and fallowed rice also have low vegetation that leaves prey accessible, and can have prey abundance comparable (or even greater than) alfalfa. However these land cover types lack the frequent cultivation and irrigation activities that provide valuable foraging opportunities, and therefore were rated "high-moderate."

Row crops with relatively dense vegetation that limits prey accessibility but still allows some foraging throughout the field (e.g., tomato, beets) were rated "moderate."

Dense, tall crops (e.g., corn, wheat) that restrict foraging to field margins were considered "low" quality foraging habitat. Because of its proximity to development, the proposed grassland along Lone Tree Canal also was considered to provide low quality foraging habitat.

Table 2-3
Habitat Quality and Harvest Months for Swainson's Hawk Foraging Habitats in the Natomas Basin[1]

Habitat	Harvest Month(s)	Growing Season Quality	Harvest Quality	Post-Harvest Quality
Alfalfa	April-Sept	High	High	High
Grassland[2]	-	High-Moderate	-	-
Idle	-	High-Moderate	-	-
Fallowed Rice	-	High-Moderate	-	-
Tomato	July-August	Moderate	High	Low
Sugar beet	September-October	Moderate	High	Low
Beans	October	Moderate	High	Low
Squash, pumpkin	October	Moderate	High	Low
Upland Marsh	-	Moderate	-	-
Pasture	-	Moderate	-	-
Ruderal	-	Moderate	-	-
Wheat	June	Low	High	Low
Unspecified crop	July-Aug	Low	High	Low
Safflower	August	Low	High	Low
Onions and garlic	August	Low	High	Low
Corn	September	Low	High	Low

Notes:
1 - Data based on CH2M Hill 2003, except for growing season quality of grassland, idle and fallowed rice, as described in methods section.
2 – Grassland in proposed reserve along Lone Tree Canal was considered to be low quality habitat because of surrounding development.

The harvest of crops makes the relatively high density of prey in cropland much more accessible, and this brief period of high accessibility and high abundance is followed by continued accessibility but rapidly declining abundance. Therefore, crops providing low and moderate quality habitat during the growing season were considered to provide high quality habitat for a two weeks at harvest, and then subsequently their habitat quality was reduced to low. Harvest times were considered to be the same as in the NBHCP analysis (CH2M HILL 2003) and these are listed in Table 2-3. For crops harvested during a two-month period, half of the acreage was assumed to be harvested each month, and for that half of the acreage, the growing season and harvest quality ratings were averaged for that month.

To calculate an estimate of food resources provided by foraging habitats, the value of each habitat type was expressed relative to high quality habitat, which was assigned a value of "1." These values are an interpretation of the relevant existing scientific literature that includes studies of the use of foraging habitat and relative prey abundance in different crop and other cover types (Estep 1989, Estep and Teresa 1992). Because in low quality habitat, the tall and dense vegetation restricts foraging to field margins, low quality habitats were assigned a value of "0.1." (However, because harvest makes prey available, the value of these lands is raised to "1" for a two-week interval during the harvest period.) Because the vegetation height and density of moderate quality crops allows some access to prey throughout the field, these crops were assigned a value of "0.3." (During harvest, moderate quality crops were assigned a “1” rating for a two-week interval, and their rating was subsequently reduced to “0.1”.) Because high-moderate quality foraging habitat has accessible and relatively abundant prey, but not the frequent harvest, flood irrigation, and other activities of high quality habitat, it was assigned a value of “0.5”.

Multiplying the acreage in each habitat quality category by these relative values, and then summing the products, provides an estimate of the total forage available to Swainson’s hawks in the Natomas Basin. The units of this estimate are the equivalent acreage of high quality foraging habitat. These estimates, though rough approximations, provide an explicit, consistent basis for analyzing changes in the quantity of food potentially available to Swainson’s hawk in the Natomas Basin. Estimates were calculated for the Greenbriar, proposed reserve, and mitigation sites with and without the proposed project and DEIR mitigation.

In addition to these analyses, other effects on habitat quality for Swainson’s hawk and giant garter snake also were considered. As in the NBHCP, effects on habitat within 1 mile of recently documented Swainson’s hawk nests (i.e., nests documented in the last 5 years) were considered. For giant garter snake, effects were also considered for upland land cover types that could provide habitat and that were adjacent to canals.

2.3.5 CONNECTIVITY OF HABITAT IN THE NATOMAS BASIN

The Greenbriar project could affect the connectivity of habitat by eliminating or creating waterways, affecting the use of waterways by covered species, or by altering the length, width, or habitat attributes of existing corridors of natural vegetation. In assessing these effects, several assumptions were made including the following.

- All of the Greenbriar site would be developed, except for a 250-foot wide corridor along Lone Tree Canal.
- All waterways in the developed portion of the Greenbriar site would be eliminated.
- In the absence of avoidance and minimization measures, all waterways and uplands within 800 feet of the Greenbriar, Spangler, or Natomas 130 sites could potentially be affected by the project. (Ecologically significant effects caused by developed land uses were considered to not extend beyond an 800-foot wide zone adjacent to developed land cover and highways, and the basis for selecting this width is further described in Section 2.2.2 *Zones with Human-Wildlife Conflicts*.)
- At the proposed Spangler and Natomas 130 reserves, waterways would remain except where rice was converted to upland land cover, and land cover would be changed as described in the Draft Conceptual Restoration Plan prepared by Wildlands, Inc. (2005) and subsequent revisions by the project applicant.

Interpretations of effects on connectivity were based on general ecological literature regarding wildlife use of corridors, recent reviews of the ecology of covered species, and consultations with species experts. Along canals, potential changes in physical conditions (e.g., flow regime, culvert dimensions), vegetation structure and extent, human disturbance, and predation were all evaluated as factors potentially altering connectivity.

2.3.6 CONNECTIVITY OF TNBC RESERVES

The connectivity of TNBC reserves can be altered by altering upland corridors or waterways between existing reserves. Upland corridors are affected by narrowing their width, altering the habitat attributes of the land in them, or by altering their length. The assessment of these potential effects was based on the same assumptions and conducted in the same manner as previously described for Connectivity of Habitat in the Natomas Basin, except that only effects on corridors between existing reserves were considered rather than effects on all lands. (Corridors were considered to not pass through urban land.) We assumed that the most ecologically important upland corridors include the shortest paths between reserves.

Waterways are also important corridors connecting TNBC reserves. Thus, altering the location or habitat value of waterways could affect the connectivity of existing reserves. This effect was evaluated by identifying all waterways within 800 feet of the Greenbriar site, and determining if they were part of the shortest path along waterways between reserves, in a corridor between reserves with multiple waterways, or otherwise could be important for species movement between reserves (e.g., species use of the waterway has been documented). We also considered the recent documentation of habitat conditions along canals by Eric Hansen (Jones & Stokes 2005, Eric Hansen, unpublished data). Our analysis of waterways connecting TNBC reserves was based on analysis of GIS data for waterways in the Natomas Basin, and on boundaries of existing TNBC reserves, MAP, City of Sacramento, and Sutter County permit areas, and of the Greenbriar, Spangler, and Natomas 130 sites, and on species distribution data and consultation with knowledgeable individuals. For this analysis, ecologically significant effects of developed land uses and roads were not considered to extend in general beyond an 800-foot zone of adjacent land; the basis for selecting this width is further described in the section describing the evaluation of zones with human-wildlife conflicts.

2.3.7 HABITAT VALUE OF EXISTING TNBC RESERVES

Changes in adjacent land cover can affect existing TNBC reserves by altering foraging habitat accessible from a reserve or by altering the habitat values of reserve lands through development or preservation of adjacent lands. Thus, we performed three analyses to evaluate effects on the habitat value of existing TNBC reserves. These analyses are described below.

- The effects of the project on foraging habitat were evaluated based on changes in land cover because of the project within 800 feet and 1 mile of existing reserves. Most effects of developed land uses and roads were considered to not extend beyond an 800-foot wide zone of adjacent land. (The basis for selecting this width is described in the section describing the evaluation of zones with human-wildlife conflicts.) Furthermore, as summarized in Section 4 of this document (*Potential Effects of the Greenbriar Project on Covered Species*), the territories and home ranges of some covered (and many other) species residing at the reserves are unlikely to extend more than 800 feet from reserve boundaries. However, Swainson's hawk and other raptors have much larger home ranges and territories; for these species, land within 1 mile of reserves was considered to include the most important habitat for individuals nesting on reserves. (This premise is comparable to that underlying the analysis of Swainson's hawk habitat in the Natomas Basin presented in *Natomas Basin Conservation Plan Impacts to Proposed Covered Species* [CH2M HILL 2003] and included in Appendix K of the NBHCP).

- The effects of additional development on habitat values of TNBC reserves were evaluated by calculating the acreage of existing TNBC reserves within 800 feet of additional developed land cover that would result from the project. This 800-foot criterion is the desired distance of reserves from urban land (described on page IV-16 of the NBHCP) and also includes the area that would experience ecologically significant effects caused by adjacent developed land uses and roads.

- The proximity of the proposed reserves to existing reserves was examined to determine if any were adjacent to existing reserves, and if they expanded the area, increased the habitat variety or reduced the perimeter-to area ratio of the reserve.

2.3.8 WATER AVAILABILITY AT TNBC RESERVES

The project could alter water availability at TNBC reserves if it were to eliminate sections of canals that are required for water deliveries to TNBC reserves, contribute to the elimination of other canals by affecting demand for water deliveries and increase the land ownership of TNBC and its corresponding water use and ownership of stock in Natomas Mutual.

It was assumed that all canals in developed portions of the Greenbriar site would be eliminated, and that consequently, sections of canal off-site but directly connected to canal segments on the Greenbriar site could be abandoned. The connection of each of these eliminated or potentially abandoned canal segments to TNBC reserves was evaluated, and the effect on water availability to reserves was assessed.

In addition, Natomas Mutual and RD 1000 were contacted regarding waterways that could be eliminated because of the project. Elimination of canals or drains by these water agencies or due to a development project, however, would likely require mitigation under either Section 7 or Section 10 of the Endangered Species Act, and therefore their effects would likely be mitigated even if their elimination occurred separately from the project.

The project's effect on TNBC stock ownership in Natomas Mutual also was considered. Natomas Mutual is a privately held water company comprised of landowner stockholders. As TNBC acquires mitigation lands in the Natomas Basin, it increases its shares in Natomas Mutual. This increased ownership could result in TNBC changing operations and maintenance practices to support the goals and objectives of the NBHCP. The project would increase TNBC ownership and thus its influence on the operations of Natomas Mutual. The magnitude of this increase in ownership and its likely effects were assessed.

2.3.9 OPPORTUNITIES TO ESTABLISH ADDITIONAL TNBC RESERVES

The Greenbriar project could affect opportunities to establish additional TNBC reserves by reducing the acreage of land available for satisfying the mitigation requirements of the development permitted through the NBHCP, or by expanding existing reserves so that more interconnected reserves can be established that exceed the 400-acre minimum desired size. These potential effects were evaluated by estimating the acreage potentially available for NBHCP mitigation with and without the project, and by examining the connectivity of the proposed Spangler and Natomas 130 reserves to existing TNBC reserves.

The acreage potentially available for NBHCP mitigation without the project was estimated by subtracting the following areas from the Natomas Basin's total acreage of land suitable for preservation followed by restoration or enhancement: MAP, City of Sacramento, and Sutter County permit areas for urban development, the County-owned airport buffer, and levee slopes around the perimeter of the plan area. Land cover considered unsuitable for restoration or enhancement included existing developed land cover outside of permit areas, and other, ruderal and rural residential land cover.

The acreage potentially available for NBHCP mitigation after development of the project was estimated by subtracting the following areas from the acreage potentially available without the project: the proposed Spangler and Natomas reserves and the developed portion of the Greenbriar site (that otherwise would be suitable for preservation). The fragmentation by the project of a block of land that otherwise was potentially suitable for preservation also was considered.

The location of the proposed reserves was examined to determine if these lands expanded existing TNBC reserves, could contribute to the expansion of TNBC reserves in the future or could be expanded into a reserve that was greater than 400 acres in size, or if they were isolated from TNBC reserves by developed lands or other barriers.

2.4 BASIS FOR INTERPRETATIONS OF EFFECTS ON COVERED SPECIES

For each covered species, we evaluated:

- construction-related effects on individuals using the Greenbriar site or adjacent lands,
- change in habitat quantity, and
- change in habitat quality.

For this evaluation, the available information on the ecology and distribution of each covered species was compiled, reviewed, and summarized. Interpretations of construction-related effects on individuals were based on the analysis of the likely alterations of survival and reproduction of individuals using the Greenbriar site or adjacent lands. Interpretations of effects on habitat availability were based on the analysis of alterations to habitat acreage that was described previously.

Interpretations of change in habitat quality were based on the analyses of land cover acreages and connectivity of habitat in the Natomas Basin, and of the acreage in zones with human activity-wildlife conflicts. We also considered changes in the acreage of preserved lands, and in the acreage of high quality habitat.

For each covered species, the interpretations of effects on habitat acreage and quality (and of construction-related effects and human-wildlife conflicts) were used to evaluate the project's overall effect on the viability of the population using the Natomas Basin. A population's viability (i.e., its likelihood of long-term persistence) is strongly influenced by population size, population demography, and environmental variability (which in turn has a strong influence on reproduction and mortality). In the Natomas Basin, fluctuations in the acreage of crop types and changes in agricultural practices cause substantial environmental variability affecting the populations that rely on agricultural habitats. By reducing the quantity or quality of habitat, urban development can reduce population size and adversely affect demography.

2.5 BASIS FOR INTERPRETATIONS OF EFFECTS ON NBHCP CONSERVATION STRATEGY

The previously described analyses of effects on population and habitat attributes, and on covered species, were used to evaluate the potential effect of the Greenbriar project on the effectiveness of the NBHCP conservation strategy. This strategy is described in Section IV.C of the NBHCP. This section describes six key components of the NBHCP's conservation strategy for effectively mitigating 17,500 acres of urban development. These components are:

- basis for 0.5 to 1 mitigation ratio (Section IV.C.1.a),
- preparation of site specific management plans (Section IV.C.1.b),
- buffers within the reserve lands (Section IV.C.1.c),
- connectivity (Section IV.C.1.d),
- foraging habitat (Section IV.C.1.e), and
- 2,500-acre/400-acre minimum habitat block size requirements (Section IV.C.1.f).

Potential effects of the Greenbriar project on each of these components was assessed individually (using the results of the analyses described in Section 2.3 *Methodology for Analyzing Alterations of Populations and Habitats*); these effects were then synthesized into an overall effect of the Greenbriar project on the effectiveness of the NBHCP's conservation strategy.

2.6 BASIS FOR INTERPRETATIONS OF EFFECTS ON HCP GOALS AND OBJECTIVES

The NBHCP's goals and objectives represent the desired outcomes from implementation of the NBHCP's conservation strategy. Nine of the NBHCP's goals and objectives could be affected by the Greenbriar project. Table 2-4 lists these goals and objectives; it also identifies the population and habitat attributes potentially affected by the project that could affect attainment of the NBHCP's goals and objectives. This effects analysis evaluated the effects of the Greenbriar project on each of these nine goals and objectives of the NBHCP. Interpretations of the project's overall effect on the attainment of a goal or objective were based primarily on the sum of these anticipated effects. Substantial effects (beneficial or adverse) could alter the viability of a covered species or interfere with attainment of a goal or objective. Effects that would reduce the viability of a covered species, preclude attainment of a goal or objective, or otherwise result in a change to the NBHCP's conservation strategy were considered significant effects that would conflict with the NBHCP.

Table 2-4
Relationships Between Applicable NBHCP Goals and Objectives and Attributes Potentially Affected by the Greenbriar Project[1]

NBHCP Goals and Objectives	Species and Habitat Attributes							
	Survival and reproduction of individuals using Project Site or adjacent lands	Zones with human-wildlife conflicts	Acreage of habitat in Natomas Basin	Connectivity of habitat in Natomas Basin	Connectivity of existing TNBC reserves	Habitat value of existing TNBC reserves	Water availability at TNBC reserves	Opportunities to establish additional TNBC reserves
Overall Goal 1. *Establish and manage in perpetuity a biologically sound and interconnected habitat reserve system that mitigates impacts on Covered Species resulting from Covered Activities and provides habitat for existing, and new viable populations of Covered Species. (NBHCP page I-15)*	-	-	X	X	X	X	X	X
Overall Goal 3. *Preserve open space and habitat that may also benefit local, non-listed and transitory wildlife species not identified within the NBHCP. (NBHCP page I-16)*	-	-	X	X	X	X	X	X
Overall Goal 4. *Ensure that direct impacts of Authorized Development upon Covered Species are avoided or minimized to the maximum extent practicable. (NBHCP, page I-16)*	X	-	-	-	-	-	-	-
Overall Objective 1. *Minimize conflicts between wildlife and human activities, including conflicts resulting from airplane traffic, roads and automobile traffic, predation by domestic pets, and harassment by people. (NBHCP, page I-16)*	X	X	-	-	-	-	-	-
Overall Objective 3. *Ensure connectivity between TNBC reserves to minimize habitat fragmentation and species isolation. Connections between reserves will generally take the form of common property boundaries between reserves, waterways (primarily irrigation and drainage channels) passing between reserves, and/or an interlinking network of water supply channels or canals. (NBHCP, page I-16)*				X	X	X	X	

Table 2-4
Relationships Between Applicable NBHCP Goals and Objectives and Attributes Potentially Affected by the Greenbriar Project[1]

NBHCP Goals and Objectives	Species and Habitat Attributes							
	Survival and reproduction of individuals using Project Site or adjacent lands	Zones with human-wildlife conflicts	Acreage of habitat in Natomas Basin	Connectivity of habitat in Natomas Basin	Connectivity of existing TNBC reserves	Habitat value of existing TNBC reserves	Water availability at TNBC reserves	Opportunities to establish additional TNBC reserves
Wetland Species/Habitat Goal/Objective 1. *Acquire, enhance and create a mosaic of wetland habitats with adjacent uplands and connecting corridors to provide breeding, wintering, foraging, and cover areas for wetland species in the Plan Area. (NBHCP, page I-17)*				**X**	**X**	**X**	**X**	**X**
Wetland Species/Habitat Goal/Objective 2. *Provide habitat to maintain, attract and sustain viable populations of the Covered Species. The habitat areas should be configured to encompass natural species migration areas, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)*	-	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Upland Species/Habitat Goal/Objective 1. *Acquire, enhance and create a mosaic of upland habitat types for breeding, foraging, and cover for species dependent on upland habitats. (NBHCP, page I-17)*	-	-	**X**	-	-	**X**	-	**X**
Upland Species/Habitat Goal/Objective 2. *Ensure reserve land connectivity with travel corridors for upland-dependent species. The habitat areas should encompass grasslands, agricultural croplands, riparian habitats, and shelter and nesting habitat areas (fence rows, clusters of shrubs and small trees), as well as wetland areas to provide a year-round source of water for upland species. The upland areas should be configured to enhance natural species migration, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)*	-	-	-	**X**	**X**	**X**	-	**X**

Note:
[1] An "X" indicates that alteration of that species or habitat attribute could directly affect attainment of that goal or objective.

3 GREENBRIAR PROJECT'S ALTERATION OF POPULATION AND HABITAT ATTRIBUTES

3.1 CONSTRUCTION-RELATED EFFECTS ON SURVIVAL AND REPRODUCTION

Based on CNDDB, surveys of the Greenbriar site, and other data on the distribution of species in the Natomas Basin, species covered by the NBHCP that likely use the Greenbriar site include Swainson's hawk, burrowing owl, loggerhead shrike and giant garter snake. For these species, construction at the Greenbriar site could affect the survival and/or reproduction of individuals by killing, injuring or disturbing individuals, or by eliminating habitat that those individuals depend on for food or shelter. These potential effects are summarized below and described in detail in the sections addressing potential effects for each covered species.

Nesting Swainson's hawks could be affected by the project's construction activities. Though no Swainson's hawk nests have been documented on the Greenbriar, Spangler or Natomas 130 sites, five nests have been recently documented within one mile of the Greenbriar site, 12 nests within one mile of the proposed Natomas 130 reserve (where marsh habitat would be constructed), and 59 nests in the Natomas Basin (Jones & Stokes 2005). Swainson's hawks at any of these nest sites might have their reproduction and survival affected to some degree by construction of the project, and those at the nest sites within one mile could have reduced nesting success or abandon their nest. To avoid and minimize these potential effects, the project includes the same measures that were included in the NBHCP to avoid and minimize construction-related effects on Swainson's hawk. An evaluation of the applicability of NBHCP measures and their inclusion in the Greenbriar project and its mitigation is presented in Appendix A. (These measures are also comparable to those incorporated into the MAP HCP [which has been superseded by the 2003 NBHCP].)

Burrowing owls nesting on or near and foraging on the Greenbriar site could be affected by the project's construction activities. A burrowing owl has been observed on the Greenbriar site. Other burrowing owls could be residing on adjacent land, and any residing within about a mile of the Greenbriar site also could be foraging on the Greenbriar site. Construction of the project could cause nest abandonment or trap or injure owls in their burrows. To avoid and minimize these potential effects, the DEIR mitigation includes the same measures that were included in the NBHCP to avoid and minimize construction-related effects on burrowing owls. An evaluation of the applicability of NBHCP measures and their inclusion in the Greenbriar project and its mitigation is presented in Appendix A. (These measures are also comparable to those incorporated into the MAP HCP [which has been superseded by the 2003 NBHCP].)

Loggerhead shrikes nesting on or near (i.e., within a quarter-mile) and foraging on the Greenbriar site could be affected by the project's construction activities. Shrikes were observed on the Greenbriar site during March 2005 surveys. Because shrikes are distributed throughout the Natomas Basin and suitable habitat is present, shrikes also could be present at the proposed Natomas 130 reserve (where marsh habitat will be constructed). Construction of the project could cause nest abandonment. To avoid and minimize this potential effect, the project includes the same measures that were included in the NBHCP to avoid and minimize construction-related effects on loggerhead shrike. An evaluation of the applicability of NBHCP measures and their inclusion in the Greenbriar project or the DEIR mitigation is presented in Appendix A. (These measures are also comparable to those incorporated into the MAP HCP [which has been superseded by the 2003 NBHCP].)

Giant garter snakes foraging or residing on the Greenbriar site could be affected by the project's construction activities. Giant garter snakes have been observed along Lone Tree Canal, which provides high quality habitat for this species; the other canals on and bordering the Greenbriar site, and the uplands adjacent to these canals, also provide habitat for giant garter snake. The proposed reserve sites also contain or are bordered by giant garter snake habitat. Because giant garter snakes in the Natomas Basin travel widely (i.e., several miles or further) during their daily and seasonal movements, the Lone Tree Canal is an important movement corridor for this species, and the Greenbriar site contains suitable habitat, giant garter snakes could be killed or injured during construction activities.

The construction activities associated with the Greenbriar project would be comparable to those covered by the NBHCP, as are the species and habitats affected by these activities. Therefore, the applicable measures from the NBHCP would be appropriate for avoiding and minimizing this project's construction-related effects, and the project includes the same measures that were included in the NBHCP to avoid and minimize construction-related effects on giant garter snake. The DEIR (EDAW 2005) also proposes additional measures to avoid and minimize construction-related effects on giant garter snake including exclusion fencing erected prior to the onset of the dormant season preceding construction, routine monitoring of giant garter snakes stranded on the interior (i.e., construction side) of the fence, and documentation and reporting of mortality with the provision to modify avoidance and minimization measures to prevent future moralities due to similar causes.

3.2 ZONES WITH HUMAN-WILDLIFE CONFLICTS

As described in the methodology, areas within 800 feet of the MAP, City of Sacramento, or Sutter County permit areas, or major highways, were considered to be areas with high levels of potential human-wildlife conflicts. The Greenbriar project would reduce the total area, and the area of most land cover types, in these zones, and would include measures to reduce effects on adjacent habitats, but it would increase the area of rice and managed marsh within 800 feet of urban development or major highways. Overall, the project with the DEIR mitigation would not significantly increase human-wildlife conflicts in the Natomas Basin.

3.2.1 FUTURE CONDITIONS UNDER THE NBHCP

Under the future conditions resulting from implementation of the NBHCP, a portion of the Greenbriar site would be adjacent to urban development or major highways, and thus potentially experiencing high levels of human-wildlife conflicts. Urban development would be adjacent to the Greenbriar site along its eastern and western sides and part of its southern side (Exhibit 1). Lone Tree Canal and Lone Tree Road would be between the Greenbriar site and urban development to the west. Highway 99 would separate the site from the urban development to the east. Along the site's southern side, Interstate 5 would be between the site and both urban development and the agricultural or natural vegetation remaining to the southwest. Along the site's northern boundary, Elkhorn Boulevard would be a six land road between the Greenbriar site and agricultural or natural land cover to the north. The expansion of Elkhorn Boulevard was authorized by the MAP HCP, and although in this analysis it was not considered urban development or a major highway that would generate high levels of human-wildlife conflicts, it would increase levels of human-wildlife conflicts.

Under the future conditions resulting from implementation of the NBHCP, the proposed Spangler reserve would be bordered to the north by development in Sutter County's permit area. A portion of the Natomas 130 parcel would be within 800 feet of urban development in the City of Sacramento's permit area, but would be separated from it by Fisherman's Lake.

3.2.2 POTENTIAL EFFECTS OF GREENBRIAR PROJECT UNDER FUTURE CONDITION

Development of the Greenbriar project would reduce the area of habitat in zones with potentially high levels of human-wildlife conflicts. This counter-intuitive result would occur because the project would develop portions of the Greenbriar site that would otherwise be in such zones, and would create smaller new zones with potentially high levels of human-wildlife conflicts. Under the future condition resulting from the NBHCP, about 230 acres of the Greenbriar site would be within 800 feet of urban development or major highways. Development of the Greenbriar site would eliminate most of this acreage and would create a new, but smaller, zone with potentially high levels of human-wildlife conflicts north of the Greenbriar site (about 62 acres in size), because this undeveloped land would be within 800 feet of urban land after development of the project. The net change would be a reduction of 137 acres in the extent of areas with high levels of human-wildlife conflicts.

Though land to the north would be adjacent to development on the Greenbriar site, a six-lane road (Elkhorn Boulevard) would be between this land and residential development on the Greenbriar site. The road would partially isolate the Greenbriar site from land to the north, and thus limit human-wildlife conflicts resulting from the Greenbriar Project.

Nonetheless, the project would increase the area of rice and managed marsh that is within 800 feet of urban development or a major highway, and thus increase the area of giant garter snake, northwestern pond turtle and white-faced ibis habitat in zones with potentially high levels of human-wildlife conflicts. In the 2001 land cover map, the area within 800 feet of the northern border of the Greenbriar site was primarily in rice (53 of 62 acres). This acreage was greater than the 47 acres of rice on the Greenbriar site that were within 800 feet of the MAP or City of Sacramento permit areas. Thus, based on 2001 land cover for the Greenbriar site, the acreage of rice in areas with high levels of human-wildlife conflicts would increase as a result of developing the Greenbriar site. In addition, up to about 14.2 acres of managed marsh could be created at the proposed Natomas 130 reserve within 800 feet of the City of Sacramento's permit area for urban development, and at the proposed Spangler reserve about 37 acres of the created marsh could be within 800 feet of the Sutter County's permit area. At the proposed reserves, on-site buffers and reserve management (e.g., limiting access) would reduce human-wildlife conflicts, and the proposed Natomas 130 reserve is separated from urban development in the City of Sacramento by Fisherman's Lake, which also would limit human-wildlife conflicts.

Compared to the total area of land in the Natomas Basin that is within 800 feet of a major highway or of the MAP, City of Sacramento, or Sutter County permit areas, these changes are relatively small. There is approximately 2,790 acres of land outside of the three permit areas but within 800 feet of such areas or of a major highway. Thus, the Greenbriar project would reduce the area of these zones by about 5%. Similarly, there are roughly 1,420 acres of rice and managed marsh in these zones, and the Greenbriar project would increase this area by 4% (52 acres).

Without mitigation, the Greenbriar project also could increase human-wildlife conflicts along Lone Tree Canal. Under the future condition resulting from the NBHCP, a 1.1 mile section of the Lone Tree Canal would be within 800 feet of urban development; these urban land uses and highways would be adjacent to one bank of the canal except at road crossings. Development of the project would place urban land uses within 200 feet of the other bank of Lone Tree Canal as well. The Lone Tree Canal is an important corridor for animal movement, particularly for giant garter snake. The project's potential effects on this canal, and measures to reduce those effects, are discussed in detail in Section 3.4 *Connectivity of Habitat in the Natomas Basin*.

The project and its mitigation would also implement measures to reduce human-wildlife conflicts. The project includes all of the applicable measures incorporated into the NBHCP to avoid and minimize human-wildlife conflicts. An evaluation of the applicability of NBHCP measures and their inclusion in the Greenbriar project or the DEIR mitigation is presented in Appendix A. To further reduce human-wildlife conflicts along Lone Tree Canal, the project also would implement a comprehensive set of measures including fencing and a barrier. These measures are described in more detail under Section 3.4 *Connectivity of Habitats in the Natomas Basin* and would be further developed during the HCP process.

Overall, the Greenbriar project, with the DEIR mitigation, would not cause a significant increase in human-wildlife conflicts in the Natomas Basin. This is in part because much of the Greenbriar site is, or under NBHCP and MAP permit conditions would be, bordered by urban development, highways, and major roads under the future condition, and in part because of the measures incorporated into the project and the DEIR mitigation.

3.3 HABITAT ACREAGE IN THE NATOMAS BASIN

The project would reduce the acreage of habitat available in the Natomas Basin for several species covered by the NBHCP. These losses would result from changes in land cover at the Greenbriar and proposed reserve sites.

3.3.1 CHANGE IN HABITAT ACREAGE AT THE GREENBRIAR SITE

The Greenbriar project would alter the Greenbriar and proposed reserve sites. Most of the Greenbriar site would be converted to urban land cover (Exhibit 2, Table 3-1). But, a 30.6 acre area along the western edge, bordering the Lone Tree Canal, would be conserved. This area would be preserved, restored as tule marsh (approximately 2.7 acres) or native grassland, and added to the TNBC reserve system. (The existing, disturbed patch of riparian land cover [at the southern end of this conserved area] would probably recover and persist.)

Table 3-1
Land Cover Acreages of Greenbriar Project

Land Cover Types	Greenbriar Site[1]			Proposed Spangler & Natomas 130 Reserves[2]			Total		
	2001	2005	Post-Project	2001	2005	Post-Project	2001	2005[3]	Post-Project
Alfalfa	-	-	-	-	-	59.6			59.6
Canals	15.0	15.0	-	7.6	7.6	6.2	22.6	22.6	6.2
Grassland	-	-	26.5	-	-	-	-	-	26.5
Idle	62.5	115.1	-	-	28.4	-	62.5	143.5	-
Non-rice crops	234.1	381.0	-	28.4	-	-	262.6	381.0	-
Pasture	33.8	-	-	-	-	-	33.8	-	-
Ponds & seasonally wet areas	-	1.7	2.7	-	-	198.2	-	1.7	200.9
Rice	160.0	-	-	228	228	0	395.4	228	0
Riparian	1.4	1.4	1.4	1.6	1.6	1.6	3.0	3.0	3.0
Roads and Highways	17.5	17.5	-	-	-	-	17.5	17.5	-
Ruderal	9.2	2.0	-	-	-	-	9.2	2.0	0
Rural Residential	43.3	43.3	-	-	-	-	43.3	43.3	-
Tree Groves	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2
Urban	-	-	546.4	-	-	-	-	-	546.4
Total	577	577	577	265.8	265.8	265.8	842.8	842.9	842.9

Note:
1 The Greenbriar site included the 30.6 acre area along Lone Tree Canal that would become a preserve and 546.4 acres that would be developed. Lone Tree Canal was considered immediately adjacent to but outside of the project site.
2 Reserve acreages do not include the additional preservation and enhancement of upland habitats required by mitigation measure 6.13-2 of the DEIR because location, acreage, and current land cover of this land has not been determined.
3 These 2005 acreages differ from those in the DEIR because they were based on a GIS analysis comparable to that performed for 2001 (as described in the methods) and the DEIR acreages were based on a different analysis that included a field survey of the site.

If the Greenbriar site were to remain predominantly in agricultural land cover, a variety of crops probably would be cultivated on it and portions of the site would be idle in many years. Land cover in 2001 and 2005 indicates the range of habitat values the Greenbriar site could provide over the long-term, and thus that would be lost by the site's development. In 2001, the site contained idle, pasture, ruderal, canal, rice, riparian, non-rice crops, and rural residential land cover (Table 3-1). In 2005, pasture and rice were no longer present and the area of idle and non-rice cropland had expanded.

Estimates of habitat loss depend on whether they are based on 2001 or 2005 land cover. For some species (e.g., giant garter snake), estimates of habitat loss would be greater if based on 2001 land cover than if based on 2005 land cover. For other species (e.g., Swainson's hawk), estimates of habitat loss would be greater if based on 2005 land cover. For evaluating how the project would alter the future condition of the Natomas Basin, changes from 2001 land cover were used because 2001 land cover was the baseline for the NBHCP's estimates of future habitat conditions.

Although different analyses were conducted for this effects analysis and for the DEIR, both considered 2001 and 2005 conditions. To evaluate the proposed project's effects on the effectiveness of the NBHCP, this effects analysis performed an extensive analysis of the project's potential effects on the future condition of the Natomas Basin. This analysis used the 2001 land cover data that represents baseline conditions of the NBHCP, and also considered 2001–2004 changes in land cover, and 2005 conditions. To comply with CEQA requirements and to assure that the proposed project does not compromise the effectiveness of the NBHCP, the impact analysis in the DEIR evaluated conditions documented in 2005 when the Notice of Preparation (NOP) was released, and provides mitigation designed to reduce impacts to less than significant under both 2005 conditions (for CEQA purposes) and 2001 conditions (to assure that the project does not compromise the effectiveness of the NBHCP).

3.3.2 Change in Habitat Acreage at Proposed Reserve Sites

Land cover would also be altered at the proposed reserve sites (Table 3-1). Approximately 45 acres of the Spangler site would be converted to upland foraging habitat (assumed to be alfalfa), 184 acres would be converted to marsh that would include upland components, and about 6 acres would be canal. At the Natomas 130 site, about 14 acres that were in non-rice crops in 2001, and are currently idle, would be converted to marsh, about 2 acres would remain in riparian habitat, and the remaining 14 acres at this site would be managed as foraging habitat for Swainson's hawk. The location and existing land cover of the mitigation site(s) providing at least an additional 49 acres of Swainson's hawk foraging habitat (to fulfill mitigation measure 6.13-2 of the DEIR) have not been specified, and thus the effects of these land cover changes are not included in Tables 3-1, 3-2 and 3-3. However, this mitigation needs to provide high quality habitat for Swainson's hawk, and so land would probably be converted from non-rice crops to alfalfa (or otherwise be managed to provide high quality foraging habitat).

3.3.3 Overall Change in Habitat Acreage

Together, these changes at the Greenbriar and proposed reserve sites, but not including additional DEIR mitigation for Swainson's hawk, would reduce the acreage of several natural or agricultural land cover types that provide habitat for covered species, and would increase the acreage of alfalfa, grassland, and of ponds or seasonally wet areas (Table 3-2).

Based on 2001 land cover, these changes represent a reduction in habitat acreage for most species that use non-rice cropland and other upland land cover, a net gain of habitat for two plant species that grow in wetlands and along canals, and a net loss for species using both canal and rice land cover (Table 3-3, which does not include additional DEIR mitigation for Swainson's hawk). (No change in the acreage of vernal pool or riparian habitats would result from the project.) Except for burrowing owl, the covered species that forage in non-rice crops and other upland land cover (Swainson's hawk, loggerhead shrike, tricolored blackbird, Aleutian Canada goose, and bank swallow) would lose from about 14 to 684 acres of habitat. Because the acreage of created marsh habitats would be much greater than the acreage of lost canal habitats, potential habitat for Sanford arrowhead and delta tule pea (which occur in marsh or canal habitats) would increase by 184 acres.

The acreage of habitat would decrease for white-faced ibis, giant garter snake, and northwestern pond turtle by 144–204 acres, because the loss of rice and canal habitats would be greater than the acreage of marsh created from non-habitat (Table 3-3).

Table 3-2
Change in Land Cover Acreage Because of Natomas Basin HCP and Greenbriar Project

Land Cover	Natomas Basin 2001[1]	Future Condition Resulting from NBHCP[1, 2]	Future Condition Resulting from NBHCP Plus Project[1, 2, 3, 4]	
			2001 Greenbriar Land Cover	2005 Greenbriar Land Cover
Airport	1,532	1,492	1,492 (0)	1,492 (0)
Alfalfa	368	368	427 (60)	427 (60)
Canals	1,753	1,162	1,146 (-16)	1,146 (-16)
Grassland	882	284	311 (27)	311 (27)
Highway or Major Road	1,353	770	753 (-18)	753 (-18)
Idle	1,449	422	360 (-63)	307 (-115)
Non-rice Crops	16,395	9,533	9,271 (-263)	9,152 (-381)
Oak Grove	94	77	77 (0)	77 (0)
Orchard	178	165	165 (0)	165 (0)
Other	460	314	314 (0)	314 (0)
Pasture	660	494	460 (-34)	494 (0)
Ponds & Seasonally Wet Areas	93	2,259	2,460 (201)	2,458 (199)
Rice	22,129	11,643	11,255 (-388)	11,415 (-228)
Riparian	115	91	91 (0)	91 (0)
Ruderal	1,882	370	361 (-9)	368 (-2)
Rural Residential	369	287	244 (-43)	244 (-43)
Tree Grove	102	44	44 (0)	44 (0)
Urban	3,725	23,763	24,309 (546)	24,309 (546)
Total	**53,538**	**53,538**	**53,538**	**53,538**

Notes:

[1] Acreage along Class II-IV canals included in acres of canals, thus reducing acreages in other categories from those given in NBHCP.

[2] Acreages include changes in land cover occurring at proposed Spangler and Natomas 130 reserves.

[3] Change in acreage from future condition of NBHCP is in parentheses.

[4] Changes resulting from the preservation and enhancement of upland habitat required by Mitigation Measure 6.13-2 are not included in these acreages.

Table 3-3 Change in Habitat Acreage Because of Natomas Basin HCP and Greenbriar Project				
Species	Natomas Basin 2001[1]	Future Condition Resulting from NBHCP[1, 2]	Future Condition Resulting from NBHCP Plus Project[1, 2, 3, 4]	
			2001 Greenbriar Land Cover	2005 Greenbriar Land Cover[5]
Giant garter snake	23,975	15,064	14,860 (-204)	15,019 (-45)
Swainson's hawk (Nesting)	311	211	211 (0)	211 (0)
Swainson's hawk (Foraging)[6]	21,636	12,018	11,796 (-222)	11,638 (-380)
Burrowing owl[6]	6,994	3,647	3,673 (24)	3,631 (-16)
Loggerhead shrike	24,339	15,555	15,415 (-141)	15,254 (-301)
Tricolored blackbird (foraging)	40,434	22,322	21,724 (-598)	21,799 (-523)
Aleutian Canada goose	39,184	21,670	20,986 (-684)	21,061 (-609)
White-faced ibis	24,343	15,432	15,228 (-144)	15,446 (-14)
Bank swallow	42,395	25,834	25,420 (-414)	25,494 (-340)
Valley elderberry longhorn beetle	115	91	91 (0)	91 (0)
Northwestern pond turtle	24,090	15,155	14,951 (-204)	15,110 (-45)
Sanford's arrowhead	1,846	3,421	3,605 (184)	3,604 (183)
Delta tule pea	1,846	3,421	3,605 (184)	3,604 (183)

Notes:

1 Acreage along Class II-IV canals were included in acres of canals, thus reducing acreages in other land cover categories from those given in NBHCP as baseline conditions; this altered habitat estimates as well.

2 Acreages include changes in land cover occurring at proposed Spangler and Natomas 130 reserves, and assume that land in MAP, City of Sacramento, and Sutter County permit areas would not provide habitat under future conditions.

3 Change in acreage from future condition because of NBHCP is in parentheses.

4 Changes resulting from the preservation and enhancement of additional upland habitat to satisfy Mitigation Measure 6.13-2 are not included in this table's acreages because the acreage, location, and current land cover of this land has not been specified.

5 2005 habitat acreages differ from those in the DEIR because different methodologies were used; this effects analysis relied on a GIS analysis comparable to analyses of 2001 land cover, whereas the DEIR used by GIS analyses and field surveys by biologists .to estimate habitat acreages.

6 For these species future condition acreages also include upland components of created marshes.

3.4 HABITAT QUALITY IN THE NATOMAS BASIN

Besides these changes in habitat acreage, changes in the quality of the remaining habitat also would occur. In part, changes in habitat quality result from changes in the acreage of land cover types providing lower or higher habitat quality. For example, the project would increase ruderal land cover that provides habitat for Swainson's hawk, burrowing owl, and loggerhead shrike, but this habitat is of lesser quality than that provided by other land cover types, including types whose acreage was reduced by the project (e.g., idle cropland). Similarly, marshland created by the project would provide higher quality habitat for some species (e.g., northwestern pond turtle and white-faced ibis) than the canal habitats eliminated by the project.

3.4.1 HABITAT QUALITY ADJACENT TO THE GREENBRIAR SITE

Habitat quality would be reduced on land adjacent to development at the Greenbriar site. Roads, urban, and exurban development detrimentally affect the provision of wildlife habitat and other ecosystem functions on adjacent lands. These effects are caused by a wide variety of mechanisms that include alteration of hydrology, water quality, disturbance regimes, and vegetation structure, and the introduction of non-native species, collisions with vehicles, noise disturbance, and harassment by humans, and predation by cats, dogs, and wildlife associated with human land uses. The distance that effects on wildlife habitat extend from developed land varies with the mechanism causing the effect, the species affected, and attributes of the development and its surrounding landscape, but distances may range from less than 10 to over 1,000 feet (De Snoo and de Wit 1998, Forman and Alexander 1998, Paul and Meyer 2001, ELI 2003, Miller et al. 2003, Allan 2004). The most likely causes of effects on adjacent habitats because of the project are:

- Decreased runoff to and lower water levels in Lone Tree Canal,
- Spread of non-native invasive species,
- Harm and harassment by humans, cats, and dogs,
- Dumping of trash,
- Increased levels of noise and nighttime light, and
- Loss of upland vegetation adjacent to canals.

Several of these effects on wildlife habitat could extend hundreds of feet from the site. Although the mechanisms by which development affects habitat are well understood, a moderate level of uncertainty exists regarding the magnitude and location of the effects resulting from specific development projects (including the Greenbriar project). The degradation of habitat on adjacent lands is also assessed in the sections of this report that address zones with high levels of human-wildlife conflicts and those addressing effects on covered species.

In addition, the habitat quality of adjacent agricultural lands would be altered by changes in crop types or the cessation of agriculture. Land cover on adjacent land north of the Greenbriar site could possibly change because of conflicts between rice cultivation and the residential development created by the project. Aerial application of pesticides and herbicides probably is not feasible immediately adjacent to residential development (C. Aubry, pers. comm.), which could cause part, or all, of the adjacent parcel to be removed from rice cultivation. The North Natomas Community Plan has reduced these conflicts through a 350-foot wide buffer of open space along roads separating developed and agricultural land uses (EDAW 2005). Similarly, the Metro Air Park includes a 250-foot wide buffer along its northern and eastern borders in which developed land uses are restricted to open space, warehouses, or parking areas (USFWS 2001). The Greenbriar project would not contain an open space buffer along its borders between its development and adjacent land uses, and the only buffer would be Elkhorn Boulevard, which would be a six lane road. The project would include notification of all prospective residents and tenants within 500 feet of existing agricultural uses describing the types of agricultural operations that could occur in proximity to their homes or businesses (DEIR mitigation measure 6.11-3). Nonetheless, agricultural-residential conflicts could occur.

The extent of potential conflicts is not known. If all agricultural use of land within 350 feet of the project's residential development were to cease, roughly 23 acres of rice would become idle land. This would increase the project's effects on giant garter snake, and on other species associated with rice but not idle land, and would decrease the project's effects on Swainson's hawk and other species associated with idle land but not rice. However, other scenarios are equally plausible, and it would be speculative to quantify the habitat that could be affected, and base mitigation on that estimate.

In addition to these local effects, development also degrades wildlife habitat through landscape-scale effects on the distribution of habitat. These effects are described in sections of this report addressing effects on connectivity, the habitat value of existing reserves, and on covered species.

3.4.2 HABITAT QUALITY AT PROPOSED RESERVES

Habitat quality would be increased through preservation and management of at least 345 acres at the Spangler, Natomas 130, Greenbriar, and DEIR mitigation sites. Habitat quality would increase at these sites because:

1. Habitat would be preserved in perpetuity;
2. Habitat would be monitored and actively managed for the benefit of covered species;
3. Habitat would not be subject to continuous disturbance caused by farming or canal maintenance activities; and
4. Habitat would be relatively free of human intrusion (USFWS 2003).

In addition to the increase in habitat quality resulting from preservation, habitat quality would be increased at the proposed reserves as a result of habitat enhancement and conversion to land cover types that provide higher quality habitat.

As part of the proposed project, at the Spangler site, 184 acres of rice at the Spangler site and 14 acres of upland at the Natomas 130 site would be converted to marsh that provides higher quality habitat, and would be managed to increase habitat quality for covered species, particularly giant garter snake. Managed marsh provides substantially greater habitat values for giant garter snakes than does rice for several reasons. These reasons include:

- Giant garter snakes primarily use the margins of rice fields, whereas they use the full extent of managed marshes. These marshes are designed to provide open water, foraging habitat, dense cover, basking sites, and refugia in close proximity throughout the marsh. (For example, an acre of managed marsh provides several times the edge habitat than does a rice field.)

- Marshes provide habitat throughout the active period of the snake. Rice fields do not provide habitat during early and mid-spring, and are typically drained before the end of the snake's active period. Thus, for a portion of their active period, giant garter snakes must rely entirely on non-rice habitats. In the Natomas Basin, these habitats are canals and managed marsh. In contrast, managed marshes provide habitat year-round.

- Rice is fallowed periodically, and thus does not provide habitat in all years; in contrast, a managed marsh does provide habitat in all years.

The quality of existing upland habitats also would be enhanced at the proposed reserves and the DEIR mitigation site(s). Upland habitat at the proposed Spangler and Natomas 130 reserves would be enhanced, and additional mitigation land (at least 49 acres) would be enhanced through conversion to alfalfa (or would be otherwise managed to provide high quality foraging habitat for Swainson's hawk).

However, some uncertainty exists regarding the magnitude of habitat enhancement that would result from the project. For example, marsh creation would be used to replace habitat values lost at the Greenbriar site because marsh has greater habitat value than rice. (The general basis for this scenario is repeatedly outlined in the NBHCP, EIR, and BO.) And, for the reasons given previously, this difference in habitat value is inferred to be substantial. But, studies have not yet been conducted that document this difference in habitat value between managed marsh and rice. Furthermore, most marshes created by TNBC are only several years old, and the habitat attributes of created marsh changes rapidly during their first few years. Therefore, the long-term results of marsh creation and management have not yet been determined. Currently, it is known that giant garter snakes are using created marshes to some extent, our understanding of giant garter snake's ecology supports arguments that marsh provides substantially higher quality habitat than rice (and higher quality than canals), and preserved lands are more likely to continue to provide habitat than unpreserved lands.

The effects of changes in the quality of habitat provided by enhanced and preserved land, are further described in the sections of this report that address potential effects on each covered species.

3.4.3 HABITAT QUALITY FOR SWAINSON'S HAWK FORAGING

The effects of the Greenbriar project on the quality of Swainson's hawk foraging habitat was evaluated through three analyses: acres of foraging habitat in low, moderate and high quality categories; total acres of foraging habitat available per month; and total foraging habitat available each month expressed as an equivalent acreage of high quality foraging habitat. The first two analyses (acres by habitat quality category and monthly availability) were conducted as in the NBHCP, and the third was developed for this evaluation of the Greenbriar project. All three methods are described in detail in the methods section. The acres of habitat types at the Greenbriar, proposed reserve and DEIR mitigation sites with and without the project that were used in these analyses of effects on Swainson's hawk foraging habitat are shown in Table 2-2.

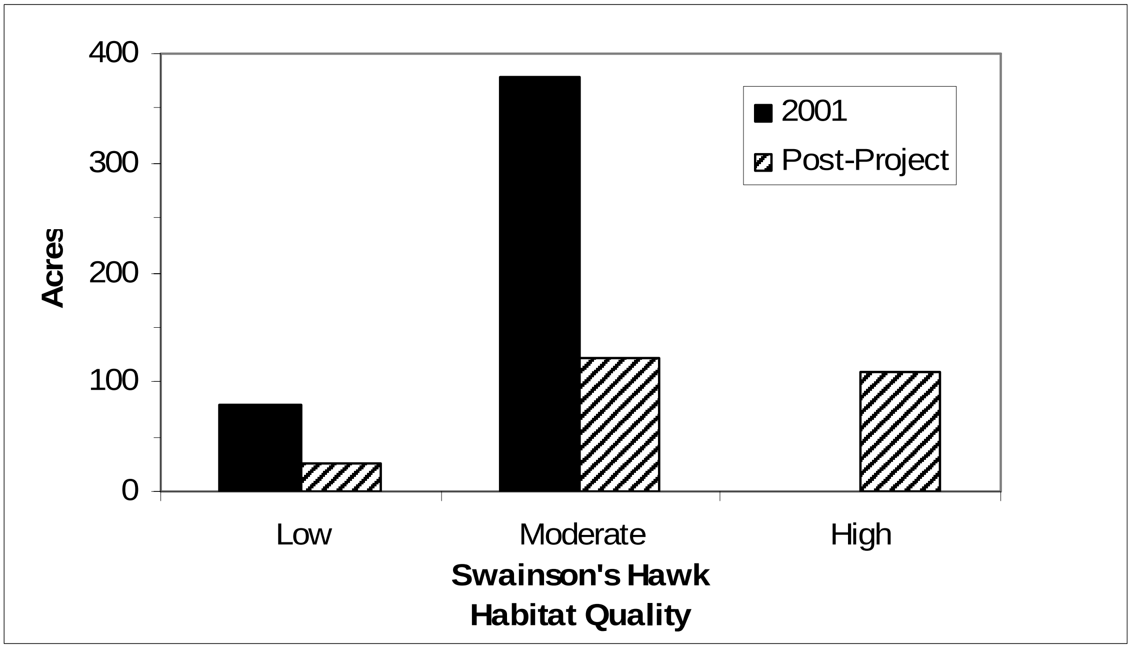
The project would result in a net loss of habitat acreage but an increased percentage of the remaining habitat would be in the high quality category (Exhibit 3a). This increase in high quality habitat would result from enhancement of habitat at the Spangler, Natomas 130, and the DEIR mitigation sites. Upland habitat at the proposed Natomas 130 reserve would be enhanced, and high quality foraging habitat would be created at the proposed Spangler reserve and to satisfy the DEIR mitigation at least 49 acres of land would be enhanced and managed to provide high quality foraging habitat for Swainson's hawk.

Based on the analysis approach in the NBHCP, the project would result in greater availability of foraging habitat during April–September, despite causing a net loss in overall acreage of habitat (Exhibit 3b). (However, this approach assumes that row and field crops are not available to foraging hawks except at harvest, and thus underestimates the acreage of foraging habitat available, particularly during April–May, which is prior to the harvest of row and field crops in the Natomas Basin.)

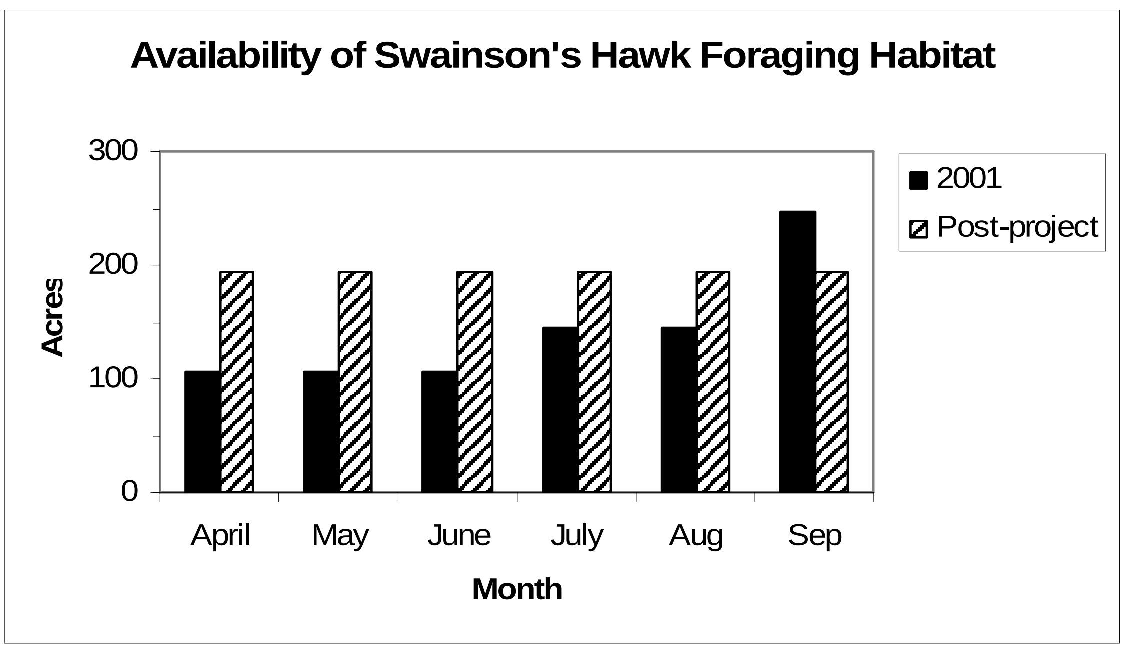
Based on EDAW's evaluation approach, total foraging resources would be comparable with and without the project. At the Greenbriar, proposed reserve, and DEIR mitigation sites, during April–June, slightly greater foraging resources would be available with the project (the equivalent of 129 acres of high quality foraging habitat with versus 122 acres without the project), while during July–September there would be less (129 versus 140 acres in July–August and 162 acres in September) (Exhibit 4). (Throughout the Natomas Basin, during July–September, more foraging resources are available because that is when most crops are harvested [CH2M HILL 2003].)

3.5 CONNECTIVITY OF HABITAT IN THE NATOMAS BASIN

The Greenbriar project would cause adverse and beneficial effects on connectivity of habitats in the Natomas Basin. By developing the Greenbriar site, it would fragment habitats for loggerhead shrike, burrowing owl, Swainson's hawk, and the other covered bird species, which would adversely affect connectivity. It also could cause detrimental effects on connectivity because of human disturbance and predation on giant garter snake and northwestern pond turtle using habitat along Lone Tree Canal. However, the project and the DEIR mitigation include measures to reduce human disturbance and predation effects resulting from the project, and to create and enhance habitat along Lone Tree Canal, which would beneficially affect connectivity of canal and marsh habitats. In addition, the proposed reserves would increase connectivity of habitats for giant garter snake and northwestern pond turtle. Further, the project would ensure the long-term conservation of a corridor along a segment of Lone Tree canal. This canal is important for maintaining connectivity of canal habitats between the southern and northern Natomas Basin, but a corridor along the canal has not yet been preserved.



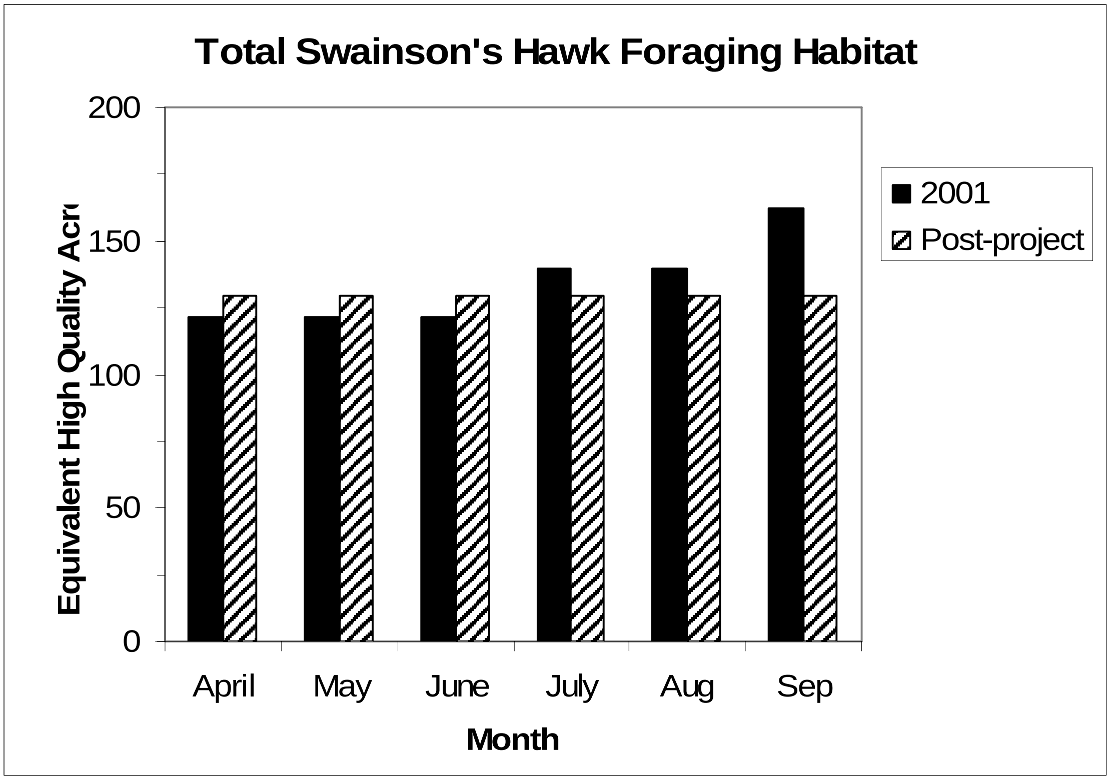
A) Total acres of high, moderate, and low quality habitat at the project and mitigation sites; quality assessed as in CH2M Hill 2003.



B) Acres of foraging habitat available by month; availability of prey assessed as in CH2M Hill 2003.

Notes: Estimates are based on approach used by CH2M Hill to support the NBHCP.
Sources: Wildlands 2005, DWR 1993, and CH2M Hill 2001

Quality and Availability of Swainson's Hawk Foraging Habitat at the Project and Mitigation Sites **Exhibit 3**



Low, moderate, high-moderate, and high quality habitats were combined in an estimate of the acreage of high quality habitat providing equivalent foraging resources, as described in the methods section.

Sources: Wildlands 2005, DWR 1993, and CH2M Hill 2001

Total Swainson's Hawk Foraging Habitat **Exhibit 4**

Overall, the project (with the mitigation included as part of the project design and with the DEIR mitigation) is unlikely to significantly reduce connectivity of habitat for covered bird species. Depending on the location, land cover, and management of the mitigation land providing foraging habitat for Swainson's hawk, the project could cause small, but significant, effects (adverse or beneficial) on connectivity of habitat for covered bird species.

The following sections provide a detailed description of the Greenbriar project's effects on connectivity at the regional and local levels, and along Lone Tree Canal. This section also evaluates the effect of the Greenbriar project on the implementation of the connectivity measures in the NBHCP's conservation strategy.

3.5.1 Overview of Existing and Future Conditions

In 2001 and currently, the proposed Greenbriar site provides agricultural and canal habitats, as do some adjacent lands. However, because the Greenbriar site is bordered to the south and east by Interstate 5 and State Route 99, respectively, habitats for less mobile animals, or those highly sensitive to human disturbance, are at least partially isolated from similar habitats to the east or south. Birds, including covered species, can fly over these highways. The Greenbriar site's canal habitats are connected to similar habitats to the south by a culvert under Interstate 5 through which Lone Tree Canal flows, and the site's canal habitats are also connected to habitats north of the site by Lone Tree Canal and a culvert in the northeastern corner of the site. These culverts may limit animal movement from the southern to central Natomas Basin across the site. Nonetheless, Lone Tree Canal currently provides a movement corridor and habitat for giant garter snake. In recent years, flows in the canal have not been optimal for giant garter snake, although the Metro Air Park HCP provides assurances that at least some water will be present in this drainage canal in the future (see pages 70-71 in Thomas Reid Associates 2001). The other canals within and along the southern and eastern borders of the Greenbriar site also have recently provided (or still provide) some habitat for giant garter snake, and they may also serve as a movement corridor. Lone Tree Canal is the primary remaining corridor for movement of giant garter snakes between the southern and central portions of the Natomas Basin (C. Aubry, pers. comm.; E. Hansen, pers. comm.). Loss of this corridor could isolate the southern portion of the Natomas Basin, dividing the current giant garter snake population into two smaller populations, which would substantially reduce the likelihood of giant garter snakes persisting in the Natomas Basin.

Under the future condition (i.e., assuming development as permitted under the NBHCP), the Greenbriar site would occupy much of one of two remaining corridors connecting the southern and central Natomas Basin. Except for these two corridors, the Sacramento International Airport, Metro Air Park and City of Sacramento would separate the southern and central Basin (Exhibit 1). A western corridor, between the airport and the Sacramento River, would be 0.4–1.6 miles wide. This western corridor may not contain sufficient canal, rice and wetland habitats to provide for connectivity of populations of giant garter snake, western pond turtle and other wetland and aquatic species between the southern and central portions of the Natomas Basin. To the east, another corridor would pass between the Metro Air Park and the City of Sacramento. At Interstate 5, this corridor would be about 0.4 miles wide and at the northern end of the Greenbriar site it would be almost a mile wide. In this eastern corridor, the Lone Tree Canal, which passes under Interstate 5, would be an important waterway, and possibly the only waterway, connecting habitats in the southern and central Natomas basin (Jones & Stokes 2005; C. Aubry, pers. comm.; E. Hansen, pers. comm.); this canal has a north-south orientation along the western edge of this corridor.

Under the future condition, the proposed Spangler and Natomas 130 reserves would be outside of but adjacent to permit areas where development has been authorized. The northern border of the proposed Spangler reserve would be immediately adjacent to development in the Sutter County permit area. The eastern border of the proposed Natomas 130 reserve would be across Fisherman's Lake from development in the City of Sacramento's permit area.

3.5.2 CONNECTIVITY OF AQUATIC, WETLAND, AND RICE HABITATS WITHIN THE NATOMAS BASIN

Within the Natomas Basin, aquatic, wetland, and rice habitats are connected by a series of irrigation and drainage canals. Most of these waterways are suitable for use and movement of a variety of animals, including giant garter snake and western pond turtle, and thus provide movement corridors for these animals between wetland and rice habitats.

In the Natomas Basin, irrigation water is provided by Natomas Central Mutual Water Company (Natomas Mutual), a private water company. Natomas Mutual diverts water from five locations along the Sacramento River and the Natomas Cross Canal, and distributes this water throughout the Basin through a series of canals and pump stations.

Drainage and flood control is provided by Reclamation District (RD) 1000, a public agency. RD 1000 operates the primary drainage canals within the Natomas Basin and is responsible for conveying and pumping nonurban stormwater runoff from the Basin. Runoff from agricultural lands within the Natomas Basin flows into numerous local drainage ditches that ultimately flow into the primary RD 1000 canals. RD 1000's primary system of interior drains includes the following:

- The East Drainage Canal conveys drainage water from the northern and eastern Natomas Basin to its confluence with the Main Drainage Canal northwest of the Interstate 80 (I-80)/Interstate 5 (I-5) interchange. At its closest point the East Drainage Canal is approximately 1.8 miles east of the Greenbriar site.

- The West Drainage Canal conveys drainage water from the western Natomas Basin northwest of Sacramento International Airport to its confluence with the Main Drainage Canal. Fisherman's Lake, a natural slough, is a portion of the West Drainage Canal. The West Drainage Canal is approximately 3,000 feet (0.6 mile) south of the Greenbriar site at its closest point across I-5, just before the drainage canal turns south toward Fisherman's Lake.

- The Main Drainage Canal conveys the combined flows of the East and West Drainage Canals from their confluence northwest of the I-80/I-5 interchange through South Natomas west of I-80. Drainage water from the Main Drainage Canal is pumped into the Sacramento River approximately 5 land miles to the south (downstream) of the Greenbriar site.

- The North Drainage Canal is an interior canal that conveys drainage water from the Sutter County portion of the Natomas Basin northward, where it is pumped into the Natomas Cross Canal.

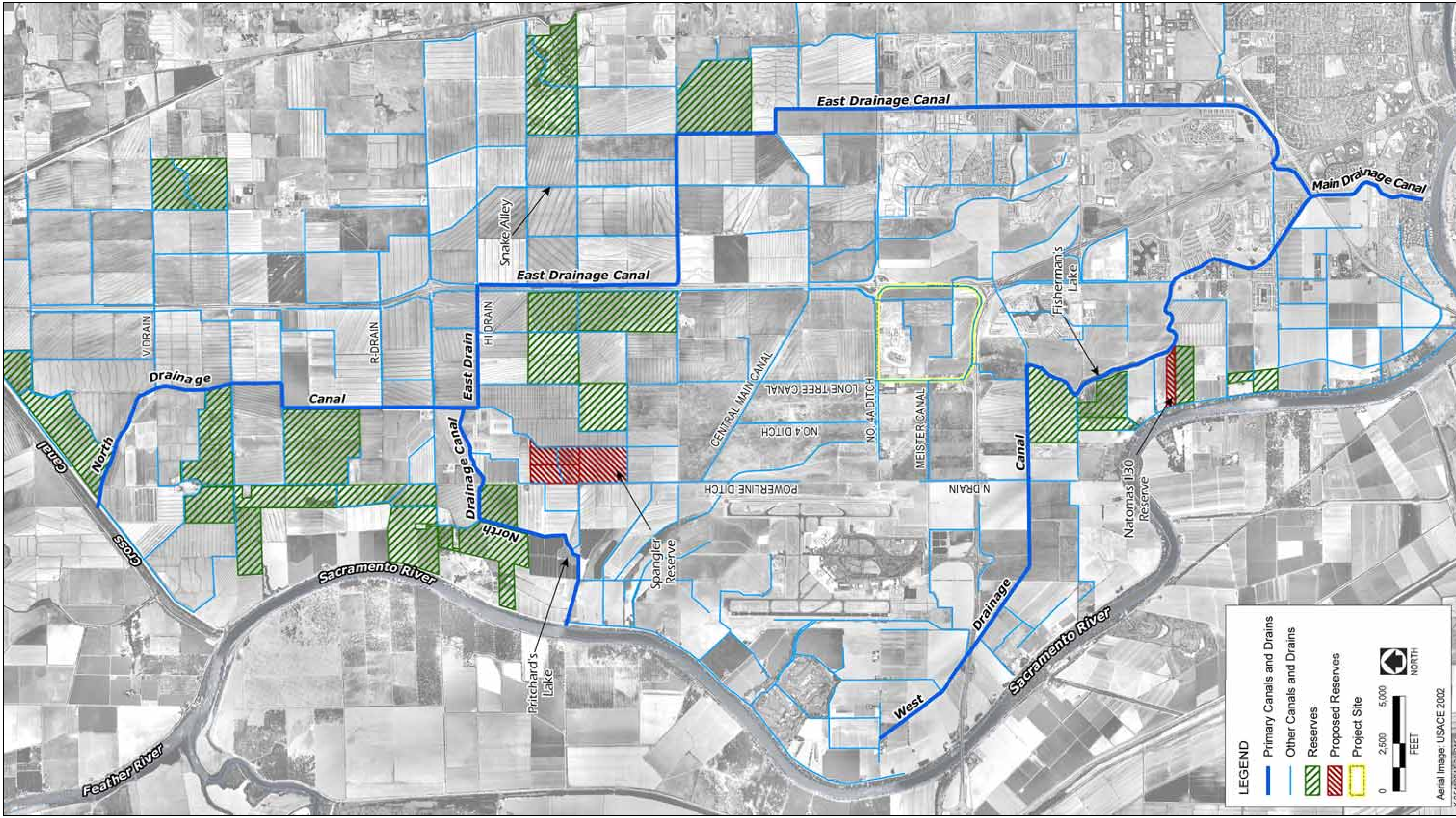
- The Cross Canal conveys drainage water from central portions of Sutter County westward to the Sacramento River. The Cross Canal connects with the Sacramento River approximately 7.1 miles north of the Greenbriar site.

- The Natomas East Main Drainage Canal conveys drainage water from Dry Creek, Arcade Creek, and a large portion of the Natomas area north of the confluence with Dry Creek. The Natomas East Main Drainage Canal is also referred to as Steelhead Creek. The Natomas East Main Drainage Canal outfalls to the Sacramento River at the northern edge of Discovery Park and near the confluence of the Sacramento River and American River approximately 5.2 miles south of the Greenbriar site.

These primary drainage canals are significant corridors of aquatic habitat to which the entire drainage network is connected. Exhibit 5 graphically depicts this primary drainage system.

Although the canal network hydrologically connects aquatic and wetland habitats throughout the Natomas Basin, roads impede or block the movement of many animals through aquatic or wetland habitats. Even for animals that could attempt crossing a road surface, such as turtles and snakes, major roads are effectively impassable (Forman et al. 2003, Dodd et al. 2004, Aresco 2005). For major roads, passage is restricted to the culverts through which the canal waters flow. Culverts are themselves obstacles to animal movement; although a wide variety of animals will move through culverts, for most species, the frequency of these movements is low (Yanes 1995, Rodriguez et al. 1996, Clevenger et al. 2001, Forman et al. 2003, Ng et al. 2004). In general, the use of culverts decreases with their length and with the presence of fencing or debris pits (Yanes 1995, Rodriguez et al. 1996, Clevenger et al. 2001, Forman et al. 2003, Ng et al. 2004). Nonetheless, regular animal crossings (including by other species of garter snake) have been documented through even long culverts that are comparable to those under I-5 (see Forman et al. 2003, Ng et al. 2004, Dodd et al. 2004). Conversely, the use of culverts increases with presence of adjacent habitat or cover, roadside fencing that "funnels" animals towards culverts, and with increased visibility through the culvert (Yanes 1995, Rodriguez et al. 1996, Clevenger et al. 2001, Forman et al. 2003, Ng et al. 2004).

Within the Natomas Basin, Interstate 5 (I-5) and State Route 99 (SR 99) are major barriers to animal movement that are crossed by only a few long culverts. Thus, habitat south of I-5 (i.e., in the southern Natomas Basin), such as at Fisherman's Lake, is partially isolated from habitat north of I-5. Similarly, habitats west of SR 99 (i.e., in the northwestern Natomas Basin), such as at Pritchard Lake, are partially isolated from habitat east of SR 99 (i.e., in the northeastern Natomas basin), such as Snake Alley.



Source: CH2M Hill, EDAW 2005

Canals and Drains of Natomas Basin **Exhibit 5**

In 2001 and presently, habitats east and west of SR 99 are linked by culverts on the V Drain, R Drain, H1 Drain, and Central Main Canal; each of these canals in turn connects to a series of drains and ditches.

In 2001, aquatic habitats north and south of I-5 were linked through culverts by the West Drainage Canal, the N Drain (parallel to Powerline Road), and the Lone Tree Canal. The West Drainage Canal passes north under I-5 to the west of the airport. The N Drain and Lone Tree Canal pass north under I-5 to the west and east of MAP where each is connected to a series of ditches, drains, and canals (including Meister Canal) throughout the northwestern portion of the Basin, and to the culverts under SR 99 to the northeastern portion of the Basin. After it passes under Interstate 5, the N Drain, via Powerline Ditch, also connects giant garter snake habitats south of I-5 to those in the northwestern portion of the Basin.

However, as the development authorized by the MAP HCP and the NBHCP has occurred, and will occur, the system of canals connected to the culverts under I-5 has been changing and will continue to change. Except for the West Drainage Canal, all corridors connecting giant garter snake habitats in the southern Natomas Basin to habitats north of I-5 pass through or drain the MAP, and thus they all will be altered under the future condition of the Natomas Basin permitted by the NBHCP. Development authorized by the MAP HCP and NBHCP will eliminate the Powerline Ditch, No. 4 and 4a ditches, and Meister Canal, eliminate water sources to the Airport East Ditch, and replace the open Central Main Canal with an underground pipe. It also will affect habitat along Lone Tree Canal by reducing the area of land draining into Lone Tree Canal, placing urban development along one side of the canal, and widening Elkhorn Boulevard to six lanes (Thomas Reid Associates 2001, USFWS 2002). (The widening of Elkhorn will not increase the length of the culvert, which is already 115 feet long, but it will increase its diameter from 2.5 feet to 4 feet.

Thus, under the future condition permitted by the NBHCP, giant garter snake habitat south of Interstate 5 would be largely isolated from habitat north of Interstate 5. Two possible corridors would remain: the West Drainage Canal and Lone Tree Canal. Both corridors could connect important habitats in the southern Natomas Basin (such as Fisherman’s Lake which is along the West Drainage Canal) with those in the northwestern and northeastern portions of the Basin. Along both of these potential corridors, there will be obstacles to giant garter snake movement. Both waterways will pass under Interstate 5 through long culverts (over 300 feet long). The West Drainage Canal currently has limited connection to other waterways north of Interstate 5; in the future, it will probably remain isolated because zones of canals and drainage ditches that are currently not suitable habitat for giant garter snake will likely continue to separate it from habitats north and east of the airport. Lone Tree Canal will pass through a culvert under Elkhorn Boulevard (115 feet long). Development of the Metro Air Park will also affect water flow within Lone Tree Canal, however, the MAP HCP includes provisions under changed circumstances (pages 70-71 in Thomas Reid Associates 2001) that address these effects if water levels are less than 12 inches.

Even if snake movement along these north-south corridors were a rare event, this movement would be very important. It would allow genetic interchange between the Basin’s northern and southern subpopulations of giant garter snake, and it would allow giant garter snakes to reestablish in the southern Natomas Basin if that smaller subpopulation were to become extirpated (e.g., due to environmental fluctuations or demographic stochasticity).

Thus, although the relative importance for connectivity of the Lone Tree Canal was not described in the NBHCP, the opportunity for giant garter snakes to move along Lone Tree Canal will be important for the viability of the giant garter snake population in the Natomas Basin.

Under the future condition permitted by the NBHCP at the Greenbriar site, water in Lone Tree Canal would flow south under Elkhorn Boulevard through a 4-foot diameter culvert 115 feet long. It would then flow in a waterway 12 feet wide at the bottom and about 6 feet deep. Along this waterway, set back 25 feet from its western bank will be a low wall 3 feet high, on the other side of which will be Lone Tree Road and commercial and industrial development. Along the eastern bank will be agricultural, ruderal, or natural vegetation. This vegetation would extend for nearly a mile and if cultivated it would include waterways that irrigate and drain the area. At the southern end of the Greenbriar site, water from the Metro Air Park would enter the canal, and together these waters would flow into three 8-foot by 5-foot box culverts and two 6.5-foot diameter pipes, and pass under Interstate 5.

For this section of Lone Tree Canal between the Interstate 5 and Elkhorn Boulevard culverts, the Greenbriar project would alter these future conditions. The following description of conditions under the future condition with the Greenbriar project is based on the description of the Greenbriar project in the DEIR, BA, the draft conceptual mitigation plan for the project and mitigation measure 6.13-1 of the DEIR. Water would still flow through a 4-foot diameter culvert 115 feet long under Elkhorn Boulevard; there would still be a low wall and development along the western shore, and water would still enter from the Metro Air Park and then flow under Interstate 5 through three 8-foot by 5-foot box culverts and two 6.5-foot diameter pipes. However, near the center of this section of Lone Tree Canal, there would be an additional road crossing (100 feet wide with a 50-foot span that would be 7 feet in height) where Meister Way would cross the canal and an additional road crossing where residential Street 3 would cross the canal (a 53-foot wide crossing). (These crossings would be designed to minimize obstacles to giant garter snake movement [as described in mitigation measure 6.13-1 of the DEIR].) Also, along the eastern bank would be strip (a bench) of tules and other emergent vegetation. This strip of marsh and open water would be relatively narrow; grassland would be on its far side, and within 250 feet of the water flowing in the canal would be a barrier wall and fence separating the corridor along the canal from residential development to the east. There would also be fencing and a wall along Meister Way where it crossed the corridor of managed vegetation along Lone Tree Canal.

This corridor of vegetation along the eastern bank, and the associated structures, would be developed, preserved, maintained, monitored, and adaptively managed by TNBC or another 503(C)(1) organization. This management would be funded by an endowment sufficient for this purpose provided along with the fee title to TNBC (or another 503(C)(1) organization if necessary) which will be established through the process of developing an HCP for the project.

Flows within the canal would also be maintained. The MAP and Greenbriar projects would reduce the area draining into Lone Tree Canal. However, the MAP HCP contains assurances that sufficient water will be maintained in Lone Tree Canal to provide aquatic habitat (as described on pages 70-71 in Thomas Reid Associates 2001), and the Greenbriar project provides an additional assurance that suitable aquatic habitat will be maintained (as described in mitigation measure 6.13-1 of the DEIR).

3.5.3 POTENTIAL CONSEQUENCES OF THE GREENBRIAR PROJECT FOR FUTURE CONNECTIVITY

Development of the Greenbriar site, and the creation, enhancement and preservation of habitat at the proposed reserves, could affect the connectivity of habitats at local and regional scales. At a local scale, both development and habitat enhancement/restoration alter the spatial distribution of habitat. Development reduces connectivity and the quantity of habitat accessible to individuals on nearby lands, increases the distance individuals must travel to meet their needs for food and shelter, and increases the risks individuals are exposed to during these movements. Conversely, the enhancement and creation of habitat can increase connectivity, by creating larger areas of contiguous habitat, increasing the food and shelter provided by habitat, or by facilitating movement of individuals. The preservation and active management for habitat values also can maintain connectivity.

POTENTIAL EFFECTS ON CONNECTIVITY AT A LOCAL SCALE

Development of the Greenbriar site would adversely affect connectivity of some habitats at a local scale. At this scale, development of the Greenbriar site would reduce the quantity and contiguity of habitat available to individuals of some species using this site and adjacent lands. These individuals would lose part or all of the habitat in their home ranges or territories, and the remaining habitat could be split into separate pieces (i.e., fragments) that would be isolated by development, or require increased risk and energetic cost to access. This fragmentation of habitat would occur along the northern and southern borders of the Greenbriar site where lands would not be developed under the future condition resulting from the NBHCP, and it would occur along the western border for those species still able to use the remaining corridor of land as habitat. Habitat fragmentation attributable to the Greenbriar project could affect all covered species, except those associated with vernal pools. For example, both burrowing owl and loggerhead shrike currently use the Greenbriar site; after development of the project, patches of habitat for these species would be smaller in size and separated by greater widths of non-habitat.

Conversely, the connectivity of habitats at a local scale would be increased by the creation, enhancement, and preservation of habitat at the proposed Spangler and Natomas 130 reserves, and at the unidentified DEIR mitigation site(s) providing the Swainson's hawk foraging habitat. For example, the marsh created at the Natomas 130 site would be in close proximity to similar habitats at Fisherman's Lake, and the adjoining TNBC Cummings Reserve (Exhibit 5). Based on the evaluation contained in this effects analysis, on balance, the proposed project would not adversely affect habitat connectivity within the Natomas Basin.

POTENTIAL EFFECTS ON CONNECTIVITY AT A REGIONAL SCALE

At a regional scale, development can create barriers that isolate areas of otherwise suitable habitat or can subdivide a population into two smaller, and thus less viable, populations. Conversely, habitat creation and enhancement as a result of a conservation strategy associated with development can reduce or eliminate barriers, and can increase connectivity at a regional scale.

In the absence of effective mitigation, development at the Greenbriar site could adversely affect habitat connectivity at a basin-wide scale. Land use at the Greenbriar site could affect connectivity of the southern and central Basin, because it occupies one of the two corridors of habitat that would remain under the future condition resulting from the NBHCP.

The Greenbriar project would convert this site to urban land cover except for a 250-foot wide zone that would remain along the Lone Tree Canal and patches of ruderal habitat east of the Greenbriar site (Exhibit 2). In addition, this remaining habitat along Lone Tree Canal would be crossed by Meister Way and Street 3, which would be new roads that connect the developed Greenbriar site to Lone Tree Road. This development would reduce connectivity of the southern and central Natomas Basin for some species.

If connectivity of habitats were reduced at the Greenbriar site, relatively few species would be adversely affected. First, most species in the Natomas Basin are abundant, widely distributed and highly mobile. (The species observed during monitoring for TNBC support this characterization [Jones & Stokes 2005].) This is largely a consequence of the Natomas Basin being primarily an agricultural (and developed) landscape that is frequently disturbed. Second, Interstate 5 (which is along the entire southern border of the site), and adjacent development to the east and west, already reduces use of the site as a movement corridor by terrestrial animals that are less mobile or are highly sensitive to human disturbance.

The species most likely to be adversely affected at a regional scale by a reduction in connectivity across the Greenbriar site are species dependant on the aquatic or wetland habitat in and immediately adjacent to canals. This is because under the future condition resulting from the NBHCP, there will be few corridors (or perhaps only this one) along canals between the southern and central Natomas Basin, none of which is likely to provide for relatively high levels of movement and dispersal. In particular, in the absence of comprehensive and effective avoidance, minimization, and mitigation measures to offset its effects, development at the Greenbriar site could cause substantial adverse effects on habitat connectivity for the giant garter snake.

At a regional scale, the mitigation for the Greenbriar project also could improve connectivity of wetland and rice habitats in the northern Natomas Basin through its enhancement of habitat at the proposed Spangler reserve, and in the southern Natomas Basin through its creation of marsh habitat at the proposed Natomas 130 reserve. These sites are connected to the regional system of waterways; thus, the restoration, enhancement and preservation of habitat at these sites could facilitate the movement of covered species along these waterways. This effect, while less important than effects at the Greenbriar site, could still be significant.

The potential effects on connectivity of giant garter snake habitat are further evaluated in the following section.

POTENTIAL EFFECTS ON CONNECTIVITY OF GIANT GARTER SNAKE HABITAT AT THE GREENBRIAR SITE

The effects analysis for the connectivity of giant garter snake habitats are based on several assumptions including:

1. Giant garter snakes currently use Lone Tree Canal at the Greenbriar site and are likely to continue to do so under the future condition resulting from the NBHCP;

2. Occasionally snakes cross through the culverts under Interstate 5;

3. The frequency of crossings under Interstate 5 is affected by the extent that snakes use the adjacent sections of Lone Tree Canal;

4. The level of snake use is affected by the habitat features provided by Lone Tree Canal and immediately adjacent land (i.e., movement along the canal is not independent of habitat availability and condition along the canal); and

5. Mitigation for other projects affecting Lone Tree Canal south of Interstate 5 and north of Elkhorn Boulevard would sustain giant garter snake habitat along those segments of Lone Tree Canal.

In the absence of effective mitigation to maintain or improve connectivity, the Greenbriar project could substantially affect the use of Lone Tree Canal (and of the entire Greenbriar site) by giant garter snakes. The project would:

- eliminate canals and natural vegetation within the Greenbriar site,
- create additional road crossings of Lone Tree Canal at Meister Way and Street 3,
- create residential development within 250 feet of Lone Tree Canal, and
- reduce the acreage draining into Lone Tree Canal (potentially reducing flow in the canal).

In the absence of mitigation, these changes could affect giant garter snake use of Lone Tree Canal. Developing agricultural land at the Greenbriar site would directly eliminate habitat that provides prey, cover, basking sites, and refugia. Additional obstacles, increased predation, and increased human activities all could degrade the quality of remaining habitat, increase mortality and reduce snake use of this segment of Lone Tree Canal.

To offset the effects resulting from these changes and to retain giant garter snake habitats and the movement corridor along Lone Tree Canal, the project would have to:

- Assure that water would be provided in the canal to maintain adequate aquatic habitat,

- Minimize effects on giant garter snake movement at the crossings of Meister Road and Street 3,

- Maintain vegetation and conditions along the canal and in adjacent uplands to meet requirements for giant garter snake use and movement, and

- Reduce the effects of human disturbance, mortality from vehicle collisions, and predation by the cats, dogs, and wildlife associated with developed land uses.

Thus, measures would need to include:

- Providing some water to the canal in perpetuity or otherwise ensuring that adequate aquatic habitat would be maintained,
- Restricting adjacent land uses to allow only those compatible with provision of snake habitat, barriers to human and animal use of the site,
- Designing the Meister Road and Street 3 crossings to minimize impediments to snake movement (e.g., maximize cross-sectional area of and visibility across the canal crossing),
- Incorporating barriers that prevent giant garter snake access to developed areas and visually screening developed areas, and
- Funding site maintenance and management of habitat along the canal and on adjacent land.

The Greenbriar project with applicant-proposed and DEIR mitigation, includes such a set of measures. Measures in the DEIR include:

a. To ensure that the project does not diminish habitat connectivity for giant garter snake between the southwest and northwest zones identified in the NBHCP, approximately 30.6 acres along Lone Tree Canal shall be protected and managed as giant garter snake habitat. This on-site habitat preservation shall protect an approximately 250-foot wide corridor of giant garter snake habitat that includes the canal and approximately 200 feet of adjacent uplands. Uplands within the linear open space/buffer area shall be managed as perennial grassland as described below. Additional aquatic habitat for giant garter snake shall be created along the east bank of Lone Tree Canal by construction and maintenance of a 2.7 acre tule bench. The habitat shall be managed in perpetuity as high-quality habitat for giant garter snake. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared within six months of completion of monitoring for any given year. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP.

b. To ensure that the project does not diminish giant garter snake movement along Lone Tree Canal, all new road crossings of Lone Tree Canal shall be designed to minimize obstacles to giant garter snake movement. The use of culverts under new road crossings on Lone Tree Canal shall be prohibited unless it can be demonstrated that the culverts will not diminish the potential for giant garter snake movement through the section of Lone Tree Canal protected by the setback fence and conservation easement. .

c. Upland giant garter snake habitat within the Lone Tree Canal linear open space/buffer area shall be created and managed to provide cover, basking areas, and refugia during the winter dormant period. Hibernaculae would be constructed at regular intervals by embedding concrete or coarse rock in the bank or in a berm along the Lone Tree Canal corridor to provide additional winter refugia. Upland habitat with the linear open space/buffer areas shall be converted to native perennial grassland and managed, in perpetuity, as perennial grassland habitat.

d. Aquatic habitat shall be maintained throughout the giant garter snake active season in Lone Tree Canal, in perpetuity. This is the legal responsibility and obligation of Metro Air Park property owners (MAP). The MAP HCP includes provisions for maintaining water in the canal such that the basic habitat requirements of the giant garter snake are met. The MAP HCP also provides a road map, through "Changed Circumstances", to address procedures to follow if water is not being maintained in the canal to meet these requirements. As described in the MAP HCP, the MAP is legally obligated to assure these requirements are met, and financial and procedural mechanisms are included in the MAP HCP to enforce this. It is, therefore, assumed that MAP will provide water to Lone Tree Canal, as required by the MAP HCP and ITP, in perpetuity. It is also assumed that USFWS will use all reasonable means available to it, to enforce this MAP HCP requirement. If water is not provided to Lone Tree Canal by the MAP to meet the habitat requirements of giant garter snake, as required by the MAP HCP, and USFWS exhausts its enforcement responsibilities, the project applicant shall assume the responsibility of providing suitable giant garter snake aquatic habitat throughout the section of Lone Tree Canal protected by the fence and conservation easement. However, as stated herein, the project applicant shall only assume this responsibility if it has been sufficiently demonstrated to the City that USFWS has exhausted all reasonable means to compel MAP to comply with the relevant conditions of the MAP ITP. Specific requirements related to ensuring suitable aquatic habitat in Lone Tree Canal is present, in perpetuity, throughout the giant garter snake active season shall be developed through consultation with DFG and USFWS, and included in the new or amended HCP for Greenbriar, and may include mechanisms, such as installation of a well, to assure water is provided in the canal to meet habitat requirements.

e. A barrier shall be installed between the giant garter snake habitat linear open space/buffer area and the adjacent Greenbriar development to ensure that giant garter snakes do not enter the development area, and to prohibit humans and pets from entering the giant garter snake habitat. The design of this barrier shall be subject to USFWS and CDFG review and approval. The entire length of the barrier, which shall be bordered by yards rather than roadways, shall be maintained on the preserve side by a nonprofit land trust to ensure that vegetation or debris does not accumulate near the barrier and provide opportunities for wildlife and pets to climb over the barrier. On the development side, Covenants, Codes and Restrictions (CCRs) shall prohibit accumulation of vegetation or debris adjacent to the barrier. Chain link fencing shall be placed at both ends of the corridor, with locked gates permitting entry only by RD 1000 and NMWD for channel maintenance, and by the preserve manager for habitat monitoring and maintenance purposes.

f. Specific requirements associated with the barrier shall be developed through consultation with USFWS and DFG, and may include the following and/or other specifications that DFG and USFWS consider to be equally or more effective:

   - Adequate height and below-ground depth to prevent snakes or burrowing mammals from providing a through-route for snakes by establishing burrows from one side to the other crossing;
   - Constructed using extruded concrete or block construction extending a minimum of 36-inches above ground level;
   - Maintenance to repair the barrier and to prevent the establishment of vegetation or collection of debris that could provide snakes with a climbing surface allowing them to breech the barrier;
   - A cap or lip extending at least two-inches beyond the barrier’s vertical edge to prevent snakes from gaining access along the barrier’s top edge; and
   - Signage to discourage humans and their pets from entering the area.

g. The Lone Tree Canal linear open space/buffer area shall be protected in perpetuity under a conservation easement and managed to sustain the value of this area for giant garter snake habitat connectivity. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP or following procedures developed in formal consultation with USFWS and DFG and contained in an ESA Incidental Take Permit for the Greenbriar project.

Assessment of Required Width and Other Setback Attributes

To date, several recommendations have been made regarding the required width of a setback to conserve canal habitat for giant garter snake use and movement. These previous recommendations include:

- In the avoidance and minimization measures of a biological opinion for a programmatic consultation with the U.S. Army Corps of Engineers, a measure was included to avoid construction activities within 200 feet from the banks of giant garter snake aquatic habitat (USFWS 1997). The basis given for this distance was that most giant garter snake use of uplands was within 200 feet of aquatic habitat. This same biological opinion also included a requirement that replacement habitat must be located at least 200 feet from roadways "to reduce vehicular mortality" (USFWS 1997).

- The NBHCP includes a requirement (for which there may be exceptions) that reserves be at least 800 feet from existing or planned urban lands, because intensively developed land is "significantly incompatible with the objectives and purposes of the reserve system" and that urban lands are likely to cause significant adverse effects on reserve viability or on covered species occupying the reserve (City of Sacramento et al. 2003, page IV-16). The NBHCP does not include an explanation of why these effects would no longer be significant with urban land at a distance of 800 feet.

- The NBHCP includes a requirement that reserves contain a buffer (typically of natural or ruderal vegetation) 30–75 feet in width to minimize the effects of incompatible land uses. These effects are referred to as "population mortality effects"; the relationship of these effects to the width of the buffer is not described.

- Planning documents for North Natomas have included setbacks ranging from 200 to 250 feet in width between urban development and adjacent agricultural areas (Padre Associates 2005). Initially, these setbacks were intended to reduce conflicts between agriculture and development; later, open space and habitat benefits were added to their purpose.

- The Fisherman's Lake Buffer Zone Study (Padre Associates 2005) includes a species account for giant garter snake, a review of the USFWS, Natomas Community Plan, and NBHCP setbacks and buffers described above, and a brief evaluation of the effectiveness of the 250- and 800-foot wide buffers that were under consideration at Fisherman's Lake. This evaluation concludes that "For GGS, all scenarios from the City Boundary and the RD 1000 ROW Boundary alternatives would provide adequate protection of 200 feet from the edge of the channel banks per USFWS guidelines." Relationships between setback width and particular effects on giant garter snake were not evaluated in this study.

Although the documents with these recommendations did not include analyses to support their recommended setback or buffer widths, our understanding of the ecology of giant garter snake, and of the effects of development on adjacent habitats is sufficient to evaluate the width of habitat required in canal setbacks, the benefits of different buffer widths, and the need for active management and for other measures in setbacks in addition to buffers.

Without a setback that includes sufficient habitat for giant garter snake use and movement, a buffer to prevent adjacent development from degrading this habitat, other measures (such as barriers) incorporated into the setback, and active management of the setback, giant garter snakes might not use and move along Lone Tree Canal.

Determining the required width and constituents of setbacks are subject to several factors. First, increasing land values are a factor in the purchase of the needed setback areas. Second, the level of scientific understanding can adequately determine the need for setbacks, but is generally not adequate for determining the required width for the setbacks (or even a relatively wide range of widths, in many cases) (ELI 2003). In general, wider setbacks reduce adverse effects of adjacent development, but some types of effects diminish only gradually with increased setback width (such as increased predation), and some adverse effects are largely unaltered across a wide range of setback widths (such as the introduction and spread of invasive plants). Consequently, unless setbacks are actively managed and include additional measures (such as barriers) only very wide setbacks (over a thousand feet wide) can preclude most adverse effects.

Although such wide buffers would sustain habitat functions, they are often impracticable, and generally would be a more inefficient use of conservation. Narrower but actively managed setbacks with barriers are also expensive and provide relatively little habitat. They are, however, justified if the conserved habitat is irreplaceable or otherwise of very high value. Assuming that giant garter snakes would use Lone Tree Canal under the future condition permitted by the NBHCP, and occasionally cross under I-5, Lone Tree Canal provides high value habitat that merits conservation even at a relatively high cost.

Along Lone Tree Canal, the purpose of the setback is to conserve giant garter snake use of, and movement along, the canal to facilitate the occasional movement of individuals through the culverts under I-5. In general, a moderate level of uncertainty exists of the attributes necessary for wildlife use of corridors (ELI 2003). Important factors affecting animal use of a corridor include the corridor's suitability as habitat, the feasibility of passing through the corridor and the level of effort and of risk involved in doing so. If a corridor does not meet a species' habitat requirements for residence or foraging, it may not be used for daily or seasonal movement, or for dispersal, and hence would not connect habitat patches (Noss et al. 1996, Rosenberg et al. 1997; Brinson et al. 2002).

Therefore, a setback along Lone Tree Canal should include sufficient habitat to support giant garter snake use of the canal for foraging and residence. This habitat would need to include the canal itself and adjacent uplands.

In general, even species associated with wetlands, streams and waterways may require and regularly use wide zones of adjacent uplands as habitat. For this reason, to provide habitat that meets year-round requirements, setbacks of several hundred feet or more have been recommended for many wetland- and riparian-associated animals (Semlitsch and Bodie 2003).

The width of uplands used by giant garter snakes varies considerably. Giant garter snakes primarily use canals, canal banks, immediately adjacent uplands, and the edges of rice fields. Giant garter snakes generally do not use non-rice agricultural crops (Wylie and Casazza 2000). Many summer basking and refuge areas used by this snake are immediately adjacent to canals and other aquatic habitats, and may even be located in the upper canal banks (Eric Hansen, pers. comm.).

Giant garter snakes, however, also use uplands hundreds of feet from waterways or wetlands. They have been observed hibernating as far as 820 feet from water, and any land within this distance could be important for snake survival in some cases (Hansen 1988). (Hibernaculae [i.e., hibernation sites] this distant from water, however, are most often found in areas with high winter floods.) Giant garter snakes also seek refuge in upland burrows during hot summer weather (Hansen and Brode 1993), and have been documented up to 164 feet from aquatic habitat during this time (Wylie et al. 1997). Use of sites at greater distances from wetlands is associated with landscapes where suitable close sites are not available. This is not generally the case in the agricultural landscape of the Natomas Basin because canal banks often provide refuges and hibernaculae, and the agricultural lands themselves are at slightly lower elevations than canal banks, generally have less cover and fewer refugia than canal banks, and may be flooded or tilled during winter.

The width required to provide cover, forage, refugia, and basking sites along Lone Tree Canal could be quite narrow. Many canals provide cover, foraging habitat, and refugia; and, giant garter snakes regularly use narrow corridors of habitat along canals crossing agricultural landscapes. Although giant garter snake use of, and movement along, a canal might require little more than habitat along the canal and its banks, habitat on adjacent land would likely increase giant garter snake use of, and movement along, a canal.

In addition to habitat, a setback also must contain a sufficient buffer to preclude degradation of canal habitats by human activities. Different types of effects on canal habitats could diminish substantially over short distances, gradually over relatively large distances, or the magnitude of effects could be largely unrelated to setback width. For example, alteration of local microclimates, drift of herbicides and pesticides applied on adjacent lands, and sediment and pollutants in runoff from adjacent land all typically diminish substantially across a distance of 50–100 feet (de Snoo and de Wit 1998, Wenger 1999, Forman et al. 2003).

In contrast, the effects of human disturbance diminish gradually with increasing distance. In this context, human disturbance is any human activity that changes the contemporaneous behavior or physiology or one or more animals (Nisbet 2000). Human activities could interrupt the foraging or reproductive activities of animals and cause them to flee or avoid an area. This may expose these animals to increased risk of mortality, or reduce their reproductive success. In essence, animals perceive humans as potential predators and respond accordingly (Frid and Dill 2002). This perceived predation risk diminishes with distance, but it is affected by other factors. The sensitivity to human disturbance varies among animal species (Cooke 1980, Blumstein et al. 2003), across sites (Blumstein et al. 2003, Rodgers et al. 1997), on trails versus off trails (Miller et al. 2001), with barriers visible to animals (Ikuta and Blumstein 2003) the number of humans (Beale and Monaghan 2004), the type of activity (Holmes et al. 1993, Rodgers and Smith 1995, Rodgers and Smith 1997, Miller et al. 2001), and the visibility of humans to animals (Richardson and Miller 1997, Phillips et al. 2001). Also, to some extent, some animals habituate to human activities (Cooke 1980, Nisbet 2000).

Giant garter snakes are highly sensitive to such human disturbance, and will abandon otherwise suitable habitat as a result of increased human activity such as fishing (Eric Hansen, pers. comm.). Human visits to areas occupied by snakes could result in lowered snake abundance even when the visits are brief in duration and no more than one person, once per day (Eric Hansen, pers. comm.). Human activities can also degrade giant garter snake habitats by trampling vegetation, compacting soils, destabilizing banks, and crushing burrows.

Human use of habitats along Lone Tree Canal would diminish with increasing distance from development. However, human access from Elkhorn Boulevard, Lone Tree Road, Meister Way, and Street 3 would allow dumping, trampling of vegetation and refugia, and harassment of snakes to occur almost independent of buffer width. This human access would probably reduce giant garter snake use of this section of Lone Tree Canal. Maintained fences, however, would probably reduce human access to levels that would not reduce snake use of the canal or degrade habitat quality by trampling vegetation and damaging banks.

Similarly, domestic and feral cats and dogs associated with residential development can range widely (hundreds of feet), and harass or prey upon a wide variety of small animals (Crooks and Soule 1999, Hayes et al. 1999, Risbey et al. 2000, Odell and Knight 2001, Lepczyk et al. 2003). Therefore, although it has not been studied, such harassment and predation of giant garter snakes should be considered likely until evidence indicates otherwise. In addition to causing mortality, this predation and harassment could reduce giant garter snake use of the canal. A wide variety of fences have been used to exclude cats and other animals from conserved areas, and many have been found to be effective with regular maintenance (Long and Robley 2004, Moseby and Read 2005).

Some effects are unrelated to buffer width. For example, the effects of road crossings and other structures within setbacks are not mitigated by increasing buffer width. Roads frequently are located across riparian areas, canals, and conserved corridors. These crossings can provide human access across buffers and setbacks, alter physical processes, cause mortality of animals from collisions with vehicles, and create obstacles to animal movement.

At the Greenbriar site, existing culverts on Lone Tree Canal reduce animal movement and the project would also add an additional road crossing at Meister Way and at an additional residential street (Street 3). The canal would not pass under Meister Way through a culvert but rather the roadway would span the canal leaving a 50-foot wide by 7-foot high space for the canal to flow through. At Street 3, the crossing would be 53 feet wide, and although flow under the crossing could be accommodated by two 42-inch culverts, mitigation measure 6.13-1 of the DEIR prohibits placing Lone Tree Canal in culverts at new road crossings (unless it is demonstrated that the culverts would not reduce the potential for giant garter snake movement). Thus, this crossing also would likely be an open span. The effect of these crossings would not be directly related to setback width, but the flow of water through this section of canal, and the enhancement and management of vegetation near the crossings, would likely affect giant garter snake use.

Collisions with vehicles may be an important source of mortality for giant garter snake (Leidy 1992; E. Hansen pers. comm.). Numerous studies have documented mortality of snakes along roads (Rosen and Lowe 1994, Bonnet et al. 1999), negative correlations of reptile or amphibian abundance with road density or traffic levels (Marchand and Litvaitis 2004; Pellet et al. 2004), and the potential for roads to affect population persistence (Marchand and Litvaitis 2004; Gibbs and Shriver 2002). Increasing setback width would not reduce this effect along roads that cross the setback. Therefore, barriers to prevent snakes from entering roads (and adjacent developed areas) should be incorporated into setbacks. The effectiveness of such barriers has been demonstrated for other species where culverts also exist to allow passage under the road (Guyot and Clobert 1988; Dodd et al. 2005; Aresco 2005).

Buffers can reduce the effects of altered hydrology where they include a considerable portion of the watershed, or where the alteration involves increased overland flow. The effects of water diversions, however, are not reduced by setbacks.

Because of the existence of effects that do not diminish with setback width (or that diminish gradually), additional measures are necessary to buffer canal habitats from adjacent land uses. These additional measures include barriers to human and pet access, visual barriers to shield nearby human activities from sight, provision of supplemental water, and active management of the buffer.

Where barriers are added to buffers, and conserved habitat and buffers are actively managed, the width required for an adequate setback (i.e., conserved habitat plus buffer) can be determined with more precision, because many types of adverse effects can be substantially reduced and some aspects of habitat structure can be maintained by human action.

For giant garter snake setbacks, the buffer must be of sufficient width to include barriers to human and pet access into the buffer, a barrier to prevent snake access to developed areas and roads, and a barrier that shields human activities in developed areas from the vision of snakes. It also should be of sufficient width to include an access road and additional habitat features that are necessary or beneficial for giant garter snake use of the protected corridor.

Because canals, unlike riparian areas, have stable boundaries, the habitat, barrier, and road components of a managed setback can be located in a zone immediately adjacent to the base of the canal bank. The width of this zone would vary primarily with the width desired for incorporating additional habitat components, because the road, fence, and other barrier features would require relatively standard widths.

A setback that consisted of a canal and a buffer of 25–50 feet from the base of each canal bank might be sufficiently wide to include a corridor of canal habitat for giant garter snake use and movement, and an access road and necessary barriers. But, it would not allow additional giant garter snake habitat to be incorporated.

Although giant garter snake uses narrow corridors within agricultural landscapes, additional habitat along canals may be necessary or beneficial in more intensively developed landscapes, particularly if such corridors are lengthy or include impediments to movement, as at the Greenbriar site. In an agricultural landscape, in addition to canal habitat, snakes have access to some cover basking sites, refugia, and foraging habitat on adjacent land, and the presence of these adjacent habitat features could influence snake use of canals. This adjacent habitat also could help protect them from predators, floodwaters, and canal maintenance and other human activities. In particular, because maintenance of vegetation along canals and fluctuations in water levels could temporarily degrade canal habitat along a conserved corridor, additional adjacent habitat may enhance use of the corridor by providing more stable conditions. (This may be important at the Greenbriar site because RD 1000 has an easement for access and maintenance of the Lone Tree Canal.)

Wider setbacks would provide the opportunity to incorporate such additional habitat, provide greater flexibility for future management, and would likely result in more effective conservation of conserved corridors along canals. Setbacks with buffers outside of the canal banks that are 100 feet or more in width probably should be sufficient to incorporate habitat components such as channels parallel to the canal and with an adjacent strip of marsh vegetation. To incorporate large water features or wide tracts of managed marsh, buffers would need to be several hundred feet wide. However, creating such extensive habitat immediately adjacent to development may not be desirable. A notable exception might be the inclusion of storm water retention basins; including these structures within canal setbacks may result in wider buffers that more effectively isolate canal habitat from development, while also making more land available for development. It is not known if storm water detention basins and associated structures can be designed to provide suitable habitat for giant garter snake.

In summary, canal habitats actively used by giant garter snake for movement along a canal may be relatively narrow (i.e., less than 50 feet from the canal banks). But, to sustain giant garter snake use of this habitat, a buffer is required to reduce adverse effects from adjacent development and allow additional habitat to be created along the canal as necessary, and to provide some flexibility for future management. To reduce adverse effects, buffers must either be very wide (hundreds to thousands of feet in width), or incorporate barriers to prevent human and pet access and to prevent giant garter snakes from entering developed areas, and must be accessible and actively managed. These components probably add 25–50 feet to the required buffer. Habitat components that may be necessary for giant garter snake use of a canal corridor through a developed landscape probably require at least an additional 50–100 feet, and some types of additional habitat features (e.g., large water bodies) may require a buffer with a width of several hundred feet. Therefore, the total width of setbacks should be at least the width of the canal and its banks, plus an additional 125–200 feet.

The setback proposed by the Greenbriar project is consistent with this width. With the DEIR mitigation it would contain fencing, barrier, habitat enhancement, and management measures, habitat would be enhanced, and the effects of adjacent land uses on this habitat would be minimized. (The specific design of fencing/barriers along Lone Tree Canal, the location of the access road, and the details of habitat enhancement and management measures would be developed in consultation with DFG and USFWS during the development of an HCP for the project.)

OVERALL EFFECT ON CONNECTIVITY OF GIANT GARTER SNAKE HABITATS

The DEIR mitigation would likely offset the Greenbriar project’s effects on giant garter snake movement along Lone Tree Canal, and are in addition to, and do not conflict with, the measures incorporated into the MAP HCP. (For example, a smaller setback and a barrier also exist on the Metro Air Park side of Lone Tree Canal.)

In addition, because existing conditions do not provide high value habitat for giant garter snake along the entire length of Lone Tree Canal and are not optimal for movement of the snake along the canal, opportunities also exist to enhance connectivity. Management of the canal and adjacent uplands for giant garter snake would result in an improvement over current conditions, and over the future condition resulting from the NBHCP. The project and the mitigation proposed in the DEIR include measures to enhance habitat along the canal (e.g., the creation of marsh habitat along the eastern bank of the canal).

In conclusion, for giant garter snake, significant adverse effects on connectivity between habitats in the southern and central Natomas Basin would be unlikely, and would not cause adverse effects on the implementation of the NBHCP giant garter snake conservation measures.

3.6 CONNECTIVITY OF EXISTING TNBC RESERVES

In the absence of effective avoidance, minimization, and mitigation, the Greenbriar project could adversely affect connectivity of TNBC reserves in the Natomas Basin. As described in the preceding section, in the absence of mitigation measures proposed in the DEIR connectivity of habitats in the southern and central portions of the Natomas Basin could be reduced by the Greenbriar development, and this reduction would be substantial for species that would not pass through the corridor remaining along Lone Tree Canal.

For species not passing through the remaining corridor along Lone Tree Canal, the connectivity of TNBC reserves would be reduced. The travel distances between reserves in the southern and central Natomas Basin, with and without passing through a corridor between the Metro Air Park and the City, indicate this change in reserve connectivity. For example, passing through the Greenbriar site, the distance between the nearest reserve in the southern Basin (the Rosa property) and the nearest reserve in the central Basin (the Tufts property) is about 4 miles across uplands and 4.2 miles along canals (Exhibit 5). If development of the Greenbriar site prevented a species from passing between the Air Park and the City, these distances would become 6.7 and 8.7 miles via uplands and canals, respectively. (These distances assume that an individual that cannot pass between the Air Park and the City also can not pass between the Air Park and the Airport.) Similarly, crossing the Greenbriar site, the shortest distance between existing reserves in the southern and central Basin (i.e., the Rosa and Ayala properties) is about 3.8 miles across uplands and 5.2 miles along canals. If development of the project prevented movement through a corridor between the Air Park and City, then these distances would increase to 9.4 and 11.2 miles via uplands and canals, respectively. Though these examples involved the southern reserves closest to the central Natomas Basin, the change in connectivity would be comparable at other reserves in the southern Natomas Basin.

However, as described in the preceding section that addressed effects on habitat connectivity, the Greenbriar project (with the mitigation proposed in the DEIR) would include a set of measures to reduce effects on connectivity; in addition, canal and adjacent upland habitats would be enhanced along Lone Tree Canal. Therefore, significant adverse effects on the connectivity of existing TNBC reserves would be unlikely.

The project's proposed off-site reserve lands also could cause some positive effects on connectivity. This would be due primarily to the enhancement of habitat on the Spangler site, which could increase connectivity among the nearby reserves to the east and northwest (the Atkinson/Ruby and Sills reserves, respectively). The preservation of additional land to provide Swainson's hawk foraging habitat (as required by mitigation measure 6.13-2 of the DEIR) also could increase connectivity of existing TNBC reserves. The location of these lands, however, has not been determined, and thus this potential benefit cannot be described in any detail.

3.7 HABITAT VALUE OF EXISTING TNBC RESERVES

The Greenbriar project would cause adverse and beneficial effects on the habitat value of existing TNBC reserves. The adverse effects would result from reducing the acreage of foraging habitat most accessible to (i.e., within 1 mile of) an existing TNBC reserve. The beneficial effects would result from preserving, creating and enhancing habitat adjacent to or near existing TNBC reserves.

3.7.1 EFFECTS OF DEVELOPMENT AT GREENBRIAR SITE

No existing TNBC reserves are within 800 feet of the Greenbriar site and only one reserve (the Rosa property) is within a mile (Exhibit 5). Development at the Greenbriar site would detrimentally affect the quantity and connectivity of foraging habitat for raptors nesting at or near this reserve, and also would similarly affect the Souza and Natomas Farms reserves that are within one and a quarter miles of the site.

The foraging habitat available to raptors nesting at these existing reserves would be detrimentally affected by development at the Greenbriar site. Of the land within a mile of TNBC's Rosa property, about 31% is in the Metro Air Park or City of Sacramento permit areas; the Greenbriar site accounts for an additional 6%. Thus, habitat value for raptors nesting at this reserve would be reduced under the future condition of the Natomas Basin, and development of the Greenbriar site would further reduce habitat value for raptors. Development of the Greenbriar site also would detrimentally affect the value of TNBC's Souza and Natomas Farms reserves for nesting raptors, though to a lesser degree than at the Rosa property because these reserves are further from the Greenbriar site (Exhibit 5).

The DEIR requires additional mitigation to offset these effects. For Swainson's hawk foraging habitat lost, mitigation measure 6.13-2 of the DEIR requires preservation of habitat that provides equal or greater habitat values than the habitat lost at the Greenbriar site. To provide equal or greater foraging habitat values, this mitigation measure would require enhancement and preservation of at least 49 acres of to provide high quality habitat within one mile of an existing TNBC reserve (or of the Swainson's hawk zone along the Sacramento River). This DEIR mitigation is in addition to the project's proposed reserves. The habitat provided by this mitigation measure would likely offset the project's effect on Swainson's hawks and other raptors residing at or near existing reserves, though the reserves benefiting from habitat enhancements may differ from those adversely affected by the loss of foraging habitat on the Greenbriar site.

Though it is possible that the project could detrimentally affect foraging habitat available to giant garter snakes at the Rosa, Souza and Natomas Farms reserves, this effect was considered insignificant. Because canals connect these reserves to habitat suitable for giant garter snake on the Greenbriar site, and because the site is within 1–2 miles of these reserves (Exhibit 5), development of the Greenbriar site could reduce the quantity of suitable habitat available to giant garter snakes foraging or residing at these reserves. While not discountable, this effect may be negligible because the culvert at Interstate 5 may restrict snake movement along the canal such that snakes residing south of Interstate 5 rarely forage north of Interstate 5. Furthermore, loss of habitat within 1–2 miles of these reserves would be partially, or perhaps even fully, offset by the creation of 14 acres of marsh habitat at the Natomas 130 parcel that is also connected to these reserves by canals, and is at a distance from the reserves comparable to that of the Greenbriar site.

3.7.2 Effects of Proposed Reserves

The restoration of marsh at the proposed reserves would cause both adverse and beneficial effects on the habitat value of existing reserves. The acreage of Swainson's hawk foraging habitat would be reduced at the Natomas 130 parcel. Restoration at this proposed reserve would reduce the acreage of Swainson's hawk habitat because 14 acres of fallow agricultural land (which was non-rice crop in 2001) would be converted to marsh, which would provide only smaller areas of moderate quality foraging habitat, while only 14 acres would be enhanced for Swainson's hawk foraging on the remainder of the site. However, the enhanced foraging habitat would be of high quality which would provide resources sufficient to offset the lost habitat acreage.

The proposed reserves could increase habitat available to giant garter snakes at existing TNBC reserves in the Central Basin (i.e., the Tufts, Sills, Ruby, and Atkinson reserves) because one of these reserves (the Spangler property) could be accessible to snakes using those reserves. These existing reserves are all within two miles of the proposed Spangler reserve where marsh would be created and rice will be managed to enhance its habitat value for giant garter snake (Exhibit 5).

The project's proposed reserves would contribute to the size and connectivity of existing TNBC reserves. The North Natomas 130 parcel is immediately north of the TNBC Cummings reserve (Exhibit 5) and would increase the size of that reserve; the Spangler parcel is located between the Tufts and Atkinson reserves and is also connected to them via canals and drains (Exhibit 5); thus, it would increase their connectivity. The preservation of additional land to provide Swainson's hawk foraging habitat (as required by mitigation measure 6.13-2 of the DEIR) also could increase connectivity of existing TNBC reserves. By increasing the size and connectivity of existing reserves, and by increasing the area of preserved land in the vicinity of existing reserves, the project would beneficially affect the habitat value of existing reserves.

3.7.3 Overall Effect on Habitat Value of TNBC Reserves

Overall, the Greenbriar project would not adversely affect the habitat quality of the existing TNBC reserve system, and could cause a beneficial effect by preserving, creating, and enhancing habitat on adjacent or nearby lands that would benefit wildlife residing at or using existing TNBC reserves. However, it could cause small adverse effects on the foraging habitat available to Swainson's hawks nesting at or near reserves in the southern Natomas Basin, and though its mitigation would provide foraging habitat for hawks nesting at TNBC reserves, these may not be the same reserves that would experience a loss of foraging habitat. Thus, individual reserves may experience small adverse or beneficial effects due to the Greenbriar project.

3.8 WATER AVAILABILITY AT TNBC RESERVES

The Greenbriar project would eliminate several canals on the Greenbriar site, and would convert this site from predominantly agricultural to urban land cover. These changes, however, would not be anticipated to alter water availability to TNBC reserves or cause additional canals to be eliminated outside of the Greenbriar site (Dave Fischer, Natomas Central Mutual Water Company, pers. comm.).

The project would alter drainage of the Greenbriar site, and eliminate delivery of irrigation water by canals. These changes would affect water levels in canals and drains connected to the site. Because no TNBC reserves are adjacent to the Greenbriar site, these alterations are not anticipated to alter water availability at TNBC reserves.

The additional reserve lands associated with the Greenbriar project are in the Natomas Basin and thus would increase the portion of the Natomas Central Mutual Water Company held by shareholders concerned with the habitat values of the canal system and with the availability of water at TNBC reserves. In fact, TNBC has already requested changes to operations and maintenance practices (J. Roberts, pers. comm.). In the future, this may contribute to attainment of NBHCP goals and objectives, but is not anticipated to alter any specific operations by the water company in the near future.

3.9 OPPORTUNITIES TO ESTABLISH ADDITIONAL TNBC RESERVES

The Greenbriar project would cause both beneficial and adverse effects on opportunities to establish additional TNBC reserves. The adverse effects would result from reducing the acreage of land available to provide the mitigation required by the NBHCP. The beneficial effects would result from increasing the total acreage of reserves in the Natomas Basin, and thus increasing opportunities to establish larger reserves.

3.9.1 EFFECTS ON AVAILABILITY OF LAND FOR NBHCP RESERVE ESTABLISHMENT

Mitigation for the NBHCP consists of 8,750 acres of managed marsh, rice, and uplands. Based on the acreage of the Metro Air Park, City of Sacramento, and Sutter County permit areas for urban development, and of existing development outside of those areas, the Natomas Basin contains substantially more than 8,750 acres of land potentially suitable as and potentially available for mitigation. Of the Natomas Basin’s 53,537 acres, about 26,376 are outside of permit areas and in land cover types suitable for preservation. However, at least 5,205 acres of these lands are unavailable for preservation as NBHCP mitigation (e.g., lands in suitable land cover that are owned by the Sacramento International Airport). Thus, there are about 21,171 acres of land that are both potentially suitable as mitigation and potentially available.

Although the acreage of potentially suitable and available land could be over twice the acreage required by the NBHCP for preservation, the NBHCP, nonetheless, requires that a substantial portion of suitable land in the Natomas Basin be preserved. Thus, numerous factors affecting the suitability of land for preservation could complicate establishment of an interconnected reserve system of this size, and may increase its cost or compromise the habitat quality of reserves. These factors include existing easements, infrastructure and buildings, availability of land for purchase, adjacent land uses and proximity to urban development, connectivity to other reserves, availability of water, suitability of soils for the establishment of managed marsh, and parcel size relative to the desired size of reserves.

The Greenbriar project would reduce the acreage available for preservation as mitigation for development permitted by the NBHCP and affect the feasibility of preserving land adjacent to the Greenbriar, proposed reserve and mitigation sites. Because of the Greenbriar project, 815 acres would become unavailable or unsuitable for preservation. These lands include: 546 acres developed at the Greenbriar site, 265.8 acres at the proposed Natomas 130 and Spangler reserves, 30.6 acres at the proposed reserve along Lone Tree Canal, and at least 49 acres of Swainson’s hawk foraging habitat required by mitigation measure 6.13-2 of the DEIR at mitigation site(s) still to be determined. Of this land, 76 acres are already in land cover types that are unsuitable for preservation and subsequent restoration or enhancement (e.g., rural residential land). Thus, overall, the Greenbriar project reduces the acreage of land potentially suitable and available for preservation by 815 acres, from 21,171 to 20,356 acres, a reduction of about 4%. Even with this reduction, the remaining acreage of land potentially suitable and available for preservation (20,356 acres) would be more than twice the 8,750 acres the NBHCP requires for the reserve system.

3.9.2 EFFECTS OF GREENBRIAR SITE DEVELOPMENT ON TNBC RESERVE ESTABLISHMENT

Though the NBHCP did not identify the Greenbriar site as a potential reserve, the NBHCP also did not identify a complete set of potential reserve sites; therefore, most land outside of areas permitted for urban development, including the Greenbriar site, could be considered a potential reserve site. Development of the Greenbriar site would reduce options for establishing a reserve over 400 acres in size that included parcels adjacent to the Greenbriar site, and would eliminate any opportunity for a reserve that included the Greenbriar site. Consequently, this eliminates the option of preserving the entire corridor between the Metro Air Park and Sacramento City permit areas.

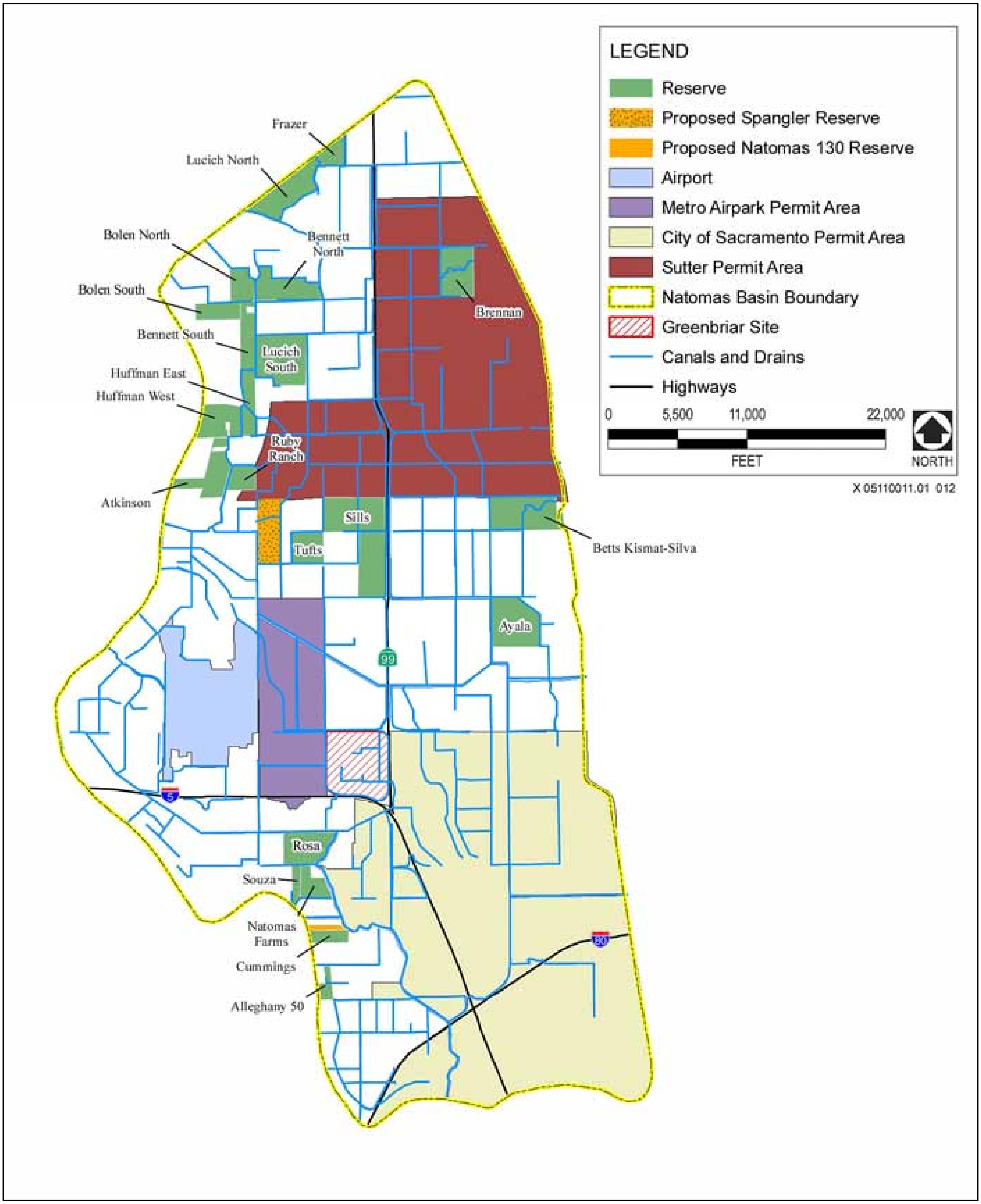
The Greenbriar site has, or could be enhanced to provide, conservation values that would merit preservation, but it also has several major limitations on the habitat values that it could provide. Much of the Greenbriar site provides habitat for covered species, and the site could be managed to provide various combinations of marsh, rice, upland, and canal habitats. It also occupies a corridor between the southern and central Natomas Basin that is important for the movement and dispersal of individuals, particularly for giant garter snake. A portion of the site, however, is in land cover types that are unsuitable for preservation and subsequent restoration or enhancement (e.g., rural residential land). Other portions of the site are immediately adjacent to major highways, or under the future condition of the Basin would be adjacent to urban development, and these areas would potentially experience high levels of human-wildlife conflicts. Nearly half of the site is either unsuitable for preservation and restoration or would be within 800 feet of a major highway or urban development. Highways and urban development would also reduce the connectivity of habitats on the Greenbriar site with habitats that would remain to the north and to the south. Despite these limitations, preserving the Greenbriar site could contribute more to sustaining the viability of the Basin's giant garter snake population and to attaining the goals and objectives of the NBHCP than would many other sites, because the Greenbriar site provides the opportunity to preserve and enhance the connectivity of canal habitats between the southern and central Natomas Basin.

Though it would develop most of the site, the project would preserve the most important portion of the site for giant garter snake and for connectivity between the southern and central Natomas Basin. It would preserve 30.6 acres immediately adjacent to Lone Tree Canal that would establish a 250-foot wide conserved corridor. This reserve would include barriers to reduce effects of adjacent development, measures to assure water flow, restoration and enhancement of habitat, and funding for TNBC to actively manage the site. Thus, the project would contribute to the conservation of a narrow, but ecologically important, corridor along this canal adjacent to the Metro Air Park.

3.9.3 EFFECTS OF PROPOSED RESERVES ON NBHCP RESERVE ESTABLISHMENT

The Greenbriar project's reserves also could contribute to the size and connectivity of future reserves. By preserving additional land adjacent to TNBC reserves, the project creates additional opportunities to create reserves of a given size and to create larger reserves (which would tend to have greater habitat values per acre than smaller reserves). For example, the Spangler reserve potentially could be joined to the Tufts reserve through future land acquisitions, as it would be only about a quarter-mile from the Tufts reserve (Exhibit 6); in this case, preservation of the intervening parcel would result in a larger reserve than would have resulted without the Greenbriar project's preservation of the Spangler property.

Overall, the Greenbriar project would not substantially reduce opportunities for establishing additional reserves for the NBHCP because sufficient suitable land is available to provide reserves both for the NBHCP and for the Greenbriar project, the project would preserve the most ecologically important portion of the Greenbriar site, and the project's reserves would increase opportunities to establish larger reserves.



Source: Wildlands 2005

Location of TNBC Reserves **Exhibit 6**

4 POTENTIAL EFFECTS OF THE GREENBRIAR PROJECT ON COVERED SPECIES

4.1 GIANT GARTER SNAKE

4.1.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Giant garter snakes (*Thamnophis gigas*) typically inhabit sloughs, marshes, and drainage canals characterized by slow flowing or standing water, permanent summer water, mud bottoms, earthen banks, and an abundance of preferred forage species.

During their active season (May through October), mature giant garter snakes typically spend the majority of their time in canals and sloughs (Wylie and Casazza 2000). During late spring and summer, rice fields also provide foraging habitat for this species (Brode and Hansen 1992). Use of rice, however, is concentrated around the perimeter of the fields (Wylie and Casazza 2000; E. Hansen, pers. comm.). (Rice may, however, be an important source of prey and may export prey with drain waters into connected canals.) Giant garter snakes avoid areas of dense riparian overstory, and use burrows, crevices, undercut banks and large rocks to hide from predators. Winter hibernaculae include small burrows and soil crevices above prevailing flood elevations; these are typically located near aquatic habitat and in grassland or ruderal vegetation. (In the Natomas Basin, most canal banks have small burrows and crevices, and thus the banks of canals that are dewatered in winter can provide hibernaculae.)

Managed marsh also provides habitat for giant garter snake. In contrast to rice, managed marsh provides habitat year-round, and habitat elements (such as dense cover, basking sites, and refugia) to meet all of the giant garter snakes daily and seasonal needs. Managed marshes in the Natomas Basin have been designed to provide these habitat elements throughout the marsh, as opposed to the limited availability of the same elements in rice, which contributes to the use of rice primarily around the perimeter of rice fields.

The USFWS (1997) has determined that essential habitat components consist of the following:

- Adequate water during the snake’s active period (early spring through mid-fall) to provide a prey base and cover;

- Emergent, herbaceous wetland vegetation, such as cattail and bulrushes, for escape cover and foraging habitat;

- Upland habitat for basking, cover, and retreat sites; and

- Higher elevation uplands for cover and refuge from flood waters.

Land cover types designated as giant garter snake habitat in the NBHCP include canals, ponds and seasonally wet areas and rice. Managed marsh also provides habitat. Small fish are the primary prey of this species; they will also take amphibians when available.

Home Range Size and Movement

Based on radio-telemetry studies by Wylie and Casazza (2000), the size of giant garter snake home ranges were between 32 and 215 acres (median = 86 acres) at Elverta and Fisherman’s Lake sites. For comparison, home ranges were between 5 and 213 acres (median = 39.5 acres) at Gilsizer Slough in Sutter County, and 22 and 2,070 acres (median = 128 acres) at the Colusa National Wildlife Refuge. Most giant garter snake activity within these home ranges is concentrated along canals, sloughs, and the edge of aquatic habitats (Wylie and Casazza 2000; Wylie et al. 2000; Wylie et al. 2003).

Giant garter snakes rely on canals and ditches as movement corridors. These corridors provide important habitat, are used during daily movements within a home range, and are necessary for giant garter snake dispersal and the resulting exchange of individuals and alleles between subpopulations. Unvegetated canals may be used as dispersal corridors, but snakes typically do not remain in exposed canals because of increased vulnerability to predators. Giant garter snakes have been reported traveling over one mile, and may move as much as two miles in a day (Hansen and Brode 1992).

The USFWS has previously considered 200 feet as the width of upland vegetation providing habitat along the borders of aquatic habitat for giant garter snake (USFWS 1997). However, the width of uplands used by giant garter snakes varies considerably. Many summer basking and refuge areas used by this snake are immediately adjacent to canals and other aquatic habitats, and may even be located in the upper canal banks (Eric Hansen, pers. comm.). Giant garter snakes have also been observed hibernating as far as 820 feet (250 m) from water, however, and any land within this distance may be important for snake survival in some cases (Hansen 1988). (Hibernaculae this distant from water, however, are most often found in areas with high winter floods.) Giant garter snakes also seek refuge in upland burrows during hot summer weather (Hansen and Brode 1993), and have been documented up to 164 feet from aquatic habitat during this time (Wylie et al. 1997).

Mechanisms of Habitat Degradation

Increased Predation

Known predators of giant garter snake include raccoons, skunks, opossums, foxes, hawks, egrets, herons, and bitterns (USFWS 1999a). All of the mammalian predators in this list increase in proximity to residential areas as a result of supplemental food sources and reduced coyote abundance (Crooks and Soule 1999). Domestic dogs may also prey on giant garter snakes, and cats may prey on juveniles. Although predation of giant garter snake by cats and dogs has not been studied scientifically, the effects of cats and dogs on small animals has been documented in a variety of ecosystems, and based on current understanding, cat and dog predation on giant garter snake is highly likely.

Disturbance from Human Activity

Giant garter snakes are highly sensitive to human disturbance, and will abandon otherwise suitable habitat as a result of increased human activity such as fishing (Eric Hansen, pers. comm.). Human visits to areas occupied by snakes may result in lowered snake abundance even when the visits are brief in duration and no more than one person, once per day (Eric Hansen, pers. comm.). Human activities can also degrade giant garter snake habitats by trampling vegetation, compacting soils, destabilizing banks, and crushing burrows, and can cause vehicle collisions with snakes.

Habitat Fragmentation

In a dynamic habitat such as the Natomas Basin, giant garter snakes frequently move in response to changing conditions in their rice, marsh, canal, and ditch habitats, especially during the dry summer months (Wylie and Casazza 2000). Connectivity between these areas is thus extremely important for snake survival and reproduction, as well as the genetic interchange and patch-recolonization ability necessary for the viability of the overall Basin population. Any loss or degradation of snake movement corridors may thus cause effects that far outreach the area of the directly impacted corridors.

Operation and Maintenance of Waterways

Water channels lose their habitat value for giant garter snakes when cleaned of aquatic vegetation, during low/no flow periods or when high water releases eliminate or alter basking sites, refugia, foraging areas or juvenile microhabitat (USFWS 1999a). In the Natomas Basin, canal and drain maintenance, and irrigation practices, involve periodic clearing of vegetation along waterways, and short-term, seasonal and inter-annual changes in flow in waterways. A recent habitat assessment of canals and drains throughout the Natomas Basin indicates that operation and management practices are reducing habitat quality along a substantial portion of these waterways (Jones & Stokes 2005). Water diversions may also reduce the abundance of the snakes' aquatic prey. Water diversions or changes in land use within the area served by a canal or drain watershed may alter flows or even cause a canal or drain to be abandoned.

Water Quality

Aquatic communities may be greatly affected by surrounding land use. Urban areas can exert different and in some cases stronger effects than agricultural lands (Bury 1972, Moore and Palmer 2005). Residential developments typically result in increased runoff of hydrocarbons and of chemicals used for lawns and gardens, and increased stormwater volume (and associated increases in flow depths and velocities) because of high coverage of impervious surfaces.

DISTRIBUTION

Information on CNDDB Occurrences

The 2002 CNDDB records cited in the NBHCP listed 168 giant garter snake occurrences in California, 38 of which occurred in the Natomas Basin. As of 2005, there are 171 known occurrences in California, of which 170 are considered extant. At this time, CNDDB lists 42 occurrences in the Natomas Basin, of which 42 are considered extant.

Other Information on Distribution and Abundance in Natomas Basin

A USGS-BRD study conducted from 1998 to 1999 recorded 277 individual giant garter snakes in the Natomas Basin (Wylie and Casazza 2000). Surveys conducted in 2004 for the Natomas Basin Conservancy recorded 152 snake observations, at least 86 of which were verified individuals (Natomas Basin Conservancy 2004). At the western edge of the Greenbriar site, sampling conducted during 1998 and 1999 detected at least five giant garter snakes in Lone Tree Canal; based on these results, giant garter snake population density for the canal was estimated at 2.4 snakes per 1,000 feet of canal length (95% confidence interval = 2–3.7) (Wylie et al. 2000). The density of snakes recorded at the Greenbriar site and elsewhere along canals and in rice lands of the Natomas Basin has a couple of important implications for this analysis. First, any alteration of even an acre of these land cover types is likely to affect at least one giant garter snake. Second, canals can provide moderate or high quality habitat, and thus arguments based on the premise that canals in general provide marginal habitat may be inaccurate.

Monitoring data collected in 2004 for The Natomas Basin Conservancy (Jones & Stokes 2005) recorded smaller snake sizes on average (corresponding to younger snakes with lower reproductive outputs) than in previous years. When combined with data from previous years, this suggests a declining trend in snake size, which would correspond to an on-going decline in population viability unless coupled with a rapidly increasing population size (which is not indicated by the monitoring data). However, changes in sampling techniques and sampling locations make the interpretation of these data problematic.

4.1.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

Changes in habitat acreages are summarized in Table 4-1. At the Greenbriar site, there would be a loss of an estimated 172 acres of GGS habitat from conditions at the time of the NBHCP (2001). At the proposed reserves, approximately 45 acres of snake habitat would be converted to non-habitat and 14 acres of snake habitat would be created from non-habitat. Thus, the project as a whole would yield a net loss of 204 acres of snake habitat.

Table 4-1
Change in Acreage of Giant Garter Snake Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Ponds & seasonally wet areas	2,259	2.7	14.2	184	200.9	2,460
Rice	11,643	-160.0	-	-228	-388	11,255
Total	15,064	-172.4	14.2	-45.4	-203.5	14,860

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

As discussed above in *Mechanisms of Habitat Degradation*, without mitigation, snakes traveling through the Lone Tree Canal or using other canal and rice habitats near the proposed development would likely be adversely affected by the project's residential development through increased predation, disturbance, and degradation of aquatic habitat. (The adjacent Metro Air Park development does not include residential development.) Development of the Greenbriar site also would reduce the acreage of land draining into Lone Tree Canal, and thus would likely lead to reduced flows in the canal. In the absence of measures to offset these alterations, the quality of giant garter snake habitat along Lone Tree Canal would likely be reduced.

The project does, however, include measures to reduce these effects, and the DEIR mitigation includes additional measures. These measures are described in the following section (*Effects on Connectivity*).

The project also could create conflicts with continued cultivation of rice on the property north of the Greenbriar site. Aerial application of pesticide and herbicide probably is not feasible immediately adjacent to residential development (C. Aubry, pers. comm.), which could affect the viability of rice cultivation on the adjacent parcel. This issue is discussed further under *Habitat Quality in the Natomas Basin* in Chapter 3 of this report.

Alteration of Habitat Quality at Proposed Reserve Sites

At the proposed Spangler and Natomas 130 reserves, in addition to the 14 acres of marsh habitat creation (from non-habitat), 190 acres of giant garter snake habitat would be enhanced by creating marsh from rice (i.e., 184 acres of marsh and 6 acres of associated canals). This change in land cover and management should considerably increase habitat quality for giant garter snake, because marsh provides higher quality habitat for giant garter snake than rice. The reasons that marsh provides higher quality habitat than rice include:

- Giant garter snakes use the full extent of managed marshes, whereas they primarily use the margins of rice fields;
- Marshes provide habitat throughout the active period of the snake, whereas rice fields do not provide habitat during early and mid-spring, and are typically drained before the end of the snake's active period; and
- Marsh provides habitat in all years, whereas rice is fallowed periodically.

Though some uncertainty exists regarding the magnitude of benefits resulting from these enhancements, it is likely that they offset the habitat values that would be lost by development at the Greenbriar site. The preservation and management of this 204 acres of habitat for giant garter snake also provides benefits (such as reduced human disturbance) in addition to the benefits resulting from the conversion of rice to managed marsh.

Effects on Connectivity

The Greenbriar project's potential effects on connectivity of giant garter snake habitat are described in detail in Section 3.5 Connectivity of Habitat in the Natomas Basin.

Effects of Construction-Related Activities

During the construction at the Greenbriar and proposed reserve sites, giant garter snakes could be killed or injured by vehicle strikes (Leidy 1992), crushed beneath heavy machinery, entombed in or excavated from their winter retreats (Wylie and Casazza 2000). The Greenbriar DEIR and Natomas Basin HCP include measures to avoid and minimize direct loss of giant garter snakes through construction. For the Greenbriar project, these measures include:

a. To ensure that the project does not diminish habitat connectivity for giant garter snake between the southwest and northwest zones identified in the NBHCP, approximately 30.6 acres along Lone Tree Canal shall be protected and managed as giant garter snake habitat. This on-site habitat preservation shall protect an approximately 250-foot wide corridor of giant garter snake habitat that includes the canal and approximately 200 feet of adjacent uplands. Uplands within the linear open space/buffer area shall be managed as perennial grassland as described below. Additional aquatic habitat for giant garter snake shall be created along the east bank of Lone Tree Canal by construction and maintenance of a 2.7 acre tule bench. The habitat shall be managed in perpetuity as high-quality habitat for giant garter snake. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared within six months of completion of monitoring for any given year. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP.

b. To ensure that the project does not diminish giant garter snake movement along Lone Tree Canal, all new road crossings of Lone Tree Canal shall be designed to minimize obstacles to giant garter snake movement. The use of culverts under new road crossings on Lone Tree Canal shall be prohibited unless it can be demonstrated that the culverts will not diminish the potential for giant garter snake movement through the section of Lone Tree Canal protected by the setback fence and conservation easement. .

c. Upland giant garter snake habitat within the Lone Tree Canal linear open space/buffer area shall be created and managed to provide cover, basking areas, and refugia during the winter dormant period. Hibernaculae would be constructed at regular intervals by embedding concrete or coarse rock in the bank or in a berm along the Lone Tree Canal corridor to provide additional winter refugia. Upland habitat with the linear open space/buffer areas shall be converted to native perennial grassland and managed, in perpetuity, as perennial grassland habitat.

d. Aquatic habitat shall be maintained throughout the giant garter snake active season in Lone Tree Canal, in perpetuity. This is the legal responsibility and obligation of Metro Air Park property owners (MAP). The

MAP HCP includes provisions for maintaining water in the canal such that the basic habitat requirements of the giant garter snake are met. The MAP HCP also provides a road map, through “Changed Circumstances”, to address procedures to follow if water is not being maintained in the canal to meet these requirements. As described in the MAP HCP, the MAP is legally obligated to assure these requirements are met, and financial and procedural mechanisms are included in the MAP HCP to enforce this. It is, therefore, assumed that MAP will provide water to Lone Tree Canal, as required by the MAP HCP and ITP, in perpetuity. It is also assumed that USFWS will use all reasonable means available to it, to enforce this MAP HCP requirement. If water is not provided to Lone Tree Canal by the MAP to meet the habitat requirements of giant garter snake, as required by the MAP HCP, and USFWS exhausts its enforcement responsibilities, the project applicant shall assume the responsibility of providing suitable giant garter snake aquatic habitat throughout the section of Lone Tree Canal protected by the fence and conservation easement. However, as stated herein, the project applicant shall only assume this responsibility if it has been sufficiently demonstrated to the City that USFWS has exhausted all reasonable means to compel MAP to comply with the relevant conditions of the MAP ITP. Specific requirements related to ensuring suitable aquatic habitat in Lone Tree Canal is present, in perpetuity, throughout the giant garter snake active season shall be developed through consultation with DFG and USFWS, and included in the new or amended HCP for Greenbriar, and may include mechanisms, such as installation of a well, to assure water is provided in the canal to meet habitat requirements.

e. A barrier shall be installed between the giant garter snake habitat linear open space/buffer area and the adjacent Greenbriar development to ensure that giant garter snakes do not enter the development area, and to prohibit humans and pets from entering the giant garter snake habitat. The design of this barrier shall be subject to USFWS and CDFG review and approval. The entire length of the barrier, which shall be bordered by yards rather than roadways, shall be maintained on the preserve side by a nonprofit land trust to ensure that vegetation or debris does not accumulate near the barrier and provide opportunities for wildlife and pets to climb over the barrier. On the development side, Covenants, Codes and Restrictions (CCRs) shall prohibit accumulation of vegetation or debris adjacent to the barrier. Chain link fencing shall be placed at both ends of the corridor, with locked gates permitting entry only by RD 1000 and NMWD for channel maintenance, and by the preserve manager for habitat monitoring and maintenance purposes.

f. Specific requirements associated with the barrier shall be developed through consultation with USFWS and DFG, and may include the following and/or other specifications that DFG and USFWS consider to be equally or more effective:

- ► Adequate height and below-ground depth to prevent snakes or burrowing mammals from providing a through-route for snakes by establishing burrows from one side to the other crossing;
- ► Constructed using extruded concrete or block construction extending a minimum of 36-inches above ground level;
- ► Maintenance to repair the barrier and to prevent the establishment of vegetation or collection of debris that could provide snakes with a climbing surface allowing them to breech the barrier;
- ► A cap or lip extending at least two-inches beyond the barrier’s vertical edge to prevent snakes from gaining access along the barrier’s top edge; and
- ► Signage to discourage humans and their pets from entering the area.

g. The Lone Tree Canal linear open space/buffer area shall be protected in perpetuity under a conservation easement and managed to sustain the value of this area for giant garter snake habitat connectivity. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP or following procedures developed in formal consultation with USFWS and DFG and contained in an ESA Incidental Take Permit for the Greenbriar project.

In combination, these measures would minimize injury and mortality to giant garter snakes as a direct result of construction-related activities.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

As discussed above in *Mechanisms of Habitat Degradation*, without mitigation, giant garter snakes would likely experience increased predation near the proposed residential development because of the increased abundance of domestic dogs and cats, as well as human-associated raccoons, skunks and opossums. Domestic cats have been recorded between 98–590 feet from homes, unattended domestic dogs between 590–1,083 feet from homes (Odell and Knight 2001), and increased abundance of native predators may extend farther. As this distance is well beyond the proposed 250-foot wide corridor between the proposed residential development and the Lone Tree Canal, the project would likely result in increased predation of snakes using the canal. The increased human population in the area would also increase the potential for human activity near the canal, which may lead to site avoidance or abandonment by snakes (Eric Hansen, pers. comm.). Increased human activity along the canal could result in increased canal maintenance including further clearing of vegetation. Snake mortality because of vehicle strikes (Leidy 1992) may also increase on existing roads because of the increased traffic associated with the project.

The project does, however, include measures to reduce these effects, and the DEIR mitigation includes additional measures. These measures are described in the preceding section (*Effects on Connectivity*).

OVERALL EFFECT ON POPULATION VIABILITY

The project would cause both adverse and beneficial effects on the giant garter snake population of the Natomas Basin. Beneficial effects would include preserving, creating, and enhancing habitat at the reserve sites, preserving a corridor along Lone Tree Canal, and contributing to the connectivity of habitat and existing TNBC reserves adjacent to or near the proposed reserves. Adverse effects would include a reduction in the total acreage of habitat, and possibly degradation of habitat near the Greenbriar site and reduced connectivity along Lone Tree Canal due to increased human disturbance and predation. The DEIR mitigation, however, would reduce adverse effects and ensure that connectivity of giant garter snake habitat was conserved along Lone Tree Canal.

Overall, the project would not adversely affect giant garter snake, and its overall effect on population viability could be beneficial. The loss of habitat acreage would probably be offset by the increased habitat quality resulting from the preservation of habitat, and conversion of rice to marsh.

The proposed creation of 14 acres of marsh from non-rice crops, conversion of 184 acres of rice to marsh, and preservation of an additional 6.2 acres along associated canals would likely offset the loss of 388 acres of rice and 16 acres of canal habitat. The basis of this interpretation is the greater habitat value of managed marsh relative to rice and the general benefits of habitat preservation.

Managed marsh provides substantially greater habitat values for giant garter snakes than rice for several reasons. These reasons include:

- Giant garter snakes primarily use the margins of rice fields, whereas they use the full extent of managed marshes. These marshes are designed to provide open water, foraging habitat, dense cover, basking sites, and refugia in close proximity throughout the marsh. (For example, an acre of managed marsh provides several times the edge habitat than does a rice field.)

- Marshes provide habitat throughout the active period of the snake. Rice fields do not provide habitat during early and mid-spring, and are typically drained before the end of the snake's active period. Thus, for a portion of their active period, giant garter snakes must rely entirely on non-rice habitats. In the Natomas Basin, these habitats are canals and managed marsh. In contrast, managed marshes provide habitat year-round.

- Rice is fallowed periodically, and thus does not provide habitat in all years; in contrast, a managed marsh does provide habitat in all years.

Preservation of habitat has benefits in addition to those of habitat enhancement. In the Natomas Basin, a particularly important benefit of habitat preservation is that it ensures that the habitat will continue to exist, and it buffers total habitat availability from year to year fluctuations. For giant garter snake, privately owned habitat in the Natomas Basin is primarily rice and associated canals, and there are no assurances that rice cultivation will continue on any particular site. Furthermore, agricultural markets will cause the total acreage of rice, and consequently of giant garter snake habitat, to fluctuate substantially from year to year. Such environmental fluctuations strongly influence populations and reduce their viability. In contrast, preserved lands will provide habitat on a much more consistent basis, and thus reduce the magnitude of fluctuations in habitat availability.

Both habitat enhancement and preservation also can contribute to population viability by reducing anthropogenic causes of mortality. Preservation reduces human disturbance, and minimizes activities that could harm or kill snakes. Habitat enhancement also reduces or eliminates agricultural activities that can harm or kill snakes. In addition, the preservation and enhancement of habitat typically results in larger blocks of higher quality habitat, and this should reduce long distance movements by snakes, which would also reduce the risk of mortality associated with those movements. (Dispersal and other long distance movements are dangerous for snakes, particularly where road crossings are involved [Bonnet et al. 1999, Rosen and Lowe 1994].)

For these reasons, an acre of managed marsh may provide habitat values comparable to or substantially greater than two acres of rice. The project would reduce rice acreage by 388 acres (and canal acreage by 16 acres) and would increase the acreage of preserved, managed marsh by 201 acres. Thus, it is likely that the project would not reduce habitat values for giant garter snake, and thus would not reduce the viability of the giant garter snake population due to a reduction in habitat values.

The project is also unlikely to reduce the viability of the giant garter snake population due to adverse effects on connectivity. The project (with the DEIR mitigation) would conserve connectivity and habitat for giant garter snake along Lone Tree Canal, which is an important waterway connecting the southern and central Natomas Basin, and proposed reserves would contribute to connectivity of habitats and reserves in the southern and central Basin.

4.2 NORTHWESTERN POND TURTLE

4.2.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Northwestern pond turtles (*Clemmys marmorata marmorata*) are most commonly found in permanent or nearly permanent wetlands, ponds, slow-moving streams and irrigation ditches (Zeiner et al. 1988). Adjacent upland areas are also used for basking and egg-laying. Land cover types designated as pond turtle habitat in the NBHCP include canals, ponds and seasonally wet areas, rice and riparian. Special habitat features that improve turtle abundance, survival and reproductive success are rocks, logs, open mud banks, emergent aquatic vegetation and streamside vegetation. These features provide the turtles with basking sites and cover from predators (Stebbins 1972). Although pond turtles feed primarily on aquatic invertebrates (USFWS 1992), they also feed on plants, small fish and carrion.

Home Range Size and Movement

Upland areas adjacent to aquatic habitat are essential for reproduction, and eggs may be laid as far as 1,319 feet (0.25 mi) from water (Hays et al. 1999). Hatchling and adult turtles may winter in upland sites, and turtles may move more than one mile overland in response to desiccation of local water bodies or other forms of habitat loss or degradation.

Mechanisms of Habitat Degradation

Increased Predation

Hayes et al. (1999) documented predation on pond turtles by domestic dogs; unattended dogs have been recorded between 590–1,083 feet (180–330 m) from homes (Odell and Knight 2001). These distances indicate the project would likely result in increased predation of any pond turtles using Lone Tree Canal for movement between habitat areas to the north and south of the property. Populations of native pond turtle predators such as raccoons and opossums also typically increase in proximity to residential areas as a result of supplemental food sources and reduced coyote abundance (Crooks and Soule 1999).

Disturbance from Human Activity

Pond turtle observations have been known to decline in areas with increased human activity (Eric Hansen, pers. comm.). Human visits to areas occupied by turtles may result in lowered turtle abundance even when the visits are brief in duration and no more than one person, once per day (Eric Hansen, pers. comm.).

Habitat Fragmentation

Although pond turtles may travel less frequently than giant garter snakes, turtles occupying dynamic habitats such as the Natomas Basin may need to travel in response to changing conditions in their aquatic habitats, especially during the dry summer months. Connectivity between these areas may thus be important for turtle survival and reproduction, as well as the genetic interchange and patch-recolonization ability that may be necessary for the viability of the overall Basin population. Any loss or degradation of turtle movement corridors may thus yield effects that outreach the area of the directly impacted corridors.

Operation and Maintenance of Waterways

Water channels lose their habitat value for pond turtles when cleaned of aquatic vegetation, during low/no flow periods and when high water releases eliminate or alter basking sites, refugia, foraging areas or hatchling microhabitat (Holland 1991a; USFWS 1999). Water diversions or changes in land use within the area served by a canal or drain watershed may alter flows or even cause a canal or drain to be abandoned.

Water Quality

Aquatic communities may be greatly affected by surrounding land use. Urban areas can exert different and in some cases stronger effects than agricultural lands (Bury 1972; Moore and Palmer 2005). Residential developments typically result in increased traffic and fuel runoff, runoff of chemicals used for lawns and gardens, and increased stormwater volume and currents because of high coverage of impervious surfaces. Increased exposure to contaminants has been implicated in pond turtle population declines (Bury 1972; Holland 1991).

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 117 known occurrences in California, of which 116 were considered extant. At that time, CNDDB did not list northwestern pond turtle occurrences in the Natomas Basin. As of 2005, there are 232 known occurrences in California, of which 231 are considered extant. At this time, CNDDB does not list northwestern pond turtle occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

Surveys conducted in 2004 for the Natomas Basin Conservancy documented six northwestern pond turtle occurrences in the Natomas Basin. Two of these occurrences were just over one mile from the Greenbriar site, one was less than a mile from the proposed Natomas 130 reserve, and another was just over a mile from the proposed Spangler reserve. Many Natomas Basin canals are considered suitable habitat for this species, and high quality habitat exists near the Greenbriar and Natomas 130 sites, at Fisherman's Lake.

4.2.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

Effects on the acreage of pond turtle habitat are summarized in Table 4-2. The proposed development at the Greenbriar site would result in the loss of an estimated 172 acres of pond turtle habitat from conditions at the time of the NBHCP (2001), and an additional 45 acres of rice habitat would be converted to upland at the Spangler site. Although the canal and marsh on the Greenbriar site were determined by the DEIR biologist to be of marginal quality and unlikely to support pond turtles, we have included these acres in our analysis for consistency with the broad habitat categories in the GIS analysis and NBHCP, and also because turtles may occasionally use the site as a movement corridor between higher quality habitats to the north and south of the site. At the proposed reserves, approximately 14 acres of pond turtle habitat would be created from non-habitat. Thus, the project as a whole would yield a net loss of 204 acres of turtle habitat.

Table 4-2
Change in Acreage of Northwestern Pond Turtle Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Ponds & seasonally wet areas	2,259	2.7	14.2	184	200.9	2,460
Rice	11,643	-160.0	-	-228	-388.0	11,255
Riparian	91	0.0	0.0	-	0	91
Total	15,155	-172.4	14.2	-45.4	-203.5	14,951

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

As discussed above in *Mechanisms of Habitat Degradation*, turtles traveling through the Lone Tree Canal or inhabiting other canals and wetlands downstream from the proposed development would likely be adversely affected by residential development through increased predation, disturbance, and degradation of aquatic habitat. (The adjacent Metro Air Park development does not include residential development.) Development of the Greenbriar site also would reduce the acreage of land draining into Lone Tree Canal, and thus could lead to reduced flows in the canal. In the absence of measures to offset this alteration, the quality of pond turtle habitat along Lone Tree Canal could be reduced by this loss of water. However, both the MAP HCP (see pages 70-71 in Thomas Reid Associates 2001) and the DEIR (mitigation measure 6.13-1) contain measures to assure the maintenance of aquatic habitat in Lone Tree Canal.

As described under *Connectivity of Habitats in the Natomas Basin* (in Section 3 of this report), the project and mitigation proposed in the DEIR for the Greenbriar project include measures that would substantially reduce the effects of development at the Greenbriar site on adjacent pond turtle habitat.

Alteration of Habitat Quality at Proposed Reserve Sites

In addition to 14 acres of managed marsh that would be created from upland at the Natomas 130 reserve and the 2.7 acres of marsh that would be created along Lone Tree Canal, rice would be converted to marsh at the Spangler reserve enhancing 190 acres of habitat (184 acres of marsh and 6 acres of associated canals). This created and enhanced habitat would be preserved and managed for its habitat values.

These changes should considerably increase habitat quality for pond turtle, primarily because marsh provides much higher quality habitat for pond turtle than rice, management would include reduce adult mortality caused by human disturbance, and nesting and overwintering habitat would be created. Though a moderate level of uncertainty exists regarding the magnitude of benefits resulting from these enhancements, it is likely that they offset the habitat values that would be lost by development at the Greenbriar site.

Effects on Connectivity

The importance of habitat connectivity for this species is discussed in *Mechanisms of Habitat Degradation*, above. In the absence of effective mitigation, the project would reduce connectivity of pond turtle habitat by altering adjacent uplands, reducing water flows in the canal, and increasing predation and human disturbance. However, as described under *Connectivity of Habitats in the Natomas Basin* (in Section 3 of this report), the project and mitigation proposed in the DEIR for the Greenbriar project include measures that would substantially reduce these effects. These measures include creation, enhancement and preservation of habitat (including tule bench along Lone Tree Canal) in the 30.6 acre reserve along Lone Tree Canal, a barrier/fencing to reduce predation and human disturbance effects, an additional assurance that aquatic habitat would be maintained in Lone Tree Canal, and funding to maintain and operate this conserved area. These measures would substantially reduce project’s effects on connectivity.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction-related activities associated with the project could affect this species, though the Greenbriar site currently provides only marginally suitable habitat. Also, construction-related degradation of water quality in Lone Tree Canal could affect turtles downstream. In addition, pond turtles could be harmed during restoration activities at the proposed Natomas 130 reserve, by crushing under equipment or entombment in their winter burrows. Measures to avoid and minimize take of northwestern pond turtles and giant garter snakes, described in the Greenbriar project DEIR and Natomas Basin HCP, would reduce any direct construction-related effects on this species. These measures where listed in Section 4.1 *Giant Garter Snake* under *Effects of Construction-related Activities*.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

As discussed above in *Mechanisms of Habitat Degradation*, in the absence of avoidance and minimization northwestern pond turtles would likely experience increased predation near the proposed residential development because of the increased abundance of domestic dogs and cats, as well as human-associated raccoons, skunks and opossums. The increased human population in the area would also increase the potential for human activity near the canal, which may lead to site avoidance by turtles (Eric Hansen, pers. comm.). Mortality because of vehicle strikes may also increase on existing roads because of the increased traffic that the project would produce.

However, as described under *Connectivity of Habitats in the Natomas Basin* (in Section 3 of this report), the project and the DEIR mitigation include measures that would substantially reduce these effects.

OVERALL EFFECT ON POPULATION VIABILITY

The project would cause both adverse and beneficial effects on the northwestern pond turtle population in the Natomas Basin. Beneficial effects would include preserving, creating, and enhancing habitat at the reserve sites, preserving a corridor along Lone Tree Canal, and contributing to the connectivity of habitat and existing TNBC reserves adjacent to or near the proposed reserves. Adverse effects would include a reduction in the total acreage of habitat, and possibly degradation of habitat near the Greenbriar site and reduced connectivity along Lone Tree Canal due to increased human disturbance and predation. The DEIR mitigation would reduce these adverse effects and ensure that connectivity of pond turtle habitat was maintained along Lone Tree Canal.

Overall, the project would not adversely affect pond turtle. The loss of habitat acreage would be more than offset by the increased habitat quality resulting from the preservation of habitat, conversion of rice to marsh, and management of rice to enhance habitats. The project would have a beneficial effect on pond turtle habitat largely because the created marsh would provide much higher quality habitat for pond turtle than rice (USFWS 2003). Also, the project (with the DEIR mitigation) would conserve connectivity and habitat for pond turtle along Lone Tree Canal and near proposed reserves in the southern and central Basin. These beneficial effects on habitat and connectivity may be sufficient to increase the viability of the Natomas Basin's northwestern pond turtle population.

4.3 SWAINSON'S HAWK

4.3.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Swainson's hawks (*Buteo swainsoni*) are most commonly found in grasslands, low shrublands, and agricultural habitats that include large trees for nesting. Land cover types designated as Swainson's hawk nesting habitat in the NBHCP include oak groves, tree groves, and riparian. These habitats are suitable for nesting only where adjacent to adequate foraging habitat. Land cover types designated as Swainson's hawk foraging habitat in the NBHCP include alfalfa, grassland, idle, non-rice crops, pasture, and ruderal. Swainson's hawks will also nest in these foraging habitats if large trees are available; however, isolated trees may be less suitable for nesting than trees in groves or riparian areas.

Prey abundance and accessibility (for capture) are the most important features determining the suitability of hawk foraging habitat. In addition, agricultural operations (e.g., mowing, flood irrigation) have a substantial influence on the accessibility of prey and thus create important foraging opportunities for Swainson's hawk (Estep 1989). Crops which are tall and dense enough to preclude the capture of prey (e.g., corn) do not provide suitable habitat except around field margins, but prey in these habitats are accessible during and immediately following harvest. Other crops (e.g., tomato, sugar beet) are tall and dense enough to inhibit but not to prevent the capture of prey during the growing season, and also provide valuable foraging opportunities during their harvest. Alfalfa, idle crop land, and most ruderal land and grassland have low and or open vegetation that doesn't impede prey capture, but prey abundance varies among these habitats and so does the frequency of agricultural operations (which are absent from ruderal land and grassland). Based on these considerations, we have divided crops and other foraging habitats into four categories of quality (i.e., low, moderate, high-moderate, and high) (Table 2-3). The basis for this classification is described in detail in the methods section (Section 2) under *Habitat Quality*.

Home Range Size and Movement

Although the most important foraging habitat for Swainson's hawks lies within a one-mile radius of each nest (City of Sacramento et al. 2003), Swainson's hawks have been recorded foraging up to 18.6 miles from nest sites (Estep 1989). Any habitat within this foraging distance may provide food at some time in the breeding season that is necessary for reproductive success. In a dynamic agricultural environment such as the Natomas Basin, the area required for hawk foraging depends on the time of season, crop cycle, crop type, and discing/harvest schedule, as these factors affect the abundance and availability of prey (City of Sacramento et al. 2003). Swainson's hawk foraging ranges during the breeding season have been estimated at approximately 1,000-7,000 acres (Bechard 1982, Estep 1989, Johnsgard 1990).

Mechanisms of Habitat Degradation

Reduction of Prey Base

The order of habitat suitability for Swainson's hawks listed above was determined by the abundance and availability of prey. Conversion of higher-suitability habitats to lower-suitability habitats would be accompanied by a reduction in prey base that may reduce nest survival or the fat reserves required by hawks for their fall migration to Central Mexico (Swainson's Hawk Technical Advisory Committee 2001), without any change in overall habitat acreage.

Changes in the hawks' rodent prey base may also result from impacts of residential development to adjacent mammalian predator communities. Crooks and Soule (1999) quantified the impacts of domestic cats on rodents and other small animals. They estimated that the average domestic cat population in moderately sized fragments (~50 acres of upland habitat bordered by 100 residences) returns about 840 rodents, 525 birds, and 595 lizards to residences each year. Assuming that cats do not bring back all prey that they kill, actual impacts to hawk prey numbers are probably even greater. Crooks and Soule (1999) also documented increased extirpations of songbird species in habitat fragments with higher densities of cats, raccoons and opossums, all of which often increase in proximity to residential development. Although rodents are the primary prey of breeding Swainson's hawks in the Natomas Basin, songbirds also contribute to their diets.

Several studies indicate that the abundance of bird species is lower near residential development. Compared to undeveloped areas at least 2,297 feet from development, Odell and Knight (2001) demonstrated lower densities of the hawks' secondary songbird prey within 1,083 feet of sparse residential development (less than 0.4 dwelling units/acre); impacts of higher density development are expected to be greater. Similarly, Blair (1996) reported 1/3 fewer bird species in lands adjacent to residential development, when compared to habitat preserves in the same area. Increased predation on the hawks' rodent prey is likely to extend between 98–590 feet from homes because of domestic cats, 590–1,083 feet from homes because of domestic dogs, and farther because of increased populations of small wild predators such as opossums and foxes (Odell and Knight 2001).

Habitat Fragmentation and Reduced Patch Size

The contiguity of foraging habitat and its placement near nest sites may also affect hawk foraging (and subsequently breeding) success. Longer foraging flights carry higher energetic costs than foraging closer to nests, and reduce the amount of time adults are present to defend nests from predators. Similarly, there may be a threshold of required habitat area near each nest, related to the foraging ranges discussed above, such that habitat loss beyond this threshold would result in a greater impact to nest survival than habitat loss from a larger area. The diversity and abundance of Swainson's hawk prey have also been reported to decline in fragmented habitat (Crooks et al. 2001; Helzer and Jelinski 1999; Hinsley et al. 1995).

Increased Predation

Corvids (crows, magpies) and great horned owls are the most common predators of Swainson's hawk eggs and nestlings (England et al. 1997). Corvid populations typically increase near human settlement because of the supplemental food source of human refuse and additional perches provided by urban trees, street lights, and other infrastructure (Steenhof et al. 1993; Marzluff et al. 2001). This increase in predator abundance may result in increased nest predation near residential development.

Nest Disturbance

Swainson's hawk responses to nest disturbance vary with each nesting pair and the timing, regularity, and nature of the disturbance. Although some researchers have described disturbed nest sites that successfully fledge young (Estep 1989; England et al. 1995), others have recorded nest abandonment in response to human activity, especially during nest building and incubation (Bent 1937; Stahlecker 1975). In addition to nest abandonment, significant disturbances near hawk nests may interfere with parental care and feeding of young in a way that reduces nest success.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 892 known occurrences in California, of which 882 were considered extant. The NBHCP did not list CNDDB occurrences for the Natomas Basin, but local surveys (described below) provided extensive data. As of 2005, there are 1,380 known Swainson's hawk occurrences in California, of which 1,350 are considered extant. At this time, 35 occurrences are known in the Natomas Basin, of which 34 are considered extant. Sixteen additional occurrences are known within one mile of the Basin, all of which are considered extant. Of these occurrences, two are within one mile of the Greenbriar site and eight are within one mile of the proposed reserve sites. All ten of these occurrences are considered extant.

Other Information on Distribution and Abundance in Natomas Basin

Estep (2001) indicates that nesting sites and foraging activity occur throughout the Basin, depending on the availability of suitable nest trees in proximity to upland foraging areas. The most recent survey of the Natomas Basin at the time the Habitat Conservation Plan was prepared located 62 breeding sites in or immediately adjacent to the Basin (Swainson's Hawk Technical Advisory Committee 2001). Hawks nesting at the 35 sites adjacent to the Basin were located along the Sacramento River and may have depended on the Basin's foraging habitat for their survival and reproduction. The NBHCP asserts that the Swainson's hawk population supported by the Natomas Basin is "important to the continued viability" of the species, which has been estimated by the California Department of Fish and Game to have declined by 94% from historical conditions in the state (Bloom 1980, California Department of Fish and Game 1989).

The most recent survey published by the Natomas Basin Conservancy mapped 89 nest sites in or adjacent to the Basin in 2004, of which 59 were active in that year. Each of these nests was within the 18.6 mile recorded foraging distance from the project and proposed reserve sites and may be affected by changes in land cover at those sites. The Natomas Basin Conservancy has mapped five nests within one mile of the Greenbriar site, two of which were active in 2004, and 12 nests within one mile of the proposed Natomas 130 reserve, six of which were active in 2004. No Swainson's hawk nests have been mapped within one mile of the proposed Spangler reserve.

The most recent monitoring report prepared for The Natomas Basin Conservancy (Jones & Stokes 2005) also contains information on population trends in the Natomas Basin. In 2004, the number of successful nests increased by five, but the downward trend in number of young per successful nest has continued, resulting in reproduction relatively similar to previous years (1999–2003).

4.3.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would not change the acreage of Swainson's hawk nesting habitat at the Greenbriar or proposed reserve sites from current (2005) conditions or conditions at the time of the NBHCP (2001), but would preserve two acres of nesting habitat.

The project's effects on foraging habitat are summarized in Table 4-3. The project would reduce the acreage of Swainson's hawk foraging habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce foraging habitat by an estimated 313 acres from conditions in 2001. At the proposed Spangler and Natomas 130 reserves, foraging habitat would increase by 91 acres. Thus, the project as a whole would yield a net loss of 222 acres of Swainson's hawk foraging habitat.

Table 4-3
Change in Acreage of Swainson's Hawk Foraging Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.6	428
Grassland	284	26.5	-	-	26.5	311
Idle	422	-62.5	-	-	-62.5	360
Non-rice crops	9,533	-234.1	-28.4	-	-262.5	9,271
Pasture	494	-33.8	-	-	-33.8	460
Ruderal	370	-9.2	-	-	-9.2	361
Upland marsh components	547	-	4.3	55.2	59.5	607
Total	12,018	-313.1	-9.9	100.6	-222.4	11,796

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

Although the expanded urban area that would be created by the Greenbriar project would result in a net reduction of areas within 800 feet or one mile of urban development or highways, the project would expand a gradient of urban influence into the previously unaffected area to the north of the property and could increase the urban influence on the agricultural land to the southwest. The impacts to Swainson's hawk prey in this area that could occur as a result of proximity to development are discussed under *Mechanisms of Habitat Degradation*, above. However, the existing roads that border the site, would function as partial barriers that limit the extent of urban influences on adjacent agricultural lands.

The current land use immediately to the north of the Greenbriar site is rice and as such does not support Swainson's hawk habitat except when fallowed. However, the creation of hawk habitat at the Greenbriar site between 2001 and 2005 attests to the potential for the area to the north to become hawk habitat in the future. The recent creation of habitat at the Greenbriar site resulted from the conversion of the rice acreage to non-rice crops and fallow agriculture. The current land use to the southwest of the property is idle cropland, which supports Swainson's hawk habitat.

Altered Habitat Quality at Proposed Reserve and Mitigation Sites

The project with the DEIR mitigation would enhance and preserve at least 190 acres of foraging habitat (26.5 acres of grassland along Lone Tree Canal, 59.7 acres of alfalfa [or other high quality foraging habitat] and 59.5 acres of upland marsh components at Spangler and Natomas 130, and at least an additional 49 acres of high quality foraging habitat required by the *DEIR* mitigation). Habitat at the unspecified DEIR mitigation site(s) and at the proposed Spangler and Natomas 130 reserves would be actively managed with the primary goal of providing high quality foraging habitat.

Conservation of the corridor along Lone Tree canal may improve its value as foraging habitat because it would be converted to perennial grassland that might have higher habitat value than the corridor's current or recent agricultural land cover. This corridor, however, would be a relatively narrow band of potential habitat surrounded by urban development, and this setting might limit its use by Swainson's hawk. Consequently, this proposed corridor was considered to provide only low quality foraging habitat.

Habitat quality for Swainson's hawks would increase in the remaining upland habitat at the proposed Natomas 130 reserve because it would be managed to provide high quality Swainson's hawk habitat.

The proposed Spangler property does not currently function as Swainson's hawk habitat except when fallowed. One hundred eighty four acres of this proposed reserve would be restored to marsh (with upland components providing foraging habitat) and the remainder (45 acres) would be converted to upland managed to provide high quality foraging habitat for Swainson's hawk. Although the Spangler property is within the 18.6 mile maximum foraging distance from all known nests in the Basin, its distance from the Greenbriar site would limit its benefit as foraging habitat for hawks affected by the project regardless of the reserve's management.

Mitigation measure 6.13-2 of the DEIR requires the enhancement and preservation of at least 49 acres to provide high quality foraging habitat that would prevent a net loss of foraging habitat values. This mitigation is in addition to the proposed reserves.

The effect of the Greenbriar project with the DEIR mitigation on the quality of Swainson's hawk foraging habitat was evaluated through three analyses:

1. acres of foraging habitat in low, moderate and high quality categories;
2. total acres of foraging habitat available per month; and
3. total foraging habitat available each month expressed as an equivalent acreage of high quality foraging habitat.

The first two analyses (acres by habitat quality category and monthly availability) were conducted as in the NBHCP, and the third was developed for this effects analysis. All three methods are described in detail in the methods section. The acres of habitat types at the Greenbriar, proposed reserve and DEIR mitigation sites with and without the project that were used in these analyses are shown in Table 2-2, and are also tabulated in tables 3-1 and 4-3.

Though the project would result in a net loss of habitat acreage, an increased percentage of the remaining habitat would be in the high quality category (Exhibit 3a). This increase in high quality habitat would result from the creation and enhancement of habitat at the Spangler, Natomas 130, and the DEIR mitigation sites. Upland habitat at the proposed Natomas 130 reserve would be enhanced, 45 acres of high quality foraging habitat would be created at the Spangler site and to provide DEIR mitigation at least 49 acres of land would be enhanced and managed to provide high quality foraging habitat for Swainson's hawk.

Based on the analysis approach in the NBHCP, the project also would result in greater availability of foraging habitat during April–September, despite causing a net loss in overall acreage of habitat (Exhibit 3). (However, this approach assumes that row and field crops are not available to foraging hawks except at harvest, and thus underestimates the acreage of foraging habitat available, particularly during April–May, which is prior to the harvest of row and field crops in the Natomas Basin.)

Based on EDAW's analysis approach, total foraging resources would be comparable with and without the project. At the Greenbriar, proposed reserve, and DEIR mitigation sites, during April–June, slightly greater foraging resources would be available with the project (the equivalent of 129 acres of high quality foraging habitat with versus 122 acres without the project), while during July–September there would be less (129 versus 140 acres in July–August and 162 acres in September) (Exhibit 4). (Throughout the Natomas Basin, during July–September, more foraging resources are available because that is when most crops are harvested [CH2M HILL 2003].)

Effects on Connectivity

With the exception of the 250-foot wide proposed conservation easement along Lone Tree Canal, the Greenbriar site would become urban land cover, which would reduce upland connectivity between the Swainson's hawk nests south of the site and foraging habitat north of the Greenbriar site. This connectivity will already be reduced by development of the Metro Air Park, which would leave the Greenbriar site as the last north-south habitat corridor in the Basin east of the mile-wide corridor along the Sacramento River. Although nesting hawks have the ability to fly past a developed Greenbriar site to northern foraging areas, they may be less likely to use foraging habitat beyond this 546-acre urban area because of the energetic cost and additional time away from the nest required by the flight. (Long foraging flights are more likely to follow lines of contiguous habitat, as hawks may scan for prey along the entire flight.)

For Swainson's hawk, the consequences of this potential habitat fragmentation depend on the distribution of foraging and nesting habitat under the future condition of the Natomas Basin resulting from the NBHCP. Currently, there is relatively little foraging habitat north and east of the Greenbriar site, and this habitat is already fragmented. There also is very little potential nesting habitat north and east of the Greenbriar site. (Both foraging habitat and nesting habitat are concentrated to the south and west of the Greenbriar site.) Thus, changes in land cover at the Greenbriar site are unlikely to cause substantial alterations of movement of Swainson's hawks across the Greenbriar site. However, the distribution of Swainson's hawk habitat in the Natomas Basin could change, and under the future condition of the Natomas Basin there would be non-urban land both north of the Greenbriar site in the central Natomas Basin and to the south of the Greenbriar site in the southern Natomas Basin. Thus, the potential for effects on connectivity of Swainson's hawk habitat can not be discounted.

The potential effects of habitat fragmentation and reduced upland connectivity on Swainson's hawk prey are discussed under *Mechanisms of Habitat Degradation*, above.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction at the Greenbriar site and habitat management at the proposed reserve sites has the potential to displace and/or disturb nesting Swainson's hawks. Nest disturbance from the operation of heavy construction equipment and continued activity near nest sites could cause nest abandonment or interfere with the incubation and feeding of young in a way that reduces nesting success.

The DEIR for the Greenbriar project and the Natomas Basin HCP both include measures to avoid and minimize construction-related effects on Swainson's hawks. In the DEIR, these measures include:

- Pre-construction surveys shall be conducted for Swainson's hawk and other raptors no more than 14 days and no less than 7 days prior to the beginning of any construction activity between March 15 and August 15. The survey area shall include all potential nesting sites located within ½ mile of the project and mitigation-sites
- Should nesting be discovered within the survey area, a qualified biologist shall notify DFG and no new disturbance shall occur within 1/2 mile of the nest until the nest is no longer active or appropriate avoidance measures are approved by DFG to ensure that the nest is adequately protected. Potential mitigation measures may include visual screening and timing restrictions for construction activity. Monitoring (funded by the project applicants) of active nests by a DFG-approved raptor biologist shall be required to determine if project construction is disturbing Swainson's hawks at the nest site. Exact implementation of this measure shall be based on specific information at the project site.

These measures should adequately reduce the impacts to Swainson's hawks that may result specifically from construction-related activities. Any construction-related displacement of hawks from foraging habitat is akin to habitat loss, as discussed above.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The proposed development is located within a ½ mile of one Swainson's hawk nest active in 2005. Although this nest tree was cut down (without authorization) during the breeding season, the pair attempted to renest in another nearby tree and may return in future years. This breeding pair would be close enough to the Greenbriar site that human disturbance from the residential development proposed at the Greenbriar site may cause nest abandonment (Bent 1937; Stahlecker 1975) or interfere with incubation and feeding of young in a way that reduces reproductive success. Predation of eggs and young chicks by crows and other corvids may also increase as a result of increased human refuse and infrastructure at the Greenbriar site (Steenhof et al. 1993; Marzluff et al. 2001). Mortality because of vehicle strikes may also increase on existing roads because of the increased traffic associated with the project. Human-wildlife conflicts are unlikely to occur at the proposed reserves.

OVERALL EFFECT ON POPULATION VIABILITY

The project would cause both adverse and beneficial effects on the Swainson's hawk population nesting and foraging in the Natomas Basin. Adverse effects would include a reduction in the total acreage of foraging habitat, fragmentation, and possibly degradation of habitat near the Greenbriar site, and a reduction in habitat available to hawks nesting at reserves near the Greenbriar site. Beneficial effects would include increasing the acreage of high quality habitat, preserving high quality habitat within a mile of TNBC reserves (or of the Swainson's Hawk zone along the Sacramento River), and possibly contributing to the connectivity of foraging habitat adjacent to the mitigation site(s) required by mitigation measure 6.13-2.

Overall, based on the USFWS interpretation of effects on Swainson's hawk due to the NBHCP (USFWS 2003), the Greenbriar project would not be expected to adversely affect the viability of the Swainson's hawk population in the Natomas Basin. Because the availability of foraging habitat during April-July is considered to limit the abundance and reproductive success of Swainson's hawk in the Natomas Basin (CH2M HILL 2003; USFWS 2003), and the project would not reduce the acreage of habitat available during these months, the project would not be expected to reduce the number of hawks nesting in the Natomas Basin or their reproductive success.

4.4 BURROWING OWL

4.4.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Burrowing owls (*Athene cunicularia hypugea*) typically inhabit grasslands, savannahs and other open habitats with low-lying vegetation. Land cover types designated as burrowing owl habitat in the NBHCP include alfalfa, grassland and pasture. Owls are also known to nest and forage in idle agricultural fields, ruderal fields and the edges of cultivated fields, although these areas provide lower quality habitat than native grasslands. The NBHCP also describes canals as potential nesting habitat for burrowing owls, although it does not include canals in the habitat table for this species. Levees and upper banks of canals and ditches provide burrowing owl nesting habitat when canal maintenance activities are limited, water levels remain below nesting burrows and the area remains relatively undisturbed. Small mammal populations (particularly California ground squirrels) are the most important feature in burrowing owl habitat, as these mammals provide both food and nesting burrows for the owls. When natural burrows are scarce, burrowing owls will also nest in artificial structures such as culverts. They often nest in elevated areas such as berms and levees, where they may scan adjacent lands for predators and prey. Burrowing owls feed primarily on large insects and rodents, and will also feed opportunistically on birds, reptiles and amphibians (NatureServe 2005).

Home Range Size and Movement

Although the more northern burrowing owl populations migrate seasonally, burrowing owls are year-round residents of the Natomas Basin. The owls often form loose colonies, with nest burrows 46–2,952 feet apart (Ross 1974; Gleason 1978). Surprisingly few data are available on home range size for this species. Published estimates vary from 0.05–1.86 square miles (Haug and Oliphant 1990).

Mechanisms of Habitat Degradation

Increased Predation

Ground- and burrow-nesting birds such as burrowing owls are particularly vulnerable to predation by domestic dogs and cats. Many wild predators of burrowing owls also increase near human habitation. In proximity to residential development, dominant carnivores such as coyotes are typically replaced by foxes, opossums, skunks, and other small predators that feed on burrowing owls (Sheffield 1997; Wellicome 1997b; Crooks and Soule 1999). Avian predators such as great-horned owls and crows may also increase in proximity to residential development, in response to introduced nesting trees, increased food supplies and increased hunting perches such as street lights and other infrastructure (Steenhof et al. 1993; Marzluff et al. 2001). This increase in predator abundance would likely result in increased predation of burrowing owl nests and adults near residential development.

Reduction of Prey Base

Changes in the owls' prey base may result from residential development affecting adjacent mammalian predator communities. Rodents and insects are the primary prey of burrowing owls; songbirds also contribute to their diets (NatureServe 2005). Crooks and Soule (1999) quantified the effects of domestic cats on small animals. They estimated that the average domestic cat population in moderately sized fragments (~50 acres of upland habitat bordered by 100 residences) returns about 840 rodents, 525 birds and 595 lizards to residences each year. Assuming that cats do not bring back all prey that they kill, actual effects on prey numbers are probably even greater. Crooks and Soule (1999) documented increased extirpations of songbird species in habitat fragments with higher densities of cats, raccoons and opossums, all of which often increase in proximity to residential development.

Compared to undeveloped areas at least 2,296 feet from development, Odell and Knight (2001) demonstrated lower densities of the owls' secondary songbird prey within 1,083 feet of sparse residential development (about 0.4 houses per acre); impacts of higher density development are expected to be greater. Similarly, Blair (1996) reported 1/3 fewer bird species in lands adjacent to residential development, when compared to habitat preserves in the same area.

Habitat Fragmentation and Reduced Patch Size

Habitat fragmentation has been implicated as a major cause of population decline in grassland birds in general, and is likely to specifically impact burrowing owls. Helzer and Jelinski (1999) found both overall avian species richness and the presence of several common grassland species to increase with the size of habitat patches (especially when >124 acres) and decrease with the perimeter-area ratio of these patches, which reflects the proportion of habitat influenced by edge effects.

In fragments 5–250 acres in size, Crooks et al. (2001) found fragment size to be the most important factor determining extinction and colonization of songbirds. No fragments up to 247 acres in size were large enough to support the full complement of native bird species with 95% probability over a 100-year period. Burrowing owls forage in larger habitat patches than the smaller birds studied by Crooks et al. (2001), and are likely to be similarly affected by fragmentation. Hinsley et al. (1995) also demonstrated the instability of bird populations in habitat fragments.

Nest Disturbance

Although burrowing owls are tolerant of human activity outside of the breeding season, they have been shown to abandon nests if disturbed during incubation. In addition to nest abandonment, significant disturbances near owl nests may interfere with parental care and feeding of young in a way that reduces nest success.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 370 known occurrences in California, of which 300 were considered extant. At that time, three occurrences were known from the Natomas Basin, all of which were considered extant. As of 2005, there are 709 known occurrences in California, of which 671 are considered extant. At this time, seven occurrences are known in the Natomas Basin, of which six are considered extant. Of these occurrences, one is within a mile of the Greenbriar site, and none are within a mile of the proposed reserve sites.

Other Information on Distribution and Abundance in Natomas Basin

No systematic surveys have been conducted to determine burrowing owl distribution or abundance across the Natomas Basin. A burrowing owl was incidentally observed in a culvert on the southwestern portion of the Greenbriar site during the March 17, 2005 site visit. A number of owl pellets and whitewash were also observed, indicating extended use of the site by at least one owl for roosting and foraging over a period of time, and possible nesting. During biological effectiveness monitoring for the NBHCP, burrowing owls were observed in the eastern Basin south of Elverta Road and in the central Basin along Highway 99 (approximately 1.3 miles north of the Greenbriar site) (Jones & Stokes 2005). Burrowing owls have also been incidentally observed east of the Greenbriar site along Elkhorn Blvd. and west of the Greenbriar site on the Metro Air Park and Sacramento International Airport.

4.4.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project's effects on foraging habitat for burrowing owl are summarized in Table 4-4. The project would reduce the acreage of burrowing owl habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce habitat by an estimated 94 acres from conditions in 2001. At the proposed reserves, 118 acres of burrowing owl habitat would be created (assuming the Swainson's hawk foraging also provided burrowing owl habitat). Thus, the project as a whole would yield a net gain of 24 acres of burrowing owl habitat. Additional burrowing owl foraging habitat may be created by the enhancement and management of at least 49 acres of land to provide high quality foraging habitat for Swainson's hawk that is required by mitigation measure 6-13.2 of the DEIR.

Table 4-4
Change in Acreage of Burrowing Owl Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.6	428
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Grassland	284	26.5	-	-	26.5	311
Idle	422	-62.5	-	-	-62.5	360
Pasture	494	-33.8	-	-	-33.8	460
Ruderal	370	-9.2	-	-	-9.2	361
Upland marsh components	547	-	4.3	55.2	59.5	607
Total	3,647	-94.1	18.5	99.2	23.7	3,673

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

Although the expanded urban area that would be created at the Greenbriar site would result in a net reduction of areas within 800 feet or 1 mile of development, the project would expand a gradient of urban influence into the previously unaffected area to the north of the property and could increase the urban influence in the idle field to the southwest. The potential effects on burrowing owls and their prey in these areas are discussed under *Mechanisms of Habitat Degradation*, above. These adverse effects, however, would be limited by Interstate 5 along the Greenbriar site's southern border, and by Elkhorn Boulevard (which would be expanded to six lanes) that would serve as partial barriers between development on the Greenbriar site and adjacent agricultural lands.

The current land use immediately to the north of the Greenbriar site is rice and as such does not support burrowing owl habitat. However, the creation of burrowing owl habitat at the Greenbriar site between 2001 and 2005 attests to the potential for the area to the north to become burrowing owl habitat in the future. The habitat creation on the Greenbriar site resulted from the conversion of a portion of the rice acreage to fallow agriculture. The current land use to the southwest of the property is fallow agriculture, which supports burrowing owl habitat.

Altered Habitat Quality at Proposed Reserve and Mitigation Sites

In addition to habitat lost due to development of the Greenbriar site, and created at the proposed reserves, the quality of burrowing owl habitat could be altered at the conserved corridor along Lone Tree Canal, the proposed Spangler and Natomas 130 reserves, and the mitigation site that would be required by mitigation measure 6.13-2 of the DEIR.

Conservation of the corridor along Lone Tree canal may improve its value as foraging habitat because it would be converted to perennial grassland that might have higher habitat value. This corridor, however, would be a relatively narrow band of potential habitat surrounded by urban development, and this setting might limit its use by burrowing owl.

At all of the proposed reserves, management practices would enhance habitat for burrowing owl. These enhancements include maintaining buffers in as natural a state as possible, controlling feral cats if necessary, and reducing human disturbance due to trespassers (City of Sacramento et al. 2003, John Roberts, TNBC, personal communication). Also, preservation of habitat, even without enhancement measures, provides some benefits, including that it precludes land use changes that would eliminate habitat, and should reduce or eliminate uses that could cause mortality of individuals.

In addition to habitat enhancement at the proposed reserves, mitigation measure 6.13-2 of the DEIR requires that at least 49 acres be enhanced to provide high quality foraging habitat. This mitigation could also benefit burrowing owls. This mitigation land will be managed to provide high quality foraging habitat for Swainson's hawk, but would also enhance foraging habitat for burrowing owl.

Effects on Connectivity

With the exception of the 250-foot wide conservation easement proposed along Lone Tree Canal, the development at the Greenbriar site would eliminate the existing contiguity of upland habitats to the north and south of the site. This connectivity will already be substantially reduced by development at the Metro Air Park, which would leave the Greenbriar site as the last north-south corridor of habitat in the Basin east of the mile-wide corridor along the Sacramento River. Owl survival and reproduction are likely to be higher in larger, more contiguous habitat areas. Connectivity benefits owls by providing greater ease of locating mates, greater flexibility in year-round foraging opportunities, and safer passages for juvenile dispersal. The potential effects of reduced connectivity on upland birds in general are discussed under *Mechanisms of Habitat Degradation*, above.

The proposed reserves and mitigation site(s) could increase connectivity of burrowing owl habitat elsewhere in the Natomas Basin. If larger, more contiguous areas of habitat resulted from the creation of these reserves, this would benefit owl survival and reproduction. Other foraging habitat is available near the Natomas 130 site, and thus this proposed reserve would result in larger more continuous areas of habitat (Jones & Stokes 2005). The land cover surrounding the Spangler property is primarily rice (Jones & Stokes 2005)

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Earth-moving activities may trap or injure owls in their burrows, and disturbance near nests may cause nest abandonment. Both the Greenbriar DEIR and Natomas Basin HCP require comparable measures to avoid impacts to burrowing owls during construction. The DEIR measures include:

a. No more than 30 days and no less than 14 day prior to project site grading, a qualified biologist shall conduct focused surveys for burrowing owls in areas of suitable habitat on and within 300 feet of the project site. Surveys shall be conducted in accordance with DFG protocol (DFG 1995).

b. If no occupied burrows are found in the survey area, a letter report documenting survey methods and findings shall be submitted to DFG, and no further mitigation is necessary.

c. If occupied burrows are found in the survey area, impacts shall be avoided by establishing a buffer of 165 feet during the non-breeding season (September 1 through January 31) or 300 feet during the breeding season (February 1 through August 31). The size of the buffer area may be adjusted if a qualified biologist and DFG determine it would not be likely to have adverse effects. No project activity shall commence within the buffer area until a qualified biologist confirms that the burrow is no longer occupied. If the burrow is occupied by a nesting pair, a minimum of 6.5 acres of foraging habitat contiguous to the burrow shall be preserved until the breeding season is over.

d. If impacts to occupied burrows are unavoidable, on-site passive relocation techniques may be used if approved by DFG to encourage owls to move to alternative burrows outside of the impact area. However, no occupied burrows shall be disturbed during the nesting season unless a qualified biologist verifies through non-invasive methods that the burrow is no longer occupied. Foraging habitat for relocated pairs shall be provided in accordance with guidelines provided by DFG (1995). DFG guidelines recommend a minimum of 6.5 acres of foraging habitat per pair or unpaired resident bird, be acquired and permanently protected.

e. If relocation of the owls is approved for the site by DFG, the developer shall hire a qualified biologist to prepare a plan for relocating the owls to a suitable site. The relocation plan must include: (a) the location of the nest and owls proposed for relocation; (b) the location of the proposed relocation-site; (c) the number of owls involved and the time of year when the relocation is proposed to take place; (d) the name and credentials of the biologist who will be retained to supervise the relocation; (e) the proposed method of capture and transport for the owls to the new site; (f) a description of the site preparations at the relocation-site (e.g., enhancement of existing burrows, creation of artificial burrows, one-time or long-term vegetation control, etc.); and (g) a description of efforts and funding support proposed to monitor the relocation. Relocation options may include passive relocation to another area of the site not subject to disturbance through one way doors on burrow openings, or construction of artificial burrows in accordance DFG guidelines.

f. The project applicant shall implement Mitigation Measure 6.12-2 to mitigate for the loss of burrowing owl foraging habitat.

By following these measures, the potential for injury, entrapment, and nest abandonment would be reduced. However, nests may be abandoned because of loss of the surrounding foraging habitat during construction, and owl viability at relocation sites is not guaranteed.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

On the remaining habitat adjacent to the proposed development, human activity may cause owl nest abandonment or interfere with the incubation and feeding of young in a way that reduces reproductive success. Increased owl predation would also likely occur in proximity to the proposed development, as a result of the typical increase in human-associated owl predators discussed above under Mechanisms of Habitat Degradation. Increased predation by domestic cats is likely to extend between 98–540 feet from homes, predation by domestic dogs is likely to extend between 540–990 feet from homes, and increased predation by wild predators is likely to extend farther (Odell and Knight 2001). Mortality because of vehicle strikes may also increase on existing roads because of the increased traffic that would result from the project.

OVERALL EFFECT ON POPULATION VIABILITY

The Greenbriar project with the DEIR mitigation would cause both adverse and beneficial effects on burrowing owl. Adverse effects would include loss of occupied habitat, and fragmentation and some degradation of habitat adjacent to development at the Greenbriar site. Beneficial effects would include a net increase in acreage of foraging habitat, and preservation and enhancement of at least 197 acres of habitat, and possibly increased connectivity of habitats in the vicinity of the mitigation lands. Overall, the project would likely result in a beneficial effect on burrowing owl. However, the project is unlikely to have a substantial effect on burrowing owls using the Natomas Basin, and since the Basin accounts for a very small portion of the Central Valley's burrowing owl population and of the habitat it occupies (USFWS 2003), the project would not alter the viability of the burrowing owl population using the Natomas Basin.

4.5 LOGGERHEAD SHRIKE

4.5.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Loggerhead shrikes (*Lanius ludovicianus*) are most commonly found in grasslands, agricultural lands, open shrublands, and open woodlands (Bent 1950). Land cover types designated as shrike habitat in the NBHCP include alfalfa, grassland, non-rice crops, oak groves, orchard, pasture, ponds and seasonally wet areas, riparian, ruderal, rural residential, tree groves, and canals. Special habitat features that improve shrike abundance, survival, and reproductive success are hunting perches, low nesting trees and shrubs, thorny vegetation, and/or barbed wire on which to impale their prey. Shrikes select a variety of prey including insects, reptiles, mammals, and birds.

Home Range Size and Movement

The mean territory size of breeding loggerhead shrikes in mainland California is 22 acres (Miller 1931). The range-wide maximum and minimum breeding territory sizes recorded are 1.7 and 44 acres (Yosef and Grubb 1994). Territory size varies with habitat quality, prey abundance and availability, and density of hunting perches (Kridelbaugh 1982, Yosef and Grubb 1992). Loggerhead shrikes have been observed foraging up to a quarter mile from active nests (Brooks 1988). Shrikes are year-round residents in California, and breeding pairs disband in autumn to defend separate, adjacent, winter territories (Miller 1951, Craig 1978). As food availability decreases in winter, seasonal home ranges may increase to 128 acres (Blumton et al. 1989). Juvenile shrikes move an average of 3.4 miles from their natal territories to their fall territories.

Mechanisms of Habitat Degradation

Increased Predation

Domestic cats are a common predator of loggerhead shrike adults, juveniles and nests (Luukkonen 1987, Novak 1989), and would increase in abundance following the proposed development. Crooks and Soule (1999) quantified the impacts of domestic cat predation on songbirds such as loggerhead shrikes, and estimated that the average domestic cat population in moderately sized fragments (~50 acres of upland habitat bordered by 100 residences) returns about 525 birds to human residences each year. Assuming that cats do not bring back all prey that they kill, actual impacts to birds are probably even greater.

Many wild mammalian predators of shrikes also increase near human habitation. In proximity to residential development, dominant, larger carnivores such as coyotes are typically replaced by foxes, opossums, skunks, and other small predators that feed on shrikes and other songbirds. Crooks and Soule (1999) have recorded increased avian extirpation rates in habitat fragments as a result of these predator increases.

Shrike nest predators such as crows also typically increase in proximity to residential development, in response to introduced nesting trees, increased food supplies, and increased hunting perches such as street lights and other infrastructure (Steenhof et al. 1993; Marzluff et al. 2001). Predation of loggerhead shrike nests is also more intense along roads, urban edges, and other linear habitats (DeGeus 1990), presumably because of the increased use of linear rights-of-way by crows and mammalian predators (Knight et al. 1995). Of loggerhead shrike nest failures, 40–90% have been attributed to predation in the various studies of this species (NatureServe). Shrike mortality from vehicle collisions has also been significant in some areas (NatureServe), and may increase with increased traffic generated by the proposed residential development.

Nest Disturbance

Loggerhead shrikes will abandon nests if disturbed by humans during egg-laying or early in incubation. Shrikes are generally tolerant of human activity near nests later in the breeding season, however, and nest abandonment is not generally a significant factor in nest failure (Collister 1994).

Habitat Fragmentation

Habitat fragmentation has been implicated as a major cause of population decline in grassland birds in general, and is likely to specifically affect loggerhead shrikes. Helzer and Jelinski (1999) found both overall avian species richness and the presence of several common grassland species to increase with the size of habitat patches (especially when >50 ha) and decrease with the perimeter-area ratio of these patches, which reflects the proportion of habitat influenced by edge effects. Hinsley et al. (1995) and Crooks et al. (2001) also demonstrated the instability of upland bird populations in habitat fragments.

DISTRIBUTION

Information on CNDDB Occurrences

Although loggerhead shrikes are known to occur in open habitats throughout California (California Department of Fish and Game 1990), they have not been extensively surveyed and few occurrence data are available in the state. The CNDDB lists five occurrences for this species, all in southern California.

Other Information on Distribution and Abundance in Natomas Basin

The Natomas Basin Conservancy lists 82 shrike occurrences throughout the Basin, and suitable nesting and foraging habitat is common throughout the area. Shrikes were observed on the Greenbriar site during March 2005 surveys.

4.5.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project's effects on the acreage of shrike habitat are summarized in Table 4-5. The project would reduce the acreage of loggerhead shrike habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce habitat by an estimated 369 acres from conditions in 2001. At the proposed Spangler reserve, shrike habitat would increase by 228 acres because habitat would be created (by converting rice to marsh and upland habitat). Thus, the project as a whole would yield a net loss of 141 acres of loggerhead shrike habitat.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

Although the urban area that would be created by the Greenbriar project would result in a net reduction of areas within 800 feet or 1 mile of development, the project would expand a gradient of urban influence into the previously unaffected area to the north of the property and could increase the urban influence in the idle field to the southwest. The potential affects on loggerhead shrikes in these areas are discussed under *Mechanisms of Habitat Degradation*, above.

Table 4-5
Change in Acreage of Loggerhead Shrike Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.7	428
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Grassland	284	26.5	-	-	26.5	311
Idle	422	-62.5	-	-	-62.5	360
Non-rice crops	9,533	-234.1	-28.4	-	-262.6	9,270
Oak groves	77	-	-	-	0.0	77
Orchards	165	-	-	-	0.0	165
Pasture	494	-33.8	-	-	-33.8	460
Ponds & seasonally wet areas	2,259	2.7	14.2	184	200.9	2,460
Riparian	91	0.0	0.0	-	0.0	91
Ruderal	370	-9.22	-	-	-9.2	361
Rural residential	287	-43.319	-	-	-43.3	244
Tree groves	44	-	0.0	-	0.0	44
Total	15,555	-368.8	0.0	228	-140.8	15,415

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

The current land use immediately to the north of the Greenbriar site is rice and as such does not support loggerhead shrike habitat. However, the creation of shrike habitat at the Greenbriar site between 2001 and 2005 attests to the potential for the area to the north to become impacted shrike habitat in the future. The habitat creation on the Greenbriar site resulted from the conversion of a portion of the rice acreage to fallow agriculture and non-rice crops. The current land use to the southwest of the property is fallow agriculture, which supports loggerhead shrike habitat.

Adverse effects on adjacent land, though probably not insignificant, would be limited by Interstate 5 along the Greenbriar site's southern border and by Elkhorn Boulevard (which would be expanded to six lanes) that would serve as partial barriers between development on the Greenbriar site and adjacent agricultural lands.

Altered Habitat Quality at Proposed Reserve and Mitigation Sites

In addition to habitat loss due to development of the Greenbriar site and habitat creation from rice at the proposed Spangler reserve, the quality of loggerhead shrike habitat could be altered at the conserved corridor along Lone Tree Canal, the proposed Natomas 130 reserve, and the mitigation site(s) that would be required by mitigation measure 6.13-2 of the DEIR.

Conservation of the corridor along Lone Tree canal may improve its value as foraging habitat because it would be converted to perennial grassland that might have higher habitat value than the current and recent agricultural land cover. This corridor, however, would be a relatively narrow band of potential habitat surrounded by urban development, and this setting might limit its use by loggerhead shrike.

At the proposed Natomas 130 reserve, there would be little overall change in habitat quality. Habitat quality would decrease on the 14 acres of created marsh, because this land cover type provides lower quality shrike habitat than the agricultural cropland it would replace. Conversely, habitat quality would increase on the 14 acres managed to provide high quality foraging habitat for Swainson's hawk. At the Spangler site, 235 acres would be enhanced for loggerhead shrike by the conversion of rice to managed marsh and uplands. Loggerhead shrike habitat would also be enhanced at the on 49 acres at the *DEIR* mitigation site. Mitigation measure 6.13-2 of the DEIR requires the enhancement and preservation of at least 49 acres to provide high quality foraging habitat. This DEIR mitigation is in addition to the proposed reserves. Its management to provide high quality foraging habitat for Swainson's hawk would also increase habitat quality for loggerhead shrike.

Overall, the project would preserve and actively manage 345 acres of habitat (30.4 acres at the Natomas 130 site, 235.4 acres at the Spangler site, 30.6 acres at the Greenbriar site, and at least 49 acres at the mitigation site required by mitigation measure 6-13.2 of the DEIR). This preservation and management would provide additional benefits (such as reduced human disturbance).

Effects on Connectivity

With the exception of the 250-foot wide proposed conservation easement along Lone Tree Canal, development at the Greenbriar site would eliminate the existing contiguity of upland habitats to the north and south of the site. This connectivity will already be substantially reduced by development at the Metro Air Park, which would leave the Greenbriar site as the last north-south habitat corridor in the Basin east of the mile wide corridor along the Sacramento River. Shrike survival and reproduction are likely to be higher in larger, more contiguous habitat areas. Connectivity benefits shrikes by providing greater ease of locating mates, greater flexibility in year-round foraging opportunities, and safer passages for juvenile dispersal and seasonal movements. The potential effects of reduced connectivity on upland birds in general are discussed under *Mechanisms of Habitat Degradation,* above.

Except for the proposed Spangler reserve, the proposed reserve and mitigation sites already provide shrike habitat, and thus their preservation and management are unlikely to significantly increase habitat connectivity. The creation of habitat at the proposed Spangler reserve could locally increase connectivity of shrike habitats.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction activities associated with the proposed development or the proposed habitat creation on proposed reserve sites could disturb or displace loggerhead shrikes and may cause nest abandonment. In the Greenbriar project DEIR and Natomas Basin HCP, preconstruction surveys for loggerhead shrikes would be conducted before construction. If shrikes are found, disturbance would be avoided during the nesting season to the maximum extent possible.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

On the remaining habitat adjacent to the proposed development, human activity may cause shrike nest abandonment or interfere with the incubation and feeding of young in a way that reduces reproductive success. Increased shrike predation would also be likely to occur in proximity to the proposed development, as a result of the typical increase in human-associated predators discussed above under *Mechanisms of Habitat Degradation*. Human-wildlife conflicts are unlikely to occur at the proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

Overall, the Greenbriar project could cause a small adverse or beneficial effect on loggerhead shrike. Though it would enhance 298 acres of shrike habitat and preserve 345 acres of habitat, these beneficial effects might not fully offset the project's adverse effects on loggerhead shrike, which include a net loss of 141 acres of habitat, reduced habitat quality on 45 acres (14 acres at Natomas 130 and 30.6 acres along Lone Tree Canal), fragmentation of habitat, a reduction of connectivity, and probably some increased mortality and habitat degradation adjacent to the Greenbriar site. However, the project's effects would be small relative to the quantity of habitat that would remain in the Natomas Basin (e.g., the project would cause the loss of approximately 1% of habitat that would be available under the future condition), and the Natomas Basin represents only a small portion of the habitat used by shrikes in the Central Valley (USFWS 2003). Thus, the project is unlikely to alter the viability of the loggerhead shrike population using the Natomas Basin.

4.6 TRICOLORED BLACKBIRD

4.6.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Tricolored blackbirds (*Agelaius tricolor*) nest in dense colonies that range from less than 25 individuals to over 80,000. As nesting and foraging habitat differ for this species, we analyzed these habitats separately. Common nesting substrates include tule and cattail marsh, blackberry, thistle, willow, nettle, and some grain crops (Beedy and Hayworth 1991). Because patches of dense nesting substrate do not necessarily correlate with the land cover types defined by the NBHCP, the NBHCP analyzed these patches separately as "tricolored blackbird nesting habitat." Special habitat features that improve nesting blackbird abundance, survival and reproductive success include dense nesting substrates and proximity to concentrated insect populations large enough to sustain the colony (Grinnell and Miller 1944, DeHaven 2000).

Tricolored blackbirds forage in grassland, pasture, silage, wetlands and flooded fields, rice, and other grain fields (Zeiner et al. 1990). Land cover types designated as tricolored blackbird foraging habitat in the NBHCP include alfalfa, grassland, non-rice crops, pasture, and rice. As they represent a transition between cropland and grassland habitats, idle and ruderal fields may also provide marginal foraging habitat. Tricolored blackbirds are primarily insectivorous, with grasshoppers, beetles, and weevils dominating their diet (Beedy and Hayworth 1991).

Home Range Size and Movement

Breeding tricolored blackbirds concentrate foraging activity in proximity to nesting colonies, and may travel up to 4 miles from nest or roost sites to forage. The species is generally nomadic when not breeding, and may be found year-round throughout lowland California.

Mechanisms of Habitat Degradation

Increased Predation

Abundance of blackbird predators such as domestic cats and foxes typically increases in proximity to residential development (Crooks and Soule 1999). Although increased predation near residential development would likely be much less for vigilant, mobile flocks of foraging blackbirds than for more stationary nesting birds such as loggerhead shrikes or burrowing owls, predation rates would be expected to increase for all small bird species near residential development.

Nest Disturbance

Nesting colonies of tricolored blackbirds are highly sensitive to disturbance, which may cause nest abandonment or interfere with the incubation and feeding of young in a way that reduces reproductive success (NBHCP 2001).

Water Diversion and Runoff

Water diversions may degrade wetland habitat for tricolored blackbirds nesting downstream from a diversion.

DISTRIBUTION

Information on CNDDB Occurrences

The NBHCP does not list state-wide or Basin-specific CNDDB occurrences of tricolored blackbirds, but notes 9 occurrences in Sutter County, 7 of which were extant in 2001. As of 2005, there are 408 known occurrences in California, of which 339 are considered extant. At this time, CNDDB does not list tricolored blackbird occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

At the time of the NBHCP in 2001, the Betts-Kismat-Silva reserve on the eastern edge of the Natomas Basin supported a tricolored blackbird colony of approximately 4,000 nesting birds (NBHCP 2001). At the time of the most recent TNBC monitoring report in 2004, the blackbirds did not nest at this site, although 125–300 birds were regularly seen in the area. Tricolored blackbirds similarly did not nest at this site in 2005 (unpublished data). Tricolored blackbirds are known to forage throughout the Basin (NBHCP), and have been observed foraging on the Metro Air Park site near the Greenbriar site (Thomas Reid Associates, 2000).

4.6.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The Project's effects on the acreage of nesting habitat for tricolored blackbirds are summarized in Table 4-6. The Greenbriar and proposed reserve sites do not currently support tricolored blackbird nesting habitat. The proposed creation of 198 acres of marsh at the Natomas 130 and Spangler sites would provide potential nesting habitat in these managed marshes. However, at the Natomas 130 site, because of the extensive urban development nearby and variety of habitats surrounding the parcel, it is unclear whether the foraging habitat surrounding the created marsh would be adequate to sustain a nesting colony of blackbirds. This is not the case at the Spangler site where most of the marsh (184 of 198 acres) would be created.

Table 4-6
Change in Acreage of Tricolored Blackbird Nesting Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Ponds & seasonally wet areas	2,259	2.7	14.2	184.0	200.9	2,460
Total	2,259	2.7	14.2	184.0	200.9	2,460

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

The Project's effects on the acreage foraging habitat for tricolored blackbirds are summarized in Table 4-7. The project would reduce the acreage of tricolored blackbird foraging habitat in the Natomas Basin. The proposed development at the Greenbriar site would eliminate an estimated 402 acres of habitat, based on 2001 land cover.

At the proposed Spangler and Natomas 130 reserves, 197 acres of foraging habitat would be eliminated (by conversion of rice and non-rice crop to marsh). Thus, the project as a whole would yield a net loss of 598 acres of tricolored blackbird foraging habitat.

Table 4-7
Change in Acreage of Tricolored Blackbird Foraging Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.6	428
Grassland	284	26.5	-	-	26.5	311
Non-rice crops	9,533	-234.1	-28.4	-	-262.6	9,270
Pasture	494	-33.8	-	-	-33.8	460
Rice	11,643	-160.0	-	-228	-388.0	11,255
Total	22,322	-401.5	-14.2	-182.6	-598.3	21,724

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

Although the urban area that would be created by the proposed Greenbriar development would result in a net reduction of areas within 800 feet or 1 mile of development, the project would expand a gradient of urban influence into the previously unaffected area to the north of the property and increase the urban influence in the idle field to the southwest. The potential effects in this area on tricolored blackbirds are discussed under *Mechanisms of Habitat Degradation*, above. These effects include increased predation of foraging tricolored blackbirds but not of nesting blackbirds. Tricolored blackbird nesting habitat does not currently exist in the vicinity of the Greenbriar site; therefore, the project would not result in nest disturbance unless new nests were established near the site.

The current land use to the north of the Greenbriar site is rice, which provides tricolored blackbird foraging habitat. The current land use to the southwest of the property is fallow agriculture, which does not support quality blackbird habitat. However, the conversion of rice to non-rice crops at the Greenbriar site between 2001 and 2005 attests to the potential for agricultural habitats to change; the area to the southwest may thus become blackbird foraging habitat in the future (and conversely, foraging habitat to the north could become less suitable).

Adverse effects on adjacent land, though probably not insignificant, would be limited by Interstate 5 along the Greenbriar site's southern border and by Elkhorn Boulevard (which would be expanded to six lanes) along the site's northern border, which would serve as partial barriers between development on the Greenbriar site and adjacent agricultural lands.

Habitat Alteration at Proposed Reserve and Mitigation Sites

The project would preserve approximately 198 acres of nesting habitat (14 acres at the Natomas 130 site and 184 acres at the Spangler site). (The 2.7 acres of marsh created at the Greenbriar site was not considered suitable as nesting habitat because of its small size and surrounding urban development.) In addition to its other benefits, preservation should reduce the level of human disturbance, which could enhance the quality of nesting habitat.

The project with the DEIR mitigation would preserve at least 135 acres of foraging habitat: 14 acres at the Natomas 130 site, 45 acres at the Spangler site, 27 acres at the Greenbriar site, and at least an additional 49 acres required by mitigation measure 6-13.2 of the DEIR. (The Spangler site is within foraging distance of the TNBC Betts-Kismat-Silva reserve where tricolored blackbirds have nested.) At the Natomas 130, Spangler, and DEIR mitigation sites, management of 109 acres to provide high quality foraging habitat for Swainson's hawk would also enhance habitat values for tricolored blackbird; however, because the benefits of such management for tricolored blackbirds have not been documented, a moderate level of uncertainty exists regarding their magnitude. (The preservation of land along Lone Tree Canal and its conversion to grassland was not considered an enhancement of foraging habitat because this site would also be affected by the proposed development.)

Effects on Connectivity

Because tricolored blackbirds are largely nomadic when not nesting, connectivity for this species is mostly pertinent to a 4-mile radius of foraging habitat surrounding nesting colonies. The Greenbriar site is at the edge of this radius from the TNBC Betts-Kismat-Silva reserve where tricolored blackbirds have nested, and thus development at the Greenbriar site would not affect connectivity of foraging habitat near this reserve (although it would reduce the habitat acreage within 4 miles of the reserve). The proposed Spangler reserve is similarly located along the edge of this radius and would preserve foraging habitat within 4 miles of the TNBC Betts-Kismat-Silva reserve (but would not affect connectivity). The proposed Natomas 130 reserve is located outside of this 4-mile radius. The land that would be preserved to provide Swainson's hawk foraging habitat also might increase connectivity of tricolored blackbird habitat depending on its location, but the location of this mitigation land has not yet been specified.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction-related activities are unlikely to affect tricolored blackbirds because they do not nest in the vicinity of the Greenbriar and proposed reserve sites. Potential effects would be limited to displacement of birds foraging or roosting on the sites during the initial phases of construction when fields are graded. This impact is largely akin to habitat loss, as the physical flight of the birds from these areas would not cause a significant effect.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

Because tricolored blackbirds do not currently nest in the vicinity of the proposed development or reserve sites, nest disturbance by humans would not be created by the project. Increased populations of human-associated predators may result in increased predation of foraging blackbirds near a developed Greenbriar site, as discussed in *Mechanisms of Habitat Degradation,* above.

OVERALL EFFECT ON POPULATION VIABILITY

There is a moderate level of uncertainty regarding the overall effect of the Greenbriar project on tricolored blackbird because of the limited current use of the Natomas Basin by tricolored blackbird, opposite effects on nesting and foraging habitat, and uncertainty regarding the benefits provided by foraging habitat enhancement. Recently, only a single colony of tricolored blackbirds has nested in the Natomas Basin (Jones & Stokes 200). However, substantial quantities of foraging habitat (over 21,000 acres, Table 3-3) and an increasing acreage of nesting habitat exist in the Basin, and thus tricolored blackbird use of the Basin could increase. The Greenbriar project would increase the quantity of nesting habitat in the Natomas Basin (by 198 acres), but would decrease the quantity of foraging habitat (by 598 acres). Although currently, nesting habitat is more limited than foraging habitat in the Natomas Basin, under the future condition much more nesting habitat will exist, and thus the additional nesting habitat that would be provided by the project may not affect the tricolored blackbird population more than the loss of foraging habitat that would also result. This loss of foraging habitat would be partially but not fully offset by the preservation of 135 acres of foraging habitat and enhancement of 109 of these 135 acres. However, the magnitude of the benefits provided by this enhancement is moderately uncertain. Because of these uncertainties, overall, the project could cause a small adverse or beneficial effect on tricolored blackbird use of the Natomas Basin.

Because the project would only cause a small effect on tricolored blackbird use of the Natomas Basin, and because the Natomas Basin accounts for only a small portion of the habitat for and population of tricolored blackbird in the Central Valley, the Greenbriar project is unlikely to alter the viability of the tricolored blackbird population using the Natomas Basin.

4.7 WHITE-FACED IBIS

4.7.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

White-faced ibis (*Plegadis chihi*) breed in wetlands with dense emergent vegetation such as cattails and rushes. They forage in shallow wetlands, irrigation ditches and a variety of irrigated crops and flooded agricultural fields (Ryder and Manry 1994, Cogswell 1977). Land cover types designated as ibis habitat in the NBHCP include alfalfa, canals, ponds and seasonally wet areas, and rice. White-faced ibis feed on aquatic and moist-soil invertebrates such as earthworms, larval insects, snails, and bivalves. Although white-faced ibis feed intensively in rice fields, rice seeds have not been noted in food samples and only trace, incidental amounts of vegetation have been recorded in ibis diets (Belknap 1957).

Home Range Size and Movement

Nesting colonies have ranged in size from 1.3 acres to 600 acres (USFWS 1985e). Foraging distances from nesting sites vary widely and depend on the availability of food. Some colonies concentrate their foraging activity within 2–4 miles of their breeding sites (Bray 1986, Bray and Klebenow 1988), while others forage 25–30 miles from nest sites (Trost 1989). Some colony locations are used for nesting year after year, while others are used more sporadically depending on water conditions and the availability of food (Ryder 1967).

Mechanisms of Habitat Degradation

Water Quality and Water Diversion

White-faced ibis depend on healthy populations of aquatic invertebrate prey, which in turn may be greatly affected by surrounding land use. Urban areas can cause different and in some cases stronger effects than agricultural lands (Bury 1972, Moore and Palmer 2005). Residential developments typically result in increased runoff of hydrocarbons and of chemicals used for lawns and gardens, and increased stormwater volume (and associated increased depths and velocities) because of high coverage of impervious surfaces. Water diversions may also reduce the abundance of ibis prey. Decreased abundance of aquatic invertebrates has been shown to impact insectivorous birds in both observational field studies and controlled field experiments (Baxter et al. 2004, in press and in review).

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were seven known breeding colonies in California, all of which were considered extant. At that time, no colonies were known in the Natomas Basin, and the nearest known nesting occurrence was in Yolo County, north of Woodland. As of 2005, there are 15 known occurrences in California, of which 13 are considered extant. At this time, CNDDB does not list white-faced ibis occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

White-faced ibis are common winter foragers in the Natomas Basin (NBHCP), and 10,000 to 11,000 ibis have been estimated in the Sacramento Valley as a whole (Hickey and Shufford 1996, Thomas Reid Associates 2000).

4.7.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

Neither the Greenbriar site nor the proposed reserves currently support potential nesting habitat for white-faced ibis. However, the proposed creation of 198 acres of marsh at the Natomas 130 and Spangler sites could provide nesting habitat. (The 2.7 acres of marsh proposed along Lone Tree Canal was not considered suitable nesting habitat because of its small size and the surrounding urban development.) Thus, the project could increase white-faced ibis nesting habitat in the Natomas Basin by up to 198 acres from conditions at the time of the NBHCP (2001).

The project's effects on the acreage of white-faced ibis foraging habitat are summarized in Table 4-8. The project would reduce the acreage of white-faced ibis foraging habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce habitat by an estimated 172 acres from conditions in 2001. At the proposed Natomas 130 reserve, 28 acres of white-faced ibis habitat would be created from non-habitat (by converting 28 acres of non-rice crop to 14 acres of marsh and 14 acres of alfalfa). Thus, the project as a whole would yield a net loss of 144 acres of white-faced ibis habitat. (This total change does not include habitat at the mitigation site required by mitigation measure 6-13.2 of the DEIR for Swainson's hawk foraging habitat because the existing land cover type of that site is not known.)

Table 4-8
Change in Acreage of White-faced Ibis Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.6	428
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Ponds & seasonally wet areas	2,259	2.7	14.2	184	200.9	2,460
Rice	11,643	-160.0	-	-228	-388.0	11,255
Total	15,432	-172.4	28.4	0	-143.9	15,288

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

Potential impacts to white-faced ibis that forage near developed areas are discussed under *Mechanisms of Habitat Degradation*, above. They are primarily associated with canal and wetland habitats, but also forage in rice, and these habitats exist near the Greenbriar site.

Habitat Alteration at Proposed Reserves and Mitigation Sites

A total of 316 acres of white-faced ibis habitat would be preserved. Of this preserved habitat, 190 acres (184 acres of rice and 6 acres of associated canals) would be enhanced by the conversion of rice to marsh at the proposed Spangler reserve. In addition, habitat values for white-faced ibis might be improved by habitat enhancement for Swainson's hawk at the proposed Natomas 130 and Spangler reserves (60 acres) and at the DEIR mitigation site (at least 49 acres to satisfy mitigation measure 6.13-2 of the DEIR).

Effects on Connectivity

Habitat connectivity is of lesser importance to foraging ibis than to nesting or less mobile animals. Ibis survival is likely to be higher, however, in larger, more contiguous foraging habitat where prey is more abundant and the energetic costs of travel are decreased.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction-related activities are unlikely to affect white-faced ibis because they do not nest in the vicinity of the Greenbriar and proposed reserve sites. Potential effects would be limited to displacement of birds foraging or roosting on the sites during the initial phases of construction when fields are graded. This would be largely akin to habitat loss, as the physical flight of the birds from these areas would not cause a significant effect.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

Humans entering active colonies may cause partial or total desertion of the colony, particularly during nest-site selection, nest-building, and incubation (Ryder and Manry 1994). Because white-faced ibis do not currently nest in the Basin, the project is unlikely to affect human conflicts with this species. (Foraging ibis are less sensitive to disturbance than nesting birds.) Similarly, changes in predator communities associated with residential development would be unlikely to affect large ibis as much as smaller birds such as burrowing owls and loggerhead shrikes.

OVERALL EFFECT ON POPULATION VIABILITY

The Greenbriar project is not likely to affect the viability of the white-faced ibis population using the Natomas Basin. Currently, white-faced ibis uses the Natomas Basin only for winter foraging. The Greenbriar project would reduce the area of foraging habitat in the Natomas Basin (by 1%), and would at least partially offset this effect by preserving and enhancing 2% of foraging habitat in the Natomas Basin. The abundance of white-faced ibis, however, is not considered limited by the availability of winter foraging habitat, and the Greenbriar project would not substantially alter the quantity of winter foraging habitat in the Natomas Basin; thus, the project's effect on foraging habitat is not likely to alter the population viability of white-faced ibis. The project would also increase the acreage of nesting habitat by creating marsh, and this could lead to the establishment of a white-faced ibis nesting colony in the Natomas Basin. While not discounted, this effect was not considered likely.

4.8 ALEUTIAN CANADA GOOSE

4.8.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Aleutian Canada geese (*Branta canadensis leucopareia*) winter in California's central valley. They forage primarily in pasture, corn, wheat, rice and other grain crops, wetlands, and grasslands, and typically prefer short vegetation. Wintering geese roost in large ponds and lakes, flooded fields, and rice checks. Land cover types designated as Aleutian Canada goose habitat in the NBHCP include non-rice crops, pasture, and rice. While Aleutian Canada geese feed primarily on grasses and wetland sedges during their Alaskan summer, they forage primarily on seeds and agricultural grains while in California in fall and winter (NatureServe 2005).

Home Range Size and Movement

Aleutian Canada geese nest in the western Aleutian Islands and migrate through coastal Oregon and northern California after the breeding season. Most wintering Aleutian Canada geese concentrate in the Modesto, Los Banos, and Colusa areas of California; the Natomas Basin may provide important foraging and roosting habitat during goose migration.

Mechanisms of Habitat Degradation

Because Canada geese are particularly well-adapted to foraging in agricultural landscapes and may persist in small numbers in suburban parks, habitat loss is a greater issue for this species than habitat degradation. This species is similarly not dependent on animal prey populations or sensitive to the increases in small mammalian or corvid predators that typically occur near residential developments.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 13 known occurrences in California, all of which were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 10 known occurrences in California, all of which are considered extant. At this time, CNDDB does not list Aleutian Canada goose occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

Although Aleutian Canada geese have not been recorded in the Basin, its proximity to important wintering areas suggests that they are likely to forage and roost in the Basin during migration.

4.8.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project’s effects on the acreage of Aleutian Canada goose habitat are summarized in Table 4-9. The project would reduce the acreage of Aleutian Canada goose habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce habitat by an estimated 428 acres from conditions in 2001. At the proposed Spangler and Natomas 130 reserves, an additional 256 acres of goose habitat would be eliminated (by converting rice and non-rice crop to marsh). Thus, the project as a whole would yield a net loss of 684 acres of Aleutian Canada goose habitat.

Table 4-9 Change in Acreage of Aleutian Canada Goose Habitat at Project Sites and in the Natomas Basin						
Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Non-rice crops	9,533	-234.1	-28.4	-	-262.6	9,270
Pasture	494	-33.8	-	-	-33.8	460
Rice	11,643	-160.0	-	-228	-388.0	11,255
Total	21,670	-428.0	-28.4	-228	-684.4	20,986

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent Developed Land or Highways

As discussed above under Mechanisms of Habitat Degradation, the predominant impacts typically associated with areas adjacent to housing developments are unlikely to adversely affect Canada geese. This species is especially well-adapted to foraging in close proximity to humans.

Habitat Alteration at Proposed Reserve and Mitigation Sites

Aleutian goose habitat probably would not be preserved or enhanced at the proposed reserve and DEIR mitigation sites. However, the 109 acres that would be actively managed to provide high quality foraging habitat for Swainson’s hawk (at the proposed reserve and DEIR mitigation sties) might provide goose habitat values.

Effects on Connectivity

Habitat connectivity is of lesser importance to foraging geese than to nesting or less mobile animals. Goose survival is likely to be higher, however, in larger, more contiguous foraging habitat where food is more abundant and the energetic costs of travel are decreased.

Effects of Construction-Related Activities

Construction-related activities are unlikely to affect Aleutian Canada geese because they do not nest in the vicinity of the Greenbriar and proposed reserve sites. Potential effects would be limited to displacement of birds foraging or roosting on the sites during the initial phases of construction when fields are graded. This effect is largely akin to temporary habitat loss.

Effects of Human-Wildlife Conflicts

Because Aleutian Canada geese do not nest in the Basin, the project would not likely result in human conflicts with this species, other than the changes in habitat. Foraging geese are less sensitive to disturbance than nesting birds. Similarly, changes in predator communities associated with residential development would be unlikely to affect large geese as significantly as smaller birds such as burrowing owls and loggerhead shrikes.

Overall Effect on Population Viability

Currently, Aleutian Canada geese do not nest in the Natomas Basin, but do roost and forage in the Basin during seasonal migration to a limited extent. Although the Greenbriar Project would reduce the acreage of foraging habitat in the Natomas Basin (by 3%), an effect on the population's viability is unlikely because the population's size is not considered to be limited by the quantity of foraging habitat available during migration and the Greenbriar project would not substantially alter the availability of this habitat, which is abundant in the Natomas Basin (approximately 21,000 acres).

4.9 BANK SWALLOW

4.9.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Bank swallows (*Riparia riparia*) nest in colonies in vertical banks, cliffs and bluffs that are typically along streams but occasionally near roads or gravel quarries. Nesting colonies may range in size from 10 to 1,500 pairs, and average 100–200 nesting pairs (NBHCP). Bank swallows forage in a variety of open habitats including wetlands, open water, grasslands, agricultural fields, shrublands, and open or riparian woodlands. Aquatic and flooded habitats provide the best foraging opportunities. Land cover types designated as bank swallow habitat in the NBHCP include alfalfa, canals, grassland, non-rice crops, pasture, ponds and seasonally wet areas, rice, and riparian. Swallows are almost exclusively insectivorous and catch their prey while flying.

Home Range Size and Movement

Most breeding season foraging flights are within a kilometer (0.62 mile) of the nesting colony (Garrison 1999). Bank swallows are long-distance migrants and may use any available foraging habitat in the Basin during migration.

Mechanisms of Habitat Degradation

Bank Erosion and Water Diversion

The major contributors to bank swallow habitat degradation are flood and erosion control projects that apply riprap or reduce the slope of river banks and canals, rendering them unusable for nesting and reducing their habitat quality for roosting and foraging (Garrison et al. 1987, Small 1994). Diversion of water may affect bank swallows if it results in the dewatering of canals or reduction of aquatic habitat for larval insects.

Water Quality and Runoff

Aquatic communities may be greatly affected by surrounding land use. Urban areas can cause different and in some cases stronger effects than agricultural lands (Bury 1972, Moore and Palmer 2005). Residential developments typically result in increased runoff of hydrocarbons and of chemicals used for lawns and gardens, and increased stormwater volume (and associated increases in depths and velocities) because of high coverage of impervious surfaces. Decreased abundance of aquatic invertebrates has been shown to impact insectivorous birds in both observational field studies and controlled field experiments (Baxter et al. 2004, in press and in review).

Predation and Nest Disturbance

Although predation of most birds increases in proximity to human settlement, bank swallows are largely protected from human-associated predators because of the cliff locations of their nests. These aerial hunters are also largely protected from human-associated predators while foraging because they spend relatively very little time foraging from perches or among vegetation. Kestrels are the primary predators of this species while foraging; snakes are most common while nesting. Bank swallows are typically tolerant of human activity near nesting colonies, if humans do not attempt to climb the nest banks (Garrison 1999).

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 171 known occurrences in California, of which 170 were considered extant. At that time, no nesting colonies were known in the Natomas Basin. As of 2005, there are 176 known occurrences in California, of which 171 are considered extant. At this time, CNDDB does not list bank swallow occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

Although no nesting colonies are known in the Basin, the area provides potential foraging habitat for migrating swallows.

4.9.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would not affect bank swallow nesting habitat, as bank swallow nesting colonies do not exist at the Greenbriar or proposed reserve sites, nor would nesting habitat be created, enhanced or preserved at the proposed reserves.

The project's effects on the acreage of bank swallow foraging habitat are summarized in Table 4-10. The project would reduce the acreage of bank swallow foraging habitat in the Natomas Basin from conditions at the time of the NBHCP (2001). The proposed development at the Greenbriar site would reduce habitat by an estimated 414 acres from conditions in 2001. At the proposed Natomas 130 and Spangler reserves, habitat acreages would be increased by about 20 acres. Thus, the project as a whole would yield a net loss of 394 acres of bank swallow habitat.

Table 4-10
Change in Acreage of Bank Swallow Habitat at Project Sites and in the Natomas Basin

Land Cover Type Providing Habitat	Future Condition	Change at Each Project Site			Total Change	Future Condition with Project
		Greenbriar	Natomas 130	Spangler		
Alfalfa	368	-	14.2	45.4	59.6	428
Canals	1,162	-15.0	0.0	-1.4	-16.4	1,146
Grassland	284	26.5	-	-	26.5	311
Non-rice crops	9,533	-234.1	-28.4	-	-262.6	9,270
Pasture	494	-33.8	-	-	-33.8	460
Ponds & seasonally wet areas	2,259	2.7	14.2	184.0	200.9	2,460
Rice	11,643	-160.0	-	-228.0	-388.0	11,255
Riparian	91	0.0	0.0	-	0.0	91
Total	25,834	-413.8	0.0	20.2	-393.6	25,420

Note: Acreages are based on 2001 land cover mapping used to evaluate future condition resulting from the NBHCP and future land cover proposed at project sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

As discussed above under Mechanisms of Habitat Degradation, the predominant effects typically associated with areas adjacent to housing developments are unlikely to negatively affect bank swallows. Effects on water quality and canal management, however, could potentially affect bank swallows.

Habitat Alteration at Proposed Reserve and Mitigation Sites

At least 345 acres of bank swallow habitat would be preserved and enhanced at the proposed reserves and at the mitigation site required by mitigation measure 6.13-2 of the DEIR. At the Spangler site, rice habitat would be converted to marsh, preserved, and managed to provide habitat values, in particular for giant garter snake. At the Spangler site, rice would also be converted to upland habitat. This upland habitat, as well as upland habitat at the Natomas 130 and the DEIR mitigation site, would be managed to provide high quality foraging habitat for Swainson's hawk. At all of these sites, habitat values for bank swallow are likely to increase as a result of the proposed management. However, because the benefits of such management for bank swallows have not been documented, a moderate level of uncertainty exists regarding their magnitude.

Effects on Connectivity

Because bank swallows do not nest in the Basin, connectivity is of less concern for this species than for less mobile species or species with limited foraging distances from breeding sites. Larger patches of more contiguous habitat are likely to be of greater value to migrating swallows, by providing more abundant food with the lower energetic cost of foraging in a contiguous area.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction-related activities are unlikely to affect bank swallows because they do not nest in the vicinity of the Greenbriar and proposed reserve sites. Potential effects would be limited to displacement of birds foraging or roosting on the sites during the initial phases of construction when fields are graded. This impact is largely akin to temporary habitat loss.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

Direct human-wildlife conflicts are unlikely to be of concern for bank swallows in the Natomas Basin. Habitat quantity and quality are the primary concerns for this species.

OVERALL EFFECT ON POPULATION VIABILITY

Although the Greenbriar project would affect land suitable for bank swallow foraging (eliminating 394 acres and preserving and enhancing 345 acres), none of these lands are near (i.e., within a mile) bank swallow nesting habitat. Currently, bank swallows are not nesting near the Natomas Basin. Near the Natomas Basin, most of the bank length of the Sacramento River is not suitable for bank swallow nesting, in part because of extensive riprap (USFWS 2003). Even if bank swallow colonies established along the Sacramento River in the future, the project and mitigation sites are not within a mile of the river, and thus would not provide important foraging habitat for colonies along the river. Although these lands may provide foraging habitat to migrating swallows, habitat availability during migration is not considered to limit the abundance of this population, and large areas of such habitat (over 25,000 acres) would remain in the future condition of the Natomas Basin with the Greenbriar project. Therefore, the Greenbriar project is unlikely to alter the viability of bank swallow populations using the Natomas Basin.

4.10 VALLEY ELDERBERRY LONGHORN BEETLE

4.10.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Valley elderberry longhorn beetles (*Desmocerus californicus dimorphus*) are dependent on elderberry bushes, which primarily occur in riparian areas. Small elderberry patches are also found in some oak groves and rural residential areas (NBHCP). The NBHCP lists riparian as the only land cover type that provides habitat for this species.

Home Range Size and Movement

Dispersal of valley elderberry longhorn beetles is extremely limited. Many adults live their entire lives on their original host plants and do not disperse at all. Dispersing individuals typically limit travel in their home drainages, limiting the ability of the species to colonize fragmented habitat (Collinge et al. 2001).

Mechanisms of Habitat Degradation

Elderberry habitat is degraded by fragmentation, pesticide and herbicide use, exotic species invasion, and hydrological alteration such as flood management, channel maintenance, and increased water diversions for urban and agricultural development (USFWS 1984; Huxel 2000; Collinge et al. 2001).

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 168 known occurrences in California, all of which were considered extant. At that time, "several" occurrences were known along the southern and western edges of the Natomas Basin, along the American and Sacramento rivers. As of 2005, there are 190 known occurrences in California, all of which are considered extant. At this time, two occurrences are known in the Natomas Basin and six additional occurrences are known within a mile of the Basin. All eight of these occurrences are considered extant. CNDDB does not list valley elderberry longhorn beetle occurrences within one mile of the Greenbriar site; CNDDB lists one VELB occurrence within one mile of a proposed reserve.

Other Information on Distribution and Abundance in Natomas Basin

The TNBC Biological Effectiveness Monitoring report concurs with the CNDDB to list eight extant VELB occurrences in the Basin, none of which are within a mile of the Greenbriar site, and one of which is within a mile of a proposed reserve.

4.10.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project will not affect the quantity of elderberry habitat available to the beetle, as elderberry shrubs are not present in the vicinity of the Greenbriar or proposed reserve sites.

Effects on Quality of Habitat

Areas Adjacent to Developed Land or Highways

As no elderberry shrubs exist in proximity to the Greenbriar site, the gradient of urban influence within 800 feet of the Greenbriar site will not affect the quality of VELB habitat.

Enhancement at Reserves

The planting of elderberry shrubs is not currently planned at the proposed reserves. However, an acre of riparian habitat exists on the Natomas 130 parcel and may be suitable for shrub planting in the future.

Effects on Connectivity

Because of the beetle's limited dispersal capability, habitat connectivity is critical for the colonization of unoccupied shrubs and the maintenance of genetic diversity. However, because all of the Basin's known VELB occurrences are located in riparian habitat near the Sacramento River, the project would not affect connectivity for this species. The proposed Natomas 130 reserve is located along the Sacramento River and would contribute to the preservation of contiguous riparian habitat along the river corridor.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

Construction-related activities for the project are unlikely to affect this species because its habitat does not exist at the Greenbriar and Spangler sites and may not be present at the Natomas 130 site. To avoid and minimize any potential impacts at the Natomas 130 site, preconstruction surveys for elderberry shrubs would be conducted according to USFWS guidelines (USFWS 1999b). If elderberry shrubs are found, they would be preserved on site unless their preservation would significantly inhibit other habitat restoration objectives on site. Following USFWS guidelines, elderberry shrubs would be avoided during habitat construction with a 100-foot construction buffer. If avoidance is not possible, shrub loss would be mitigated by transplanting the shrubs during their dormant season and planting a specified number of seedlings.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

Human-wildlife conflicts for this species would not be affected by the project because elderberry habitat does not exist on site. Although VELB and elderberry shrubs are not known to be present on the proposed reserves, preservation of the Natomas 130 parcel may reduce human conflicts with habitat in the Sacramento River riparian corridor.

OVERALL EFFECT ON POPULATION VIABILITY

VELB is not known from the vicinity of the Greenbriar site or the proposed reserve sites. A small area of riparian vegetation, which is potentially suitable habitat for this species, exists at the Natomas 130, and would be preserved by the project. It is not known if elderberry bushes are present in this riparian vegetation, and the draft restoration plan does not include the planting of elderberry bushes. Thus, the preservation of this riparian vegetation would be a very small potential benefit to VELB that would not be sufficient to alter its population viability.

4.11 CALIFORNIA TIGER SALAMANDER

4.11.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

California tiger salamanders (*Ambystoma californiense*) require two major habitat components: aquatic breeding sites and terrestrial aestivation or refuge sites. Tiger salamanders breed primarily in vernal pools and other ephemeral rainwater ponds (Loredo et al. 1996). They will occasionally breed in stockponds, reservoirs and small lakes, but fail to reproduce in water bodies that support predatory fish or bullfrogs (Stebbins 1972, Zeiner et al. 1988). The highest quality breeding habitat for tiger salamanders exists in large, contiguous vernal pool complexes in a grassland matrix with pools that last for more than 10 weeks (Jennings and Hayes 1994).

California tiger salamanders spend the majority of their lives in upland habitats within one mile (1.6 km) of aquatic breeding areas (Center for Biological Diversity 2001). These upland habitats are essential for salamander foraging, aestivation, migration, and dispersal. Upland habitats used by migrating salamanders include grassland, pasture, and open woodlands. The NBHCP lists ponds and seasonally wet areas as the only land cover type providing tiger salamander habitat because these upland habitats will only be used by salamanders when in close proximity to aquatic breeding areas. Tiger salamanders depend on burrows of small mammals such as California ground squirrels and Botta's pocket gopher for shelter during aestivation.

Home Range Size and Movement

California tiger salamanders typically range within 2,200 feet (0.7 km) of breeding habitat during the breeding season (Trenham and Shaffer). During migration, however, they have been recorded as far as one mile (1.6 km) from aquatic habitats (Center for Biological Diversity 2001).

Mechanisms of Habitat Degradation

Tiger salamander habitat is frequently degraded by roads, buildings, and other barriers to migration (Shaffer and Fisher 1991; Shaffer and Stanley 1992; Barry and Shaffer 1994). Erosion because of grading for nearby developments can degrade breeding wetlands by increasing sedimentation. Tiger salamanders are also sensitive to pesticides, herbicides and fertilizers associated with suburban lawn care and agriculture. Burrowing mammal control programs and the introduction of predatory bullfrogs and nonnative fishes have also contributed to declines in tiger salamander populations (Jennings and Hayes 1994).

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 465 known occurrences in California, all of which were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 793 known occurrences in California, of which 738 are considered extant. At this time, CNDDB does not list California tiger salamander occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

California tiger salamanders have not been recorded in the Natomas Basin.

4.11.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would have no effect on the quantity of California tiger salamander habitat. Suitable breeding habitat does not exist in the maximum salamander dispersal distance from these sites. Restoration plans for the proposed reserves do not include the creation of tiger salamander habitat.

Effects on Quality of Habitat

The project would have no effect on the quality of California tiger salamander habitat, as salamander habitat does not exist in the vicinity of the Greenbriar and proposed reserve sites.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

The project would have no effect on tiger salamanders during construction-related activities, as salamander habitat does not exist in the vicinity of the Greenbriar and proposed reserve sites.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The project would have no effect on human-wildlife conflicts relating to tiger salamanders, because salamander habitat does not exist in the vicinity of the Greenbriar and proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

California tiger salamander is not known from the vicinity of the Greenbriar site or the proposed reserve sites, or adjacent lands. Potentially suitable habitat for this species does not exist at or in the vicinity of the Greenbriar and proposed reserve sites. Therefore, the Greenbriar project would cause no effects on the population viability of California tiger salamander.

4.12 WESTERN SPADEFOOT TOAD

4.12.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Western spadefoot toads (*Scaphiopus hammondii*) breed in shallow, seasonal wetlands in a matrix of grassland, chaparral or woodland habitat, and are rarely found in creeks, drainages, and ponds. Grassland vernal pools provide optimal spadefoot habitat; the toads attach their eggs to rain pool vegetation and burrow underground after the pools become dry (Stebbins 1972). The NBHCP lists ponds and seasonally wet areas as the only land cover type that provides habitat for this species. Adults feed on insects, worms, and other invertebrates; tadpoles feed on invertebrates and algae.

Home Range Size and Movement

During the breeding season, western spadefoot toads rarely travel more than several meters from breeding pools (Jennings and Hayes 1994). Outside of the breeding season, data are not available on the dispersal distances, movement patterns, or colonization abilities of this species (Jennings and Hayes 1994).

Mechanisms of Habitat Degradation

The project would not degrade habitat for this species, as its habitat does not exist in the vicinity of the Greenbriar proposed reserve sites.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 173 known occurrences in California, of which 172 were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 308 known occurrences in California, of which 306 are considered extant. At this time, CNDDB does not list western spadefoot occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

Western spadefoot toads have not been recorded in the Natomas Basin.

4.12.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would have no effect on the quantity of western spadefoot habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of western spadefoot habitat.

Effects on Quality of Habitat

The project would have no effect on the quality of western spadefoot habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of western spadefoot habitat.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

The project would have no effect on spadefoot toads during construction-related activities, because spadefoot habitat does not exist in the vicinity of the Greenbriar or proposed reserve sites.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The project would have no effect on human-wildlife conflicts relating to spadefoot toads, because spadefoot habitat does not exist in the vicinity of the Greenbriar and proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

Western spadefoot toad is not known from the vicinity of the Greenbriar site or the proposed reserve sites, or adjacent lands. Potentially suitable habitat for this species does not exist at or in the vicinity of the Greenbriar and proposed reserve sites. Therefore, the Greenbriar project would cause no effects on the population viability of western spadefoot toad.

4.13 VERNAL POOL FAIRY SHRIMP

4.13.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Vernal pool fairy shrimp (*Branchinecta lynchi*) inhabit vernal pools (79% of observations) and other seasonal wetlands (Helm 1998). Although they may occur in larger, deeper pools, vernal pool fairy shrimp are typically found in pools less than 2,200 square feet and less than 2 inches deep (Helm 1998). The NBHCP lists ponds and seasonally wet areas as the only land cover type that provides habitat for this species.

Mechanisms of Dispersal

Vernal pool fairy shrimp rely on wind and motile species such as birds, mammals, and amphibians for their dispersal. Shrimp eggs are transported in the stomachs of waterfowl and amphibians, and in small clumps of soil attached to mammalian hooves and hair, bird feet, and feathers. Dispersal distances have not been measured, but will likely equate with movement distances of the egg-transporting animals (Silveira 1998 cited in Bay Area O&M). As such, connectivity of upland and aquatic habitat between vernal pools will benefit shrimp dispersal by increasing the opportunities for egg transport by mammals and amphibians. Dispersal may continue between disconnected pools through avian transport.

Mechanisms of Habitat Degradation

The project would not degrade habitat for this species, because its habitat does not exist in the vicinity of the Greenbriar or proposed reserve sites.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 270 known occurrences in California, all of which were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 366 known occurrences in California, all of which are considered extant. At this time, two occurrences are known in the Natomas Basin and eight additional occurrences are known within one mile of the Basin. All ten of these occurrences are considered extant, and are located near the eastern border of the Basin. At this time, CNDDB does not list vernal pool fairy shrimp occurrences within one mile of the Greenbriar or proposed reserve sites.

Other Information on Distribution and Abundance in Natomas Basin

Vernal pool fairy shrimp were not detected by Natomas Basin Conservancy surveys, and no additional information is available regarding their distribution in the Basin.

4.13.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would have no effect on the quantity of vernal pool fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of vernal pool fairy shrimp habitat.

Effects on Quality of Habitat

The project would have no effect on the quality of vernal pool fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of vernal pool fairy shrimp habitat.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

The project would have no effect on vernal pool fairy shrimp during construction-related activities, because habitat for this species does not exist in the vicinity of the Greenbriar or proposed reserve sites.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The project would have no effect on the quantity of vernal pool fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

Vernal pool fairy shrimp is not known from the vicinity of the Greenbriar site or the proposed reserve sites, or adjacent lands. Potentially suitable habitat for this species does not exist at or in the vicinity of the Greenbriar and proposed reserve sites. Therefore, the Greenbriar project would cause no effects on the population viability of vernal pool fairy shrimp.

4.14 VERNAL POOL TADPOLE SHRIMP

4.14.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Vernal pool tadpole shrimp (*Lepidurus packardi*) are found primarily in vernal pools; they inhabit other seasonal wetlands to a limited extent. They occupy vernal pools with a variety of depths and water volumes, and with areas ranging from 20 square feet to over 3,750,000 square feet (Helm 1998). The NBHCP lists ponds and seasonally wet areas as the only land cover type that provides habitat for this species.

Mechanisms of Dispersal

Vernal pool tadpole shrimp rely on wind and motile species such as birds, mammals, and amphibians for their dispersal. Shrimp eggs are transported in the stomachs of waterfowl and amphibians, and in small clumps of vernal pool soil attached to mammalian hooves and hair, bird feet, and feathers. Dispersal distances have not been measured, but will likely equate with movement distances of the egg-transporting animals (Silveira 1998 cited in

Bay Area O&M). As such, connectivity of upland and aquatic habitat between vernal pools will benefit shrimp dispersal by increasing the opportunities for egg transport by mammals and amphibians. Dispersal may continue between disconnected pools through avian transport.

Mechanisms of Habitat Degradation

The project would not degrade habitat for this species, because its habitat does not exist in the vicinity of the Greenbriar or proposed reserve sites.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 154 known occurrences in California, of which 153 were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 209 known occurrences in California, of which 208 are considered extant. At this time, one occurrence is known in the Natomas Basin and one additional occurrence is known within one mile of the Basin. Both of these occurrences are considered extant, and are located near the eastern border of the Basin. At this time, CNDDB does not list vernal pool tadpole shrimp occurrences within one mile of the Greenbriar or proposed reserve sites.

Other Information on Distribution and Abundance in Natomas Basin

Vernal pool tadpole shrimp were not detected by Natomas Basin Conservancy surveys, and no additional information is available regarding their distribution in the Basin.

4.14.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would have no effect on the quantity of vernal pool tadpole shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of vernal pool tadpole shrimp habitat.

Effects on Quality of Habitat

The project would have no effect on the quality of vernal pool tadpole shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of vernal pool tadpole shrimp habitat.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

The project would have no effect on vernal pool tadpole shrimp during construction-related activities, because habitat for this species does not exist in the vicinity of the Greenbriar and proposed reserve sites.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The project would have no effect on human conflicts with vernal pool tadpole shrimp, because habitat for this species does not exist in the vicinity of the Greenbriar or proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

Vernal pool tadpole shrimp is not known from the vicinity of the Greenbriar site or the proposed reserve sites, or adjacent lands. Potentially suitable habitat for this species does not exist at or in the vicinity of the Greenbriar and proposed reserve sites. Therefore, the Greenbriar project would cause no effects on the population viability of vernal pool tadpole shrimp.

4.15 MIDVALLEY FAIRY SHRIMP

4.15.1 SPECIES ECOLOGY

HABITAT ASSOCIATIONS/REQUIREMENTS

Habitat Type

Midvalley fairy shrimp (*Branchinecta mesovallensis* n. sp.) appear to be vernal pool obligates, as 93% of observations have occurred in vernal pools and the remaining 7% have occurred in vernal swales (Helm 1998). This species is associated with the smallest (less than 2,200 square feet) and most ephemeral (average depth of 4 inches) vernal pools (Helm 1998). The NBHCP lists ponds and seasonally wet areas as the only land cover type that provides habitat for this species.

Mechanisms of Dispersal

Midvalley fairy shrimp rely on wind and motile species such as birds, mammals, and amphibians for their dispersal. Shrimp eggs are transported in the stomachs of waterfowl and amphibians, and in small clumps of vernal pool soil attached to mammalian hooves and hair, bird feet, and feathers. Dispersal distances have not been measured, but will likely equate with movement distances of the egg-transporting animals (Silveira 1998 cited in Bay Area O&M). As such, connectivity of upland and aquatic habitat between vernal pools will benefit shrimp dispersal by increasing the opportunities for egg transport by mammals and amphibians. Dispersal may continue between disconnected pools through avian transport.

Mechanisms of Habitat Degradation

The project would not degrade habitat for this species, because its habitat does not exist in the vicinity of the Greenbriar or proposed reserve sites.

DISTRIBUTION

Information on CNDDB Occurrences

When information was compiled for the NBHCP in 2001, there were 14 known occurrences in California, all of which were considered extant. At that time, no occurrences were known from the Natomas Basin. As of 2005, there are 62 known occurrences in California, all of which are considered extant. At this time, CNDDB does not list midvalley fairy shrimp occurrences within one mile of the Natomas Basin.

Other Information on Distribution and Abundance in Natomas Basin

Midvalley fairy shrimp have not been recorded in the Natomas Basin.

4.15.2 PROJECT EFFECTS ON SPECIES

LONG-TERM EFFECTS ON HABITAT

Effect on Quantity of Habitat

The project would have no effect on the quantity of midvalley fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of midvalley fairy shrimp habitat.

Effects on Quality of Habitat

The project would have no effect on the quality of midvalley fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites. Restoration plans for the proposed reserves do not include the creation of midvalley fairy shrimp habitat.

EFFECTS OF CONSTRUCTION-RELATED ACTIVITIES

The project would have no effect on midvalley fairy shrimp during construction-related activities, because habitat for this species does not exist in the vicinity of the Greenbriar and proposed reserve sites.

EFFECTS OF HUMAN-WILDLIFE CONFLICTS

The project would have no effect on the quantity of midvalley fairy shrimp habitat, because habitat for this species does not currently exist in the vicinity of the Greenbriar or proposed reserve sites.

OVERALL EFFECT ON POPULATION VIABILITY

Midvalley fairy shrimp is not known from the vicinity of the Greenbriar site or the proposed reserve sites, or adjacent lands. Potentially suitable habitat for this species does not exist at or in the vicinity of the Greenbriar and proposed reserve sites. Therefore, the Greenbriar project would cause no effects on the population viability of midvalley fairy shrimp.

4.16 COVERED PLANT SPECIES

Of the seven plant species covered by the NBHCP (Table 4-11), the Greenbriar project would not affect the five vernal pool-associated species because these species are not known to occur in the vicinity of the Greenbriar or proposed reserve sites (or in the Natomas Basin), nor is suitable habitat present at or near these sites. These plant species are: Boggs Lake hedge-hyssop, Sacramento Orcutt grass, slender Orcutt grass, Colusa grass and legenere. The other two covered plant species (delta tule pea and Sanford's arrowhead) are not known to occur at the Greenbriar or the proposed reserve sites, or in the Natomas Basin (Table 4-1), but potentially suitable habitat for these species does occur at or near some of these sites, which have not been surveyed for these species. Therefore, the possibility that the project could affect these species cannot be discounted; thus, the DEIR mitigation includes a rare plant survey requirement and the applicable avoidance and minimization measures from the NBHCP for these species. The project also would eliminate approximately 16 acres of canal at the Greenbriar site and would create approximately 201 acres of marsh at the proposed reserves. Thus, overall, the project would increase the acreage of potentially suitable habitat for these species (i.e., marsh and canal habitats) in the Natomas Basin by about 184 acres (or about 4%). Nonetheless, because these species are not known to occur in the Natomas Basin, the project probably would not alter the viability of any of their populations.

Table 4-11
Primary Habitats and Distribution of Plant Species Covered by the NBHCP

Species	Growth form	Primary Habitat(s)	Distribution
Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)	Biennial-perennial, herbaceous vine in the pea family (Fabaceae)	Riparian scrub, marsh (primarily tidal, fresh or brackish)	Alameda, Contra Costa, Napa, Sacramento, San Joaquin, and Solano Counties; not known from the Natomas Basin
Sanford's arrowhead (*Sagittaria sanfordii*)	Perennial, rhizomatous aquatic with emergent leaves, in the water-plantain family (Alismataceae)	Marsh and other shallow freshwater habitats	Butte, Del Norte, Fresno, Kern, Merced, Orange, Sacramento, Shasta, San Joaquin, and Tehama Counties; not known from the Natomas Basin
Bogg's Lake hedge-hyssop (*Gratiola heterosepala*)	Small semi-aquatic annual, up to 4 inches in height, in the figwort family (Scrophulariaceae)	Vernal pools and swallow lake margins	Fresno, Lake, Lassen, Madera, Merced, Modoc, Placer, Sacramento, San Joaquin, Shasta, Siskiyou, Solano, and Tehama Counties; not known from the Natomas Basin
Sacramento Orcutt grass (*Orcuttia viscida*)	Annual in the grass family (Poaceae)	Vernal pools (generally larger, deeper pools)	Sacramento County; not known from the Natomas Basin
Slender Orcutt grass (*Orcuttia tenuis*)	Annual in the grass family (Poaceae)	Vernal pools (generally larger, deeper pools)	Butte, Lake, Lassen, Modoc, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties; not known from the Natomas Basin
Colusa grass (*Neostapfia colusana*)	Annual in the grass family (Poaceae)	Vernal pools (generally larger, deeper pools)	Colusa, Merced, Solano, Stanislaus, and Yolo Counties; not known from the Natomas Basin or Sacramento County
Legenere (*Legenere limosa*)	Annual, in the bellflower family (Campanulaceae)	Vernal pools and swales, seasonal marshes, artificial ponds, floodplains of intermittent streams, and other seasonally inundated habitats	Lake, Napa, Placer, Sacramento, San Joaquin, San Mateo, Santa Clara, Shasta, Solano, Sonoma, Stanislaus, Tehama, and Yuba Counties; not known from the Natomas Basin

5 POTENTIAL EFFECTS ON THE CONSERVATION STRATEGY OF THE NBHCP

Based on the analyses presented in sections 3 (Alteration of Population and Habitat Attributes by the Greenbriar Project) and 4 (Potential Effects of the Greenbriar Project on Covered Species), this section summarizes the effect of the Greenbriar project on the conservation strategy of the NBHCP that is described is section IV.C of the NBHCP. Overall, the Greenbriar project (with the DEIR mitigation) would not reduce the effectiveness of the NBHCP's conservation strategy because it would not alter the basis of this conservation strategy. In Section IV.C.1 (pages IV 5-15), the NBHCP describes the basis of the key components of the NBHCP's conservation strategy and how these components provide effective mitigation for 17,500 acres of urban development. These components are:

- Basis for 0.5 to 1 mitigation ratio (Section IV.C.1.a),
- Preparation of site specific management plans (Section IV.C.1.b),
- Buffers within the reserve lands (Section IV.C.1.c),
- Connectivity (Section IV.C.1.d),
- Foraging habitat (Section IV.C.1.e), and
- 2,500-acre/400-acre minimum habitat block size requirements (Section IV.C.1.f).

The effects of the Greenbriar project on each of these components is described in the following sections, and then these effects are synthesized, along with the effects on population viability of the covered species (see chapters 3 and 4) as the overall effect of the Greenbriar project on the effectiveness of the NBHCP's conservation strategy.

5.1 BASIS FOR 0.5 TO 1 MITIGATION RATIO

On pages IV-6 and IV-7, the NBHCP describes eight key considerations for determining that the 0.5 to 1 mitigation ratio mitigates the impacts of incidental take authorized under the NBHCP. These eight key considerations are summarized below.

1. Overall, reserves will provide greater habitat value than the agricultural land that will be converted to urban development. (This consideration overlaps with other considerations.)

2. Much of the land to be developed is either of limited value as habitat or serves as habitat to a limited number of species.

3. For several wetland and vernal pool-associated species, reserves will provide opportunities for reintroduction to the Basin.

4. Reserves would provide habitat for migratory bird species that have limited habitat in the Basin.

5. Reserves would be managed to minimize take related to agricultural and land management activities.

6. Reserves would provide permanent habitat for covered species.

7. Reserves would be monitored and adaptively managed.

8. Reserves would be consolidated into large blocks of habitat.

Because the Greenbriar project would not alter the habitat value of land authorized for development under the NBHCP, and would not adversely affect the habitat value of TNBC reserves established under the NBHCP, the project would not affect this basis for the 0.5:1 mitigation ratio for the 17,500 acres of urban development authorized by the NBHCP. Similarly, the project would not adversely affect the monitoring and management of reserves, or opportunities to consolidate reserves into large blocks of habitat. (The project's effects on the habitat quality of existing reserves, water availability at TNBC reserves, and opportunities to establish additional TNBC reserves are evaluated in sections 3.7, 3.8, and 3.9, respectively.)

Although not explicitly stated in section IV of the NBHCP, the 0.5:1 mitigation ratio is related to other elements of the conservation strategy (e.g., maintenance of habitat connectivity). With the DEIR mitigation, the Greenbriar project would not adversely affect these other elements of the conservation strategy, and thus the project would not affect this basis of the 0.5:1 mitigation ratio.

The 0.5:1 mitigation ratio of the NBHCP is also related to the habitat values provided by other lands in the Natomas Basin (outside of reserves established through the NBHCP). With the DEIR mitigation, the Greenbriar project would not cause a net loss in habitat values for giant garter snake and Swainson's hawk in the Natomas Basin, and thus the project would not affect this basis of the 0.5:1 mitigation ratio.

In order to be compatible with the conservation strategy of the NBHCP, the Greenbriar project has had to propose a conservation strategy that differs in some regards from the NBHCP conservation strategy. These differences include a larger mitigation ratio, greater emphasis on measures to maintain connectivity, and more extensive restoration and enhancement of preserved land. The implementation of the Greenbriar conservation strategy will likely be more costly (on a per acre basis) than the NBHCP conservation strategy, and thus will likely require a greater endowment for NBHCP reserves.

5.2 PREPARATION OF SITE SPECIFIC MANAGEMENT PLANS

For each reserve, TNBC prepares and implements a site-specific management plan that addresses the specific resources and habitat values of each reserve site, and how these will be managed in support of the goals and objectives of the NBHCP.

The potential effects of the Greenbriar project that could affect reserve management include altering adjacent land uses, connectivity, water availability, or affecting opportunities to establish additional reserves. These effects are evaluated in sections 3.7, 3.6, 3.8, and 3.9, respectively. In brief, the project would not affect water availability, the proposed reserves and mitigation could change adjacent land uses of existing and future reserves but the effect would be beneficial, and with the DEIR mitigation it would not affect connectivity. Therefore, the Greenbriar project probably would not affect the management plans prepared for existing and future reserves with the exception of altering Swainson's hawk foraging habitat in the vicinity of the Greenbriar site and the proposed reserves, and of preserving and enhancing land that could be consolidated into current or future reserves, which could alter existing site-specific plans.

Also, where the proposed reserves could be consolidated into existing or future reserves, the site-specific management plans of these reserves would need to be revised. These revisions would reflect the beneficial effects of the increased in reserve size. This would occur, for example, at the Cummings reserve, which would probably be consolidated with the proposed Natomas 130 reserve that is immediately adjacent to it.

5.3 BUFFERS WITHIN RESERVE LANDS

Buffers are incorporated into reserves to minimize the effects of incompatible adjoining land uses. These buffers consist of a 30–70 foot wide strip of native or ruderal vegetation along the edge of the reserve. Development at the Greenbriar site would not alter the need for or effectiveness of reserve buffers at existing reserves because the Greenbriar site is not adjacent to an existing reserve. (Potential effects of the Greenbriar project on human-wildlife conflicts and reserve habitat values are evaluated in sections 3.2 and 3.7, respectively.) Also, because under the future condition of the Natomas Basin resulting from the NBHCP, the Greenbriar site would already be bordered by urban development, highways or major roads on all sides, development of the Greenbriar site could cause only very limited effects on the effectiveness of buffers within future reserves, even if reserves were established on adjacent land to the north or southwest (i.e., adjacent land that would not be developed under the future condition of the Natomas Basin).

The proposed reserves could reduce the need for buffers at existing and future reserves. The proposed Natomas 130 reserve borders the existing Cummings reserve (Exhibit 5), and thus along their shared border, there would no longer be a need for a buffer from incompatible adjacent land uses. If in the future, reserves were established adjacent to the reserves proposed by this project, buffers would be unnecessary along their shared borders.

5.4 CONNECTIVITY

The conservation strategy of the NBHCP emphasizes the need for maintaining connectivity of reserves and the importance of existing canals and drains for providing that connectivity. But, the NBHCP would not preserve or enhance habitat along canals, although it does contemplate future needs to preserve habitat along canals in some instances. The NBHCP states (on page IV-8) that elimination of drains or canals would primarily be related to urban development, and thus would be unlikely to affect reserves. Nonetheless, the NBHCP acknowledges (on page IV-9) that once reserves are established and key connectivity corridors have been identified, changes in water delivery and drainage along these waterways could occur, and thus these changes must be considered by TNBC and measures taken to ensure connectivity. Suggested measures include MOAs, easements, or purchase of land.

Lone Tree Canal is a key connectivity corridor between existing reserves (Jones & Stokes 2005). The project's potential adverse effects on connectivity, and in particular on Lone Tree Canal, would be mitigated so that connectivity would not be reduced (and could be enhanced) along the adjacent section of Lone Tree Canal. This mitigation includes enhancing and preserving habitat within a 250-foot wide setback along the canal, installing a barrier/fencing to keep snakes out of adjacent development and to exclude humans and domestic/feral animals from the Lone Tree Canal corridor, providing an additional assurance for water flow in the canal, and creating habitat along the canal. (Both the potential effects and the mitigation that reduces or eliminates them are described in greater detail in Section 3.5 *Connectivity of Habitat in the Natomas Basin* and in Section 3.6 *Connectivity of Existing TNBC Reserves*.) This mitigation would ensure that connectivity would be maintained along this section of Lone Tree Canal, and is comparable to the measures contemplated in the NBHCP (on page IV-9) for ensuring connectivity.

The proposed reserves would likely have a beneficial effect on connectivity of TNBC reserves by enhancing and preserving habitat in between existing and future reserves. For example, the proposed Spangler reserve is located between the Ruby Ranch and Atkinson reserves to the west and the Tufts and Sills reserves to the east (Exhibit 5). Therefore, the enhancement and preservation of habitat at this site would likely enhance and preserve connectivity between these reserves.

5.5 FORAGING HABITAT

As described on pages IV-11 through IV-13 of the NBHCP, the viability of populations of covered bird species, and in particular the Swainson's hawk, depends on foraging habitat both on TNBC reserves and on unpreserved agricultural lands in the Natomas Basin. Therefore, the NBHCP includes measures to be implemented if foraging habitat outside of the permit areas (i.e., the areas authorized for urban development under the NBHCP) is converted to urban land uses without adequate provisions to maintain foraging habitat values and the effectiveness of the operating conservation program is potentially compromised. These measures include modifying acquisition criteria, substituting impacted reserves with unaffected replacement sites, modifying the percentages of habitat types at TNBC reserves, and pursuing outside funding to acquire additional reserves.

The Greenbriar project, however, would include adequate provisions to maintain foraging habitat values, and thus would not compromise the effectiveness of the operating conservation program. The effects on habitat acreage and quality in the Natomas Basin are evaluated in Sections 3.3 and 3.4, respectively. (In addition, effects on habitat values of existing reserves are evaluated in Section 3.7.) The project would reduce the acreage of foraging habitat but would increase habitat quality at the proposed reserves and at the DEIR mitigation site. As a result, for Swainson's hawk, total foraging resources available in the Natomas Basin would not be reduced by the project. For other bird species, foraging resources of the Natomas Basin either would not be reduced or the reduction would not be sufficient to alter the viability of the species' population in the Natomas Basin (as described for each species in Section 4 *Potential Effects of the Greenbriar Project on Covered Species*).

To evaluate the effects of habitat loss and enhancement on foraging resources for Swainson's hawk in the Natomas Basin, the approach used by CH2M HILL in evaluating the NBHCP was used in this effects analysis and a new model developed by EDAW was also used. The EDAW model expresses the habitat value of different habitats, on a monthly basis, in terms of the equivalent acreage of high quality foraging habitat. The basis and structure of this model, and the scenarios evaluated, are described in detail in Section 2.2 *Methodology for Analyzing Alterations of Populations and Habitats*. Based on CH2M HILL's approach, there was a net decrease in habitat acreage, but an increase in high quality habitat and an increase in available habitat during April–August. Based on the EDAW model, during April–June, the increase in foraging habitat value at the proposed reserves and mitigation sites would be slightly greater than the value of the lost foraging habitat (the equivalent of 129 acres of high quality habitat with the project versus 122 acres without the project). During July–September, the increase in foraging habitat value at the proposed reserves and mitigation sites would not fully offset the value of the foraging habitat lost at the Greenbriar site (129 versus 140 acres during July–August and 162 acres in September). However, during these months, foraging resources in the Natomas Basin increase due to harvesting of crops, and so the project's affect on foraging resources available during July–September is not likely to affect the viability of Swainson's hawk, nor the effectiveness of the conservation strategy of the NBHCP. The results of these analyses of foraging resources are presented in Section 3.4 *Habitat Quality in the Natomas Basin*, and are displayed in Exhibits 3 and 4.

5.6 MINIMUM HABITAT BLOCK SIZE REQUIREMENTS

A requirement of the NBHCP is that by the end of the 50-year period, one habitat block within the reserve system will be at least 2,500 acres in size and the balance of reserve lands shall be in habitat blocks of at least 400 acres in size. The NBHCP (on page IV-14) provides four bases for this size requirement. These bases are:

1. large blocks minimize the "perimeter effect",
2. large blocks promote biodiversity by allowing multiple species and niches to occupy the site,
3. the benefit to genetic diversity of dispersing interconnected reserves throughout the Natomas Basin, and
4. the 400-acre reserve size is considered the minimum size to allow persistence of covered species.

No aspect of the Greenbriar project would alter any of these bases for the minimum habitat block size requirements of the NBHCP. The project could however affect opportunities to establish additional TNBC reserves, and thus affect the ability to consolidate reserves into habitat blocks that satisfy the size requirements. The Greenbriar project's potential affect on opportunities to establish additional TNBC reserves was evaluated in Section 3.9. In brief, the project would adversely affect the preservation of large blocks of habitat at or adjacent to the Greenbriar site, but elsewhere it would enhance and preserve additional habitat (296 acres plus at least 49 acres of DEIR mitigation), increasing opportunities to establish additional reserves; The project also would reduce the quantity of land available to provide mitigation under the NBHCP, but the remaining acreage of land potentially suitable for preservation would substantially exceed the acreage required for the NBHCP's reserve system. Overall, the project would probably have a beneficial effect on the fulfillment of the requirement for minimum habitat block size.

Interestingly, the Greenbriar project does illustrate the need for smaller reserves in some instances to preserve connectivity. The Greenbriar project necessitates enhancement and preservation of land along a waterway to maintain connectivity for the giant garter snake. This land would be partially isolated by major roads and both existing and proposed development, and would not become part of a larger habitat block in the future. In general, corridors along canals and drains near roads and development will be more difficult to incorporate into larger blocks of habitat because of the adverse effects of roads and development on reserves. Yet, it is in precisely these locations that preserving and managing corridors would be most beneficial or even necessary. Though it acknowledges that evidence may be discovered in support of smaller reserves, the NBHCP does not address the effects of preserving corridors on the attainment of its minimum habitat block size requirements.

Overall, the project would beneficially affect the establishment of large blocks of preserved habitat. It would enhance and preserve 296 acres of additional habitat, most of which would be adjacent to or near existing TNBC reserves; the DEIR mitigation would increase this benefit by requiring the preservation of at least an additional 49 acres of land. The project would adversely affect the preservation of large blocks of habitat by developing existing habitat at the Greenbriar site. However, under the future condition of the Natomas Basin, this land would be surrounded by major roads and urban development, and the project would preserve the most ecologically important portion of the site, which is the corridor of land along Lone Tree Canal.

5.7 EFFECTIVENESS OF THE CONSERVATION STRATEGY OF THE NBHCP

As described in the preceding sections, effects on the key components of the NBHCP's conservation strategy resulting from the Greenbriar project (with the DEIR mitigation) would be minor, and some of these effects would be beneficial. Therefore, the Greenbriar project would not reduce the effectiveness of the conservation strategy, and thus no changes in the conservation strategy would be necessitated by the project.

In large part, the project would avoid affecting the effectiveness of the conservation strategy because of its mitigation of effects on connectivity and foraging habitat. This mitigation of effects on connectivity (through substantial investment in wide setbacks, barriers, and habitat management in perpetuity) and foraging habitat (by increasing habitat values on mitigation lands sufficiently to replace habitat values lost on development sites) could serve as a general approach for future projects to avoid reducing the effectiveness of the conservation strategy of the NBHCP.

6 POTENTIAL EFFECTS OF THE GREENBRIAR PROJECT ON NBHCP GOALS AND OBJECTIVES

For each applicable goal and objective in the NBHCP, this section summarizes the effects of the Greenbriar project on attainment of that goal or objective. These effects were analyzed in the preceding sections of this report that addressed effects on covered species, habitat acreage, human-wildlife conflicts, connectivity, habitat values at TNBC reserves, water availability at TNBC reserves, and the opportunity to establish additional reserves.

Because the Greenbriar project would be located outside of the areas where urban development was authorized by the NBHCP, and thus would result in a net increase of land potentially developed in the NBHCP plan area, the project's avoidance, minimization and mitigation measures could be consistent with the measures of the NBHCP and yet the project could still detrimentally affect attainment of the NBHCP's goals and objectives, or otherwise reduce the likelihood of sustaining populations of covered species in the Natomas Basin.

For example, the 0.5 to 1 ratio of developed to conserved land in the NBHCP was not necessarily intended to apply to development outside the 17,500 acre permit area (as described on page IV-12 of the NBHCP), and was based, in part, on the interpretation that on average habitat quality was lower in the areas permitted for development than in the areas that would be preserved (City of Sacramento et al. 2003).

Similarly, the NBHCP conservation strategy was based in part on the assumption that most of the Natomas Basin in agricultural use at the time of the NBHCP's approval would remain in agricultural land uses that provide habitat for most covered species (e.g., as described on page IV-11 of the NBHCP). The retention of a substantial acreage of existing agricultural habitats limits the risks associated with relying on enhancement and restoration efforts to offset habitat losses. It also retains, largely unaltered, the canals and upland corridors that connect habitats; and it would leave reserves surrounded by agricultural lands that increase the benefits of reserves for covered species. Therefore, development outside of areas permitted by the NBHCP could eliminate higher quality habitats, reduce habitat connectivity, and detrimentally affect reserves to a much greater degree than the development permitted by the NBHCP. Such development also could create conflicts with the continued use of adjacent lands for agriculture.

These examples illustrate that both the types and magnitudes of effects caused by development outside of the areas permitted by the NBHCP can differ from those caused by comparable development inside of the areas permitted by the NBHCP; thus, mitigation comparable to that in the NBHCP may not adequately offset these effects. This situation was anticipated during the development of the NBHCP and is reflected in the text of the NBHCP, BO, Final EIR/EIS and the implementation agreement for the NBHCP (e.g., page IV-12 of the NBHCP).

Therefore, interpretations of the Greenbriar project's effects on the NBHCP were based primarily on the sum of the anticipated effects on the TNBC reserve system, and on the sum of anticipated effects on the viability of populations of covered species using the Natomas Basin. An overall negative effect on the existing reserve system was considered adverse to the attainment of the NBHCP's goals and objectives. Effects that would preclude attainment of a goal or objective, reduce the viability of a covered species or otherwise necessitate a change in the NBHCP's conservation strategy were considered substantial effects that would conflict with the NBHCP.

Overall, the Greenbriar project would not conflict with attainment of the goals and objectives of the NBHCP. Through most mechanisms by which a project could affect the NBHCP, the Greenbriar project causes adverse and beneficial effects on the goals and objectives of the NBHCP. However, many of these effects are small relative to the acreages of development authorized by the NBHCP and of habitats in the Basin. Also, most beneficial and adverse effects would be reduced by opposing effects, and the DEIR mitigation further reduces adverse effects. Consequently, the Greenbriar project would not cause an overall adverse effect on attainment of any of the goals or objectives of the NBHCP, and the project could provide an overall benefit towards the attainment of several goals. (For example, the project [with DEIR mitigation] would preserve 345 acres of land and this preserved land would contribute to the connectivity and quality of habitat preserved through the NBHCP.) In the following sections of text, the project's effects are assessed for each potentially affected goal and objective of the NBHCP. These assessments, in turn, are based on the analyses presented in Chapter 3 *Alteration of Population and Habitat Attributes by the Greenbriar Project* and Chapter 4 *Potential Effects of the Greenbriar Project on Covered Species*.

6.1 OVERALL GOALS

6.1.1 OVERALL GOAL 1

Establish and manage in perpetuity a biologically sound and interconnected habitat reserve system that mitigates impacts on Covered Species resulting from Covered Activities and provides habitat for existing, and new viable populations of Covered Species. (NBHCP, p. I-15)

A project could potentially affect attainment of this goal by affecting the:

- acreage of habitat in the Natomas Basin,
- quality of habitat in the Natomas Basin,
- connectivity of habitat in the Natomas Basin,
- connectivity of TNBC reserves,
- habitat value of TNBC reserves,
- water availability at TNBC reserves, and opportunities to establish additional TNBC reserves.

The Greenbriar project would cause both adverse and beneficial effects on the attainment of this goal through all of these mechanisms, except for water availability at TNBC reserves (which the project would not affect). The project's beneficial effects would include increased habitat quality resulting from the preservation, creation, and enhancement of habitats, increased connectivity of existing TNBC reserves and of habitats, and increased opportunities to establish additional TNBC reserves. Without mitigation, the project's adverse effects would include a reduction in the acreage of upland and wetland habitats in the Natomas Basin, reduced foraging habitat values within a mile of an existing TNBC reserve, fragmented upland habitats in the vicinity of the Greenbriar site, degraded habitat quality of adjacent agricultural lands to the north and southwest, and possibly reduced connectivity along Lone Tree Canal (despite preserving and enhancing a corridor of habitat along the canal). A detailed assessment of these effects is provided in sections *3 Alteration of Population and Habitat Attributes by the Greenbriar Project* and *4 Potential Effects of the Greenbriar Project on Covered Species*.

The mitigation proposed in the DEIR would reduce the project's adverse effects by incorporating additional measures to ensure that connectivity along Lone Tree Canal is sustained (as described in Sections 3.5, 3.4, 4.1, and 4.2.), and to preserve and enhance an additional 49 acres of foraging habitat within a mile of existing TNBC reserves (as described in Sections 3.4, 3.7, and 4.3). This mitigation also would cause additional beneficial effects (as described in Sections 3.6, 3.7, and 3.8), because the preserved and enhanced foraging habitat would not only mitigate effects on foraging habitat and on TNBC reserves, but also could increase connectivity of habitat and of TNBC reserves. Similarly, by ensuring that connectivity along Lone Tree Canal would be maintained, the project (with its proposed mitigation) would conserve a portion of an important corridor connecting reserves and habitats of the southern and central Natomas Basin. (The connectivity of upland habitats, however, would still be reduced at the Greenbriar site.)

As described in Section 3.9, the project (with the DEIR mitigation) would have an overall beneficial effect on the establishment and management of reserves for the NBHCP. Because the acreage of land in the Natomas Basin that is potentially available and suitable for preservation substantially exceeds the 8,750 acres that will be preserved by the NBHCP, the project would not preclude the preservation of sufficient land to attain the NBHCP's goals and objectives. It would provide 345 acres of additional reserve lands, with much of this acreage adjacent to or near existing reserves, which would increase the connectivity of habitats and the resources available to covered species using reserves established by the NBHCP; in addition, it would conserve an important corridor of canal habitat along Lone Tree Canal. The project also would increase opportunities to establish new reserves, particularly to create larger reserves by preserving additional land adjacent to existing TNBC and project's proposed reserves. (Sections 3.6–3.9 provide a detailed assessment of effects on the management and establishment of TNBC reserves.)

Although the project would cause a net reduction in the acreage of upland and wetland habitats, the preservation and enhancement of habitat by the project would adequately mitigate for its impacts on upland and wetland habitats for covered species. Effects on the acreage and quality of habitats are summarized below, and a detailed assessment of these effects is presented in Sections 3.3 and 3.4. (These effects are also evaluated separately for each covered species in Chapter 4 *Potential Effects of the Greenbrier Project on Covered Species*.)

For wetland land cover (i.e., rice, canal, and ponds and seasonally wet areas), the net reduction in acreage resulting from the project would be offset by an increase in the habitat quality by creating marsh habitat at the project's proposed reserves. Based on 2001 land cover mapping, the Greenbriar project would eliminate 388 acres of rice and 16 acres of canal habitats, but would increase the acreage of marsh by 201 acres, creating a net loss of 204 acres of these wetland land cover types and of the habitats they provide. An acre of marsh, however, provides a greater quantity and variety of habitat than does an acre of rice, and thus the additional habitat values provided by the created marsh offsets the habitat lost in the rice and canal land cover types. Managed marsh provides substantially greater habitat values for giant garter snakes than rice for several reasons. These reasons include:

- Giant garter snakes use the full extent of managed marshes, whereas they primarily use the margins of rice fields;

- Marshes provide habitat throughout the active period of the snake, whereas rice fields do not provide habitat during early and mid-spring, and are typically drained before the end of the snake's active period; and

- Marsh provides habitat in all years, whereas rice is fallowed periodically.

In addition, the project would preserve, and manage for its habitat values, 201 acres of marsh (i.e., about 1.0 acre for each acre lost) and approximately 6 acres of canal habitat. This preservation and management would increase the habitat value of these lands because:

- Habitat would be preserved in perpetuity;
- Habitat would be monitored and actively managed for the benefit of covered species;
- Habitat would not be subject to continuous disturbance caused by farming or canal maintenance activities; and
- Habitat would be relatively free of human intrusion (USFWS 2003).

Therefore, the loss of wetland habitats (i.e., those provided by land cover mapped as rice, canal, and ponds and seasonally wet areas) is more than offset by the creation of a comparable area of marsh (from rice and upland land cover), and the preservation and management of this marsh. These effects are described in detail in Sections 3.3–

3.4 and 4.1–4.2. As described in Section 3.5, the project with its mitigation would also conserve an important corridor of canal and adjacent upland habitat at the Greenbriar site.

For upland land cover (i.e., alfalfa, grassland, idle, non-rice crop, pasture, and ruderal), the net reduction in acreage resulting from the project also would be offset by an increase in the habitat quality of preserved and enhanced habitat. Based on 2001 land cover mapping, the Greenbriar project would cause a net reduction of 281 acres of upland land cover providing habitat for covered species, but would enhance the habitat value of 14 acres at the proposed Natomas 130 site and 45 acres at the Spangler site, and the DEIR mitigation for loss of Swainson's hawk would enhance at least an additional 49 acres; thus, a total of 109 acres of upland habitat would be enhanced. This habitat would be preserved, as would 27 acres of grassland along Lone Tree Canal and 60 acres of upland components within created marshes; thus, a total of 195 acres of upland habitat would be preserved. For some covered species associated with uplands (including Swainson's hawk, burrowing owl, and loggerhead shrike) the additional habitat values provided by the preservation and enhancement of this upland habitat (i.e., 0.7 acres preserved for each acre lost and over half of this enhanced) would fully offset the habitat values of the upland acreage lost as a result of the project. For other covered species (including Aleutian Canada goose, tricolored blackbird, and bank swallow), the additional habitat values provided by the preservation and enhancement of this 195 acres of upland habitat would only partially offset the habitat values of the upland acreage lost as a result of the project. (The analysis of the foraging habitat value lost at the Greenbriar site and of the value gained at the proposed reserve and mitigation sites is summarized in Section 3.4 *Habitat Quality in the Natomas Basin*.) For example, based on the methods used by CH2M HILL, the upland habitats that would result from the project would provide a greater acreage of available foraging habitat during April–August, when Swainson's hawks are nesting in the Basin. Based on EDAW's model of habitat values, the enhancement of uplands by the project (with the DEIR mitigation) would provide foraging habitat values during the months of April–June that are slightly greater than the habitats that would be eliminated by the project (Exhibits 3b and 4). During July–August, the project's enhancement of habitat would not fully offset the lost habitat values, but during these months foraging habitat values increase in the Natomas Basin as a result of crop harvest.

On the basis of the project's establishment of reserves that provide habitat for covered species and mitigate the project's impacts to those covered species, implementing the proposed project (with the DEIR mitigation measures) would either not alter or would improve the connectivity of the NBHCP reserve system and provide habitat for viable populations of covered species. In addition, because the viability of covered species would either be unaltered or improved (e.g., giant garter snake, northwestern pond turtle), the project would not adversely affect attainment of this goal.

6.1.2 Overall Goal 3

Preserve open space and habitat that may also benefit local, non-listed and transitory wildlife species not identified within the NBHCP. (NBHCP, page I-16)

A project could potentially affect attainment of this goal by affecting the:

- Acreage of habitat in the Natomas Basin,
- Quality of habitat in the Natomas Basin,
- Connectivity of habitat in the Natomas Basin,
- Connectivity of TNBC reserves,
- Habitat value of existing TNBC reserves,
- Water availability at TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

The Greenbriar project would cause both beneficial and adverse effects on the attainment of this goal through most of these mechanisms. By preserving, enhancing, and creating habitat, the project would increase the quality of habitats, increase the connectivity of habitats and TNBC reserves, and create additional opportunities to establish additional TNBC reserves. By developing most of the Greenbriar site, the project would reduce the acreage of habitat in the Natomas Basin, and it would fragment, degrade, and reduce the connectivity of adjacent habitats, reduce the foraging habitat available at an existing TNBC reserve, and without the DEIR mitigation, it could reduce connectivity along Lone Tree Canal (despite preserving a corridor along it.)

The DEIR mitigation reduces the project's adverse effects by incorporating additional measures to ensure that connectivity along Lone Tree Canal is sustained (including additional requirements for fencing and barriers), and to preserve and enhance an additional 49 acres of upland foraging habitat within a mile of existing TNBC reserves. This additional foraging also could increase connectivity of habitat and of TNBC reserves. Similarly, by ensuring that connectivity along Lone Tree Canal would not be reduced, the project (with the DEIR mitigation) would conserve a portion of an important corridor connecting reserves and habitats of the southern and central Natomas Basin. (The connectivity of upland habitats, however, would still be reduced at the Greenbriar site.)

As described in Sections 3.6–3.9, the project (with the DEIR mitigation) would have an overall beneficial effect on the establishment and management of reserves for the NBHCP. Because the acreage of land in the Natomas Basin that is potentially available and suitable for preservation substantially exceeds the 8,750 acres that will be preserved by the NBHCP, the project would not preclude the preservation of sufficient land to attain the NBHCP's goals and objectives. It would provide reserve lands adjacent to or near existing reserves, increasing the connectivity of habitats and the resources available to covered species using reserves established by the NBHCP; in addition, it would conserve a portion of an important corridor of canal habitat along Lone Tree Canal. The project also would increase opportunities to establish new reserves, particularly to create larger reserves by preserving additional land adjacent to existing TNBC and project's proposed reserves.

Because the project would cause both beneficial and adverse effects on the attainment of this goal, and because the project's adverse effects would not reduce the likelihood that the NBHCP would be able to preserve sufficient habitat for non-listed species to attain this goal, the Greenbriar project would not adversely affect the attainment of this goal.

6.1.3 OVERALL GOAL 4

Ensure that direct impacts of Authorized Development upon Covered Species are avoided or minimized to the maximum extent practicable. (NBHCP, page I-16)

A project could potentially affect attainment of this goal by causing construction-related effects on the survival or reproduction of individuals that are using the project or mitigation sites and adjacent lands.

Development of the Greenbriar site would likely affect giant garter snake, Swainson's hawk, burrowing owl, and loggerhead shrike, and could affect several other covered species including northwestern pond turtle, tricolored blackbird, white-faced ibis, Aleutian Canada goose, Sanford's arrowhead, and Delta tule pea. These potential effects (which are described in detail in Chapter 4) would be comparable to the construction-related effects that could be caused by development permitted by the NBHCP.

The avoidance and minimization measures incorporated into the project and into the DEIR mitigation would substantially reduce these effects. These measures include all of the applicable avoidance and minimization measures that were included in the NBHCP to avoid and minimize construction-related effects, which are a comprehensive set of effective measures for reducing these effects. (An assessment of the applicability of these measures is in Appendix A.) In addition, the DEIR mitigation would include several more stringent minimization measures. Therefore, with its proposed mitigation, the project would not adversely affect attainment of this goal because it would implement a comprehensive set of measures to avoid and minimize effects on covered species. The Greenbriar project also would not alter the effectiveness of any NBHCP conservation measures for avoiding and minimizing the effects of development authorized by the NBHCP (Appendix A).

6.2 OVERALL OBJECTIVES

6.2.1 OVERALL OBJECTIVE 1

Minimize conflicts between wildlife and human activities, including conflicts resulting from airplane traffic, roads and automobile traffic, predation by domestic pets, and harassment by people. (NBHCP, page I-16)

A project could potentially affect attainment of this objective by causing construction-related effects on survival or reproduction of individuals using project sites and adjacent lands, or by altering the area, types of habitats, or level of conflicts in zones with high levels of human-wildlife conflicts.

Without the DEIR mitigation, the project would reduce the overall area in zones with high levels of human-wildlife conflicts, but it would increase the area of rice habitat and the level of conflicts within such zones, and it would cause construction-related effects in these zones. (Section 3.2 provides a detailed description of effects on zones with high levels of human-wildlife conflicts.) These human-wildlife conflicts and construction-related effects would be comparable to those resulting from the development authorized by the NBHCP.

The DEIR mitigation includes avoidance and minimization measures that would substantially reduce these effects. These measures include all of the applicable measures that were included in the NBHCP to avoid and minimize construction-related effects and to reduce human-wildlife conflicts. (An assessment of the applicability of these measures is included as Appendix A.) As described in Section 3.1, these measures represent a comprehensive set of effective measures for avoiding and minimizing the project's effects. In addition, the project also incorporates additional measures (e.g., fencing and barriers) to reduce human-wildlife conflicts along Lone Tree Canal.

Therefore, with the DEIR mitigation, the project would not adversely affect attainment of this objective because it would implement a comprehensive set of measures that would minimize human-wildlife conflicts. The Greenbriar project also would not alter the effectiveness of any NBHCP conservation measures for minimizing human-wildlife conflicts (Appendix A).

6.2.2 OVERALL OBJECTIVE 3

Ensure connectivity between TNBC reserves to minimize habitat fragmentation and species isolation. Connections between reserves will generally take the form of common property boundaries between reserves, waterways (primarily irrigation and drainage channels) passing between reserves, and/or an interlinking network of water supply channels or canals. (NBHCP, page I-16)

A project could potentially affect attainment of this goal by affecting:

- Connectivity of habitat in the Natomas Basin,
- Connectivity of TNBC reserves,
- Habitat value of TNBC reserves, and
- Water availability at TNBC reserves.

The Greenbriar project would cause beneficial and adverse effects on the attainment of this objective through most of these mechanisms. The main beneficial effect would be increased connectivity of habitats and TNBC reserves due to preservation, creation, and enhancement of habitat at the project's proposed reserves, two of which are adjacent to or near (i.e., within a half mile of) existing TNBC reserves. Adverse effects would include reducing the foraging habitat within a mile of a TNBC reserve, fragmenting and reducing the connectivity of upland habitats adjacent to the Greenbriar site, and possibly reducing the connectivity of wetland habitats and TNBC reserves because of effects on Lone Tree Canal (despite preserving a corridor along the canal). (Sections 3.4–3.7 provide detailed descriptions of these effects.)

The DEIR mitigation reduces the project's adverse effects by incorporating additional measures to ensure that connectivity along Lone Tree Canal is sustained, and to preserve and enhance foraging habitat within a mile of existing TNBC reserves. This mitigation also would cause additional beneficial effects because the preserved and enhanced foraging habitat would not only mitigate effects on TNBC reserves, but also could increase connectivity of habitat and of TNBC reserves. Similarly, by ensuring that connectivity along Lone Tree Canal will not be reduced, the project (with the DEIR mitigation) would conserve a portion of an important corridor connecting reserves and habitats of the southern and central Natomas Basin. (The connectivity of upland habitats, however, would still be reduced at the Greenbriar site.)

In the absence of an adverse effect on connectivity along Lone Tree Canal, the project would cause only small effects on the attainment of this objective, and most of these effects would be beneficial. Therefore, the project's overall effect on the attainment of this objective would not be adverse.

6.3 WETLAND SPECIES/HABITAT GOALS AND OBJECTIVES

6.3.1 WETLAND SPECIES/HABITAT GOAL/OBJECTIVE 1

Acquire, enhance and create a mosaic of wetland habitats with adjacent uplands and connecting corridors to provide breeding, wintering, foraging, and cover areas for wetland species in the Plan Area. (NBHCP, page I-17)

A project could potentially affect attainment of this goal by affecting:

- Acreage of habitat in the Natomas Basin,
- Quality of habitat in the Natomas Basin,
- Connectivity of habitat in the Natomas Basin,
- Connectivity of TNBC reserves,
- Habitat value of TNBC reserves,
- Water availability at TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

The Greenbriar project with the DEIR mitigation would cause beneficial and adverse effects on the attainment of this goal/objective through several of these mechanisms. By acquiring, enhancing, and creating wetland habitats, the project would increase the area of preserved land in the Natomas Basin, which would increase the connectivity of habitats and create additional opportunities to create larger reserves. By developing most of the Greenbriar site, the project would reduce the acreage of wetland habitats in the Natomas Basin (by approximately 204 acres), and without the DEIR mitigation, could reduce the connectivity of wetland habitats because of effects on Lone Tree Canal, and could cause some degradation of wetland habitats on lands to the north and southwest of the Greenbriar site. With its proposed mitigation, however, the project would not adversely affect connectivity of habitats along Lone Tree Canal. (Section 3.5 provides an assessment and more detailed description of the anticipated effects on connectivity.) Therefore, the main adverse effect of the project on attainment of this goal would be due to the reduction of the acreage of wetland habitats.

This reduction in wetland acreage would not cause an effect on attainment of this goal/objective that would necessitate changes to the conservation strategy of the NBHCP. First, the effect would be offset by the enhancement of 204 acres of wetland habitats on the project's proposed reserves (which is described in Section 3.4). Second, as described in Section 3.3, only a small percentage of the Basin's wetland habitats would be lost (approximately 1%). Third, as described in Section 3.5, no reduction in the connectivity of wetland habitats or in opportunities to preserve, enhance, and acquire wetland habitats would result. Fourth, as described in Section 4, the population viability of covered species using these habitats would not be reduced.

Because the project would contribute directly to the attainment of this goal, and would not cause any adverse effects on the goal's attainment that would need to be offset by changes in the conservation strategy of the NBHCP, the project's overall effect on the attainment of this goal is not adverse.

6.3.2 WETLAND SPECIES/HABITAT GOAL/OBJECTIVE 2

Provide habitat to maintain, attract and sustain viable populations of the Covered Species. The habitat areas should be configured to encompass natural species migration areas, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)

A project could potentially affect attainment of this goal by affecting:

- Zones with human-wildlife conflicts,
- Acreage of habitat in the Natomas Basin,
- Quality of habitat in the Natomas Basin
- Connectivity of habitat in the Natomas Basin,
- Connectivity of TNBC reserves,
- Habitat value of TNBC reserves,
- Water availability at TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

The Greenbriar project, with the DEIR mitigation, would cause beneficial and adverse effects on the attainment of this goal/objective through several of these mechanisms. Based on the analyses presented in Section 3 *Alteration of Habitat and Population Attributes by the Greenbriar Project*, the project (with the DEIR mitigation) would cause a net loss in the acreage of wetland habitats, improve the habitat quality of some wetlands, and could improve connectivity of habitat and TNBC reserves, and increase opportunities to establish additional TNBC reserves. Overall, the project would not adversely affect attainment of this goal.

The net loss of habitat acreage resulting from the project would be offset by the creation of marsh at the project's proposed reserves. Based on 2001 land cover mapping, the Greenbriar project would eliminate 388 acres of rice and 16 acres of canal habitats, but would increase the acreage of marsh by 201 acres, creating a net loss of 204 acres of these wetland land cover types and of the habitats they provide. An acre of marsh, however, provides a greater quantity and variety of habitat than does an acre of rice, and thus the additional habitat provided by the created marsh offsets the habitat lost in the rice and canal land cover types. In addition, the project would preserve, and manage for its habitat values, 201 acres of marsh (i.e., about 1.0 acre for each acre lost). This preservation and management would increase the habitat quality of these lands because:

1. Habitat would be preserved in perpetuity;
2. Habitat would be monitored and actively managed for the benefit of covered species;
3. Habitat would not be subject to continuous disturbance caused by farming or canal maintenance activities; and
4. Habitat would be relatively free of human intrusion (USFWS 2003).

Therefore, the loss of wetland (i.e., land cover mapped as rice, canal, and ponds and seasonally wet areas) is more than offset by the creation of a comparable area of marsh (from rice and upland land cover) and the preservation, and management of the created marsh. Because the project would increase the acreage of land preserved in the Natomas Basin, it would provide opportunities to increase the size and connectivity of TNBC reserves (which are described in Sections 3.6 and 3.9). The project with the DEIR mitigation would also conserve an important corridor of canal and adjacent upland habitat at the Greenbriar site (as described in Section 3.5).

Consequently, as described in Section 4 *Potential Effects of the Greenbriar Project on Covered Species*, the project would either benefit or be unlikely to alter the viability of covered species using wetland land cover (i.e., rice, canal, or ponds and seasonally wet areas). Because the project would not reduce the viability of covered species, and creates additional reserves that contribute to efforts to sustain viable populations and prevent fragmentation of habitat, the project does not adversely affect this goal/objective.

6.4 UPLAND SPECIES/HABITAT GOALS AND OBJECTIVES

6.4.1 UPLAND SPECIES/HABITAT GOAL/OBJECTIVE 1

Acquire, enhance and create a mosaic of upland habitat types for breeding, foraging, and cover for species dependent on upland habitats. (NBHCP, page I-17)

A project could potentially affect attainment of this goal by affecting:

- Acreage of habitat in the Natomas Basin,
- Quality of habitat in the Natomas Basin,
- Habitat value of existing TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

For upland habitats, the Greenbriar project would affect the attainment of this goal through each of these mechanisms. The project's beneficial effects on the attainment of this goal/objective would include the preservation, creation and enhancement of habitats that increase habitat quality and contribute to the connectivity of existing TNBC reserves and of habitats, and increase opportunities to establish additional TNBC reserves. The project's adverse effects on the attainment of this goal/objective would include reduced acreage of upland habitats in the Natomas Basin, reduced foraging habitat within a mile of an existing TNBC reserve, fragmented and reduced connectivity of upland habitats in the vicinity of the Greenbriar site, and probably degraded quality of adjacent habitat to the north and southwest of the Greenbriar site. Sections 3 *Alteration of Population and Habitat Attributes by the Greenbriar Project* and 4 *Potential Effects of the Greenbriar Project on Covered Species* provide detailed assessments of these effects.

The DEIR mitigation reduces the project's adverse effects by incorporating a measure to preserve and enhance additional foraging habitat within a mile of existing TNBC reserve(s) that would be sufficient to offset the loss of habitat values due to the Greenbriar project. This mitigation also would cause additional beneficial effects because the preserved and enhanced foraging habitat would not only mitigate effects on TNBC reserves, but also could increase connectivity of habitat and of TNBC reserves.

The project would not cause effects on habitat acreage, quality, and connectivity sufficient to alter the likelihood of attaining this goal/objective. Under the future condition of the Natomas Basin resulting from the NBHCP, approximately 12,000 acres of upland habitats would remain in the Natomas Basin. To attain this goal/objective of the NBHCP, under the future condition of the NBHCP, 18% of this remaining upland habitat would need to be preserved and enhanced as part of the TNBC. The project would reduce the acreage of upland habitat in the Natomas Basin (under the future condition) by about 2.5%. To offset effects resulting from the reduction in upland acreage, the project would preserve and enhance much of another 1.7% of the upland habitats that would remain under the future condition. This land would be unavailable for the NBHCP. Thus, the Greenbriar project would reduce the upland habitat available for preservation through the NBHCP by several percent, which would not be sufficient to affect the attainment of this goal/objective.

In contrast, as described in Section 3.9, the land preserved by this project could increase opportunities to establish reserves. For example, the NBHCP has minimum size requirements for habitat blocks within the reserve system. At least two of the reserves resulting from this project (the proposed Natomas 130 and Spangler reserves) would be adjacent to or near (i.e., within a half mile or less of) existing reserves (Exhibit 5); these lands would provide opportunities additional to create larger reserves by preserving additional land connected to existing TNBC reserves and/or the project's proposed reserves. Therefore, the Greenbriar project could contribute directly to preserving, creating, and enhancing blocks of habitat of sufficient size for effective conservation of upland habitats by the NBHCP.

Overall, the project would not adversely (and could beneficially) affect this goal/objective. Because the acreage of upland habitat in the Natomas Basin that is potentially available and suitable for preservation is substantially more than the acreage of upland habitat that would be preserved and enhanced by the NBHCP, and the project would affect only a small percentage of this land, the project would not preclude the preservation of sufficient land to attain the NBHCP's goals and objectives. The project would, however, increase opportunities to establish new reserves, which would aid the attainment of this goal/objective.

6.4.2 UPLAND SPECIES/HABITAT GOAL/OBJECTIVE 2

Ensure reserve land connectivity with travel corridors for upland-dependent species. The habitat areas should encompass grasslands, agricultural croplands, riparian habitats, and shelter and nesting habitat areas (fence rows, clusters of shrubs and small trees), as well as wetland areas to provide a year-round source of water for upland species. The upland areas should be configured to enhance natural species migration, minimize species isolation, and prevent future habitat fragmentation. (NBHCP, page I-17)

A project could potentially affect attainment of this goal by affecting:

- Connectivity of habitat in the Natomas Basin,
- Connectivity of existing TNBC reserves,
- Habitat value of existing TNBC reserves, and
- Opportunities to establish additional TNBC reserves.

The Greenbriar project, with the DEIR mitigation, would affect the attainment of this goal/objective through each of these mechanisms. Beneficial effects would include the preservation, creation, and enhancement of upland habitats that contribute to the connectivity of existing TNBC reserves and of habitats, and increase opportunities to establish additional TNBC reserves. Adverse effects would include reduced foraging habitat within a mile of an existing TNBC reserve, and fragmented and reduced connectivity of upland habitats in the vicinity of the Greenbriar site. Sections 3.5–3.7 and 3.9 provide a detailed assessment of these effects.

The DEIR mitigation would reduce the project's adverse effects by incorporating a measure to preserve and enhance foraging habitat within a mile of existing TNBC reserves (or of the Swainson's hawk zone along the Sacramento River). This mitigation also would cause additional beneficial effects because the preservation and enhancement of at least an additional 49 acres of foraging habitat would not only mitigate effects on TNBC reserves, but also could increase connectivity of habitat and of TNBC reserves.

The project's proposed reserves at the Spangler and Natomas 130 sites would contribute to travel corridors connecting reserve lands. The proposed Natomas 130 site would contain upland and wetland habitats, and would be immediately adjacent to a TNBC reserve, Fisherman's Lake, and the Sacramento River (Exhibit 5). The proposed Spangler reserve would contain mainly wetland habitats, but upland habitats would be a component of the created marshes and reserve buffers, and this site is within a quarter mile of an existing reserve and would connect to habitat on buffer lands surrounding Sacramento International Airport to the south (Exhibit 5).

The proposed reserve on the Greenbriar site, along Lone Tree Canal, would contain grassland, marsh, and canal habitats managed to sustain connectivity of habitat for giant garter snake. This would also provide some benefit as a travel corridor for upland species; however, the partial isolation of the site by Elkhorn Boulevard to the north and Interstate 5 to the south would limit this benefit.

The project would, however, reduce connectivity of upland habitats adjacent to the Greenbriar site, and this could reduce dispersal and movement of upland species between reserves in the central and southern Natomas Basin. Under the future condition of the Natomas Basin resulting from the NBHCP, the Greenbriar site would be a corridor of upland habitat between the Metro Air Park and the City of Sacramento. At Interstate 5, this corridor would be about 0.4 miles wide and at the northern end of the Greenbriar site it would be almost a mile wide. The Greenbriar project would reduce this to a 250-foot wide and approximately one-mile long corridor of grassland, marsh, riparian, and canal habitats that would be preserved and managed as part of the TNBC reserve system. A moderate level of uncertainty exists regarding the attributes necessary for wildlife use of corridors, and this much narrower corridor surrounded by urban development may not be used, or may be used less frequently, by upland wildlife.

However, as described in Section 3.5, a reduction in connectivity of upland habitats at and adjacent to the Greenbriar site, would affect relatively few upland species. First, most upland species in the Natomas Basin are abundant, widely distributed and highly mobile. (The species observed during monitoring for TNBC support this characterization [Jones & Stokes 2005].) Second, Interstate 5 (which is along the entire southern border of the site), adjacent urban development, and in the future a six lane Elkhorn Boulevard along the site's northern border, limits use of the site by animals that are less mobile or are highly sensitive to human disturbance.

Based on the assessments presented in Section 4 *Potential Effects of the Greenbriar Project on Covered Species*, a reduction in connectivity of upland habitats at the Greenbriar site also would be unlikely to alter the viability of the populations of covered species using upland habitats in the Natomas Basin. Of the covered species, Swainson's hawk, burrowing owl, and loggerhead shrike all could be affected, because they probably use the Greenbriar site. These are highly mobile animals that could fly over or around the site, though they may not choose to do so, may do so less frequently, or doing so may expose them to additional risks. Development at the Greenbriar site would reduce and fragment upland habitats, and this could reduce the survival or reproduction of individuals using the site and adjacent lands. However, habitat would be enhanced and preserved along Lone Tree Canal and at the proposed reserves, and the DEIR mitigation would enhance and preserve additional upland habitat within a mile of existing TNBC reserves. This enhanced and preserved land would likely improve connectivity of upland habitats, and could increase the survival or reproduction of individuals using those sites. Also, burrowing owls and loggerhead shrikes using the Natomas Basin are part of large populations, a reduction of connectivity at the Greenbriar site would affect a very small portion of their range and numbers, and their loss of habitat would be mitigated by habitat preservation, creation, and enhancement at the proposed reserve and DEIR mitigation sites. Thus, the project is unlikely to alter the viability of populations of covered species using the Natomas Basin.

A moderate level of uncertainty exists regarding the overall effect of the Greenbriar project on this goal/objective. The proposed changes at the Greenbriar site would have an uncertain effect on the movement and dispersal of upland species; also there is some uncertainty regarding the project's contributions to connectivity elsewhere in the Basin because the location of the DEIR mitigation site has not been determined.

However, because the project would cause adverse and beneficial effects that are similar in nature and magnitude, and because it would affect only a small portion of the Basin's land area, the project would have only a small overall effect on the attainment of this goal/objective, whether it was beneficial or adverse. This effect would not alter the viability of any covered species using upland habitats, and would not necessitate any changes in the conservation strategy of the NBHCP.

7 CUMULATIVE EFFECTS

For the Greenbriar project, this section evaluates cumulative effects as defined by NEPA and ESA. In Section 7 of the Greenbriar DEIR, *Other CEQA-Required Analyses*, projects contributing to potential cumulative effects are described and the cumulative impacts of these projects, and the Greenbriar project, are analyzed. That analysis evaluates cumulative effects as defined by Section 15130 of the California Environmental Quality Act Guidelines (State CEQA Guidelines). Because that analysis addresses a range of resources and issues, it is broader and includes more detail on proposed projects than does the following analyses, which only address effects on species covered by the NBHCP.

7.1 ANALYSIS OF CUMULATIVE EFFECTS UNDER NEPA

NEPA defines cumulative impacts as those that result “from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions” (40 CFR 1508.7).

7.1.1 CUMULATIVE CONTEXT

The Natomas Basin includes much of the American Basin, which is one of the nine major basins in the Central Valley. Basins are flat, low-lying areas adjacent to the natural levees that form along the major rivers. Theses basins fill with flood waters and over time they accumulate the fine sediments carried by these waters. Prior to urban development, the Natomas Basin would regularly become inundated by the winter river flows, and remain inundated for weeks to months during most years (Kelley 1989; Smith and Verrill 1996). The predominant vegetation was probably seasonal wetland with marsh growing at the lowest elevations, and riparian forest and scrub growing at higher elevations on alluvial soils near the Sacramento and American Rivers.

The City of Sacramento has developed over the past 150-plus years beginning in the late 1840s immediately following the discovery of gold. Over this time the City, and the Sacramento region, has shifted largely, though not entirely, from natural habitat to agriculture and urban development.

Reclamation of the Natomas Basin through a series of levees and drains was first attempted in the 1860s after the state created a Board of Swampland Commissioners. The Board’s appointed engineer estimated that the construction of this system of levees and drains would cost only about $38,000, which was far less than the $1 per acre fee that had been established to fund such reclamation. This estimate was inaccurate and the project ran out of funds within a year, and inundation of the Natomas Basin continued. It was not until 1915 that a system of levees and drainage and irrigation canals was completed, and the Natomas Basin drained. At that time, virtually the entire basin was converted to agricultural land uses.

In the Natomas Basin, urbanization occurred much later than agricultural uses. In 1924, after almost the entire Natomas Basin had been converted to agricultural land uses, developed land uses were still almost nonexistent. There were few structures, and few roads, most of which were not paved (McClure 1925). By the 1960s, Sacramento International Airport, and major highways had been constructed, and some urban development had begun in the southern Basin, adjacent to Sacramento. Over the next 40 years, this urban development continued, primarily in the southern basin, and by 2001 approximately 21% of the Basin was occupied by developed land cover.

7.1.2 PROJECTS CONTRIBUTING TO CUMULATIVE IMPACTS

DEVELOPMENT AUTHORIZED BY THE NBHCP

The NBHCP authorized 17,500 acres of land in the Natomas Basin for development. About two-thirds of this land has yet to be developed. Once this land is developed it is projected to contain over 50,000 homes as well as a variety of other retail, commercial and industrial uses; to date, about 15,000 homes have been constructed (McCarthy and Lamb 2006). This development is occurring in three areas authorized by the NBHCP: North Natomas and Metro Air Park in Sacramento County, and the Measure M area of Sutter County. Authorized development includes projects sponsored by either private developers or public entities that occur within these permitted areas.

This development is described in more detail below, and the effects of this development have previously been analyzed in conjunction with the NBHCP (CH2M HILL 2002). Additional information on the effects caused by this development is also provided in Section 3.3 *Habitat Acreage in the Natomas Basin,* and Appendix B *Change in Natomas Basin Land Cover in 2001–2004*.

North Natomas Community Plan

Development projects in the North Natomas community that have been approved but are yet to be fully built out have been identified and evaluated by the NNCP and the associated environmental review documents prepared in compliance primarily with CEQA.

The North Natomas community is bounded by Elkhorn Boulevard to the north, I-80 to the south, the Natomas East Main Drainage Canal to the east, and the West Main Drain Canal to the west, covering more than 9,000 acres in the northwest portion of the city that was predominantly in agricultural use prior to development. The NNCP provides a long-term vision for the development of the North Natomas community. The environmental consequences from implementation of the NNCP were addressed in the 1986 NNCP EIR (certified by the Sacramento City Council in May 1986) as well as the 1993 Supplement to the 1986 NNCP EIR. Development within the NNCP started to take off in 1999.

There are several development projects that have been approved in the North Natomas community. Some of these projects are fully built-out and occupied at this juncture, while others are still in development phases. These projects are generally located to the south and east of the project site and include: the Westborough project, Cambay West, Natomas Crossing, Natomas Town Center, Panhandle, and Natomas Creek. In 2000, there were approximately 2,002 people, occupying 740 housing units in North Natomas (SACOG 2001). Currently, there are about 15,000 homes (McCarthy and Lamb 2006). At buildout (year 2016), the NNCP estimates a population of 66,495 in the North Natomas community occupying 33,257 housing units on approximately 9,038 acres, and 72,016 employees. Buildout has been rapid since approval of the NNCP and NBHCP, and this trend is expected to continue as a result of high demand for developed uses near downtown Sacramento.

Metro Air Park

In addition to development anticipated within the North Natomas community, the Metro Air Park is a newly developing project located adjacent to the Sacramento International Airport and along the westerly edge of the Greenbriar site. The Metro Air Park totals 1,983 acres and has been approved for development of approximately 20 million square feet of commercial and industrial development, and off-site infrastructure. This off-site infrastructure includes the widening of Elkhorn Boulevard along the northern border of the Greenbriar site. The project is located in an area that has historically been dominated by agricultural uses. Construction of the Metro Air Park began in September 2003.

Development within the Metro Air Park (authorized by the MAP HCP and NBHCP) will eliminate several canals connecting habitats north and south of Interstate 5, and connecting habitats from the Sacramento International Airport to Highway 99. It will eliminate the Powerline Ditch, No. 4 and 4a ditches, and Meister Canal. It also will eliminate water sources to the Airport East Ditch, and replace the open Central Main Canal with an underground pipe, and will affect habitat along Lone Tree Canal by reducing the area of land draining into Lone Tree Canal and placing urban development along one side of the canal (Thomas Reid Associates 2001, USFWS 2002).

Measure M

In 2004, Sutter County voters passed Measure M, an advisory measure intended to provide the Board of Supervisors with an indication of how the citizens of Sutter County feel about the types and level of development in the 7,500-acre area of the South Sutter County Industrial / Commercial Reserve. The southern boundary of the Measure M area forms the Sutter/Sacramento county line, approximately 4 miles north of Greenbriar. The vote did not approve any specific development proposals, but did provide guidance on how development may be viewed in the future. Measure M included potential development for the South Sutter area of the following uses:

- At least 3,600 acres for commercial/industrial development;
- At least 1,000 acres for schools, parks, other public uses, and retail; and
- No more than 2,900 acres for residential development, with a population cap of 39,000.

Applications for the Measure M area have not been submitted to Sutter County, as of December 2005, so the specifics of development proposals are not known beyond the parameters outlined above.

Other Proposed Projects Contributing to Cumulative Effects

Several other projects are being planned in the Natomas Basin outside of that areas permitted for development by the NBHCP. These projects are described below.

Sacramento International Airport Development Plan

The Airport Development Plan will include the major improvements that are needed over a 20-year planning period. These improvements are safety, security, and capacity enhancement projects that will enable the Sacramento County Airport System to meet customer service goals at increased levels of activity in passengers, air cargo, and aircraft operations.

The plan is still under development; but, the Sacramento International Airport Master Plan Study (PB Aviation 2004) contains a recommended Airport Development Plan that illustrates the type, location, and scale of projects under consideration. Most projects would be within the existing Airport Operations Area (AOA) Outside of the APA, potential projects include roughly 400 acres of development (parking and commercial development) on adjacent land along Interstate 5, and roughly 500 acres of development (aviation-related and commercial development) on adjacent land to the north of the AOA.

The recommended Airport Development Plan also would eliminate several waterways, including:

- 4.4 miles of the drainage ditch north of Elverta Road,
- 2.0 miles of the drainage ditch west of Power Line Road,
- 1.0 miles of the canal adjacent to the access road west of Power Line Road, and
- 0.5 miles of the drainage ditch along Bayou Road.

Together with the elimination of canals permitted by the MAP HCP, the elimination of these waterways could further reduce connectivity of habitats within the Natomas Basin. However, the effect on connectivity would be addressed during environmental review of development projects at the airport, and avoidance, minimization, and mitigation measures would likely reduce the effect on connectivity to an insignificant level.

Sacramento Area Flood Control Levee Upgrade Project

To assess the risk of levee failure and to identify potential remedies, SAFCA commissioned the Natomas Levee Evaluation Study in 2005. This study indicated that the risk of flooding at the 100-year level was greater than previously assumed (SAFCA 2006). A variety of remedies were proposed for identified problems. Most of these remedies involve levee improvement and bank protection techniques, including construction of cutoff walls within existing levees, and placement of toe rock and revegetation of banks at locations along existing levees that pose erosion problems. These remedies would cause an estimated 8 acres of permanent habitat loss for species covered by the NBHCP (EDAW 2005).

As a potential remedy, the study also assessed constructing a secondary levee along the upper 5 miles of the east levee of the Sacramento River. This levee would be set back about 1,000 feet from the existing levee. Under this alternative the existing levee would continue to confine the river; the new levee would ensure safe containment of a 200-year flood if the existing levee were to fail. The construction of this levee would directly affect roughly 133 acres of habitat for species covered by the NBHCP. (This estimate assumes a 175-foot wide footprint and is based on additional information in SAFCA 2006, EDAW 2005.) The levee also would bisect several canals and existing TNBC reserves. The overall affect of this potential remedy on covered species also would depend on the future condition of the land between the secondary levee and the Sacramento River, and the future habitat quality of the levee slopes. The design of the secondary levee alternative has not yet been developed to this level of detail.

Natomas Mutual Water Company American Basin Fish Screen and Habitat Improvement Project (ABFSHIP)

The Natomas Mutual Water Company (Natomas Mutual) annually diverts nearly 100,000 acre feet of water from the Sacramento River and the Natomas Cross Canal and distributes that water throughout the Natomas Basin. Natomas Mutual is currently planning and designing two new diversions to replace its existing five diversions. These pumps would be located along the Sacramento River near Sankey Road and between Elverta Road and Elkhorn Road, respectively. These new diversions would retain the same pumping capacity of the existing diversions (630 cfs), plus an additional 14 cfs to accommodate the Bolen Ranch, which would then eliminate its existing, independent diversion. The new pumps, however, would be variable frequency drive pumps that would facilitate the management of water levels throughout the canal system. Other changes to the current infrastructure would include:

- Construction of a new highline canal between the proposed Sankey Diversion along the landside of the Natomas Cross Canal south Levee to the existing Northern Pumping Plant;
- Relocation and extension of the existing Vestal Drain adjacent to the new highline canal between RD 1000’s Pumping Plant No. 4 and the new Sankey Diversion site;
- Decommissioning and removal of the existing Verona Diversion Dam and Lift Pumps;
- Additional capacity for the internal re-lift pumps at RD 1000 Pumping Plant No. 3 in place of the removed Riverside Pumping Plant;
- Re-grading the Riverside Main Highline Canal from RD 1000 pumping Plant No. 3 to the existing Riverside Pumping Plant;
- Upgrading of two control structures, the County Line Check and Lift Pump and the Elkhorn Check and Lift Pumps;
- Removing the five pumping plants (two along the Natomas Cross Canal and three along the Sacramento River);

- Re-grading the North Drainage Canal from the V Drain to Highway 99 in order to improve conveyance; and,

- Re-grading the Elkhorn Main Highline Canal between the existing Prichard Pumping Plant and the existing Elkhorn Pumping Plant.

The design and environmental review of these infrastructure improvements have not been completed, and thus it would be speculative and possibly misleading to assess the effects on covered species based on current information. However, many of these improvements are also being considered as part of the Sacramento River Water Reliability Study, for which we have used available information to make a rough estimate of their effects. This estimate is provided in the section below that describes the Sacramento River Water Reliability Study.

Sacramento River Water Reliability Study

The Sacramento River Water Reliability Study (SRWRS) was initiated in 2002 by the Bureau of Reclamation, Placer County Water Agency (PCWA), Sacramento Suburban Water District (SSWD), City of Roseville (Roseville), and City of Sacramento (Sacramento). Its goal is to develop a water supply plan that is consistent with the Water Forum Agreement (The Water Forum 2000). It would fulfill this goal by provide additional water supply to PCWA for planned urban growth, to SSWD for groundwater stabilization, to Roseville for planned urban growth and a local conjunctive use program, and to Sacramento for water supply reliability and wheeling services with neighboring water purveyors to meet their water supply demands and to reduce their reliance on groundwater. It also would increase the interconnectivity and source redundancy to the water supply system to maximize long-term water supply reliability.

An initial alternatives report has been prepared for this study (USBR 2005) that developed four alternatives. These alternatives are:

- **SRWS Elverta Diversion Alternative.** This alternative consists of a diversion on the Sacramento River with an associated pump station and water treatment plant, and treated water pipelines to water distribution systems of the SRWRS partners. Water pipelines would extend from the Sacramento River across the Natomas Basin along or adjacent to Elverta Road, and from Elverta Road south to the City of Sacramento. Their total length would be approximately 9 miles.

- **Joint SRWS-ABFSHIP Elverta Diversion Alternative.** This alternative consists of a consolidated diversion on the Sacramento River and associated facilities to accommodate the needs of the SRWRS partners and the NMWC from the Elkhorn Diversion planned under the ABFSHIP. Water pipelines would extend from the Sacramento River across the Natomas Basin along or adjacent to Elverta Road, and from Elverta Road south to the City of Sacramento. Their total length would be approximately 9 miles.

- **ARPS-Elverta Diversion Alternative.** This alternative consists of facility expansions by PCWA in Placer County, increased use of groundwater by Roseville, and construction of a diversion on the Sacramento River and of associated treatment and transmission facilities by Sacramento. (Under this alternative, NMWC would construct and operate its planned Elkhorn Diversion independent of the SRWRS, or continue to divert from its existing diversion.) Water pipelines would extend from the Sacramento River along or adjacent to Elverta Road for approximately 5 miles, and from Elverta Road south to the City of Sacramento. Their total length would be approximately 6.5 miles.

- **ARPS-Joint Sacramento-ABFSHIP Elverta Diversion Alternative.** This alternative would include the same facilities as the ARPS-Elverta Alternative plus additional diversion capacity and facilities at the diversion if the ABFSHIP lead agencies select the Sankey/Elkhorn Diversions alternative for the ABFSHIP. Water pipelines would extend from the Sacramento River along or adjacent to Elverta Road for approximately 5 miles, and from Elverta Road south to the City of Sacramento. Their total length would be approximately 6.5 miles.

The effects of these alternatives have been assessed qualitatively relative to each other, but have not yet been quantified. Similarly, specific designs for these pipelines have not been developed and the likely mitigation is not known. Therefore, their potential effects on existing canals, Jacob's slough are not known.

However, a rough estimate of the acreage of affected habitat can be made. Assuming a 100-foot wide corridor of habitat would be permanently eliminated along these pipelines, and that the water treatment plant and associated facilities would eliminate 100 acres of habitat, these alternatives would eliminate from 179 to 209 acres of habitat for covered species. This, however, is probably an overestimate, because the corridor of permanently eliminated habitat would probably be much less than 100 feet wide, particularly if pipelines follow existing roads, which may be the case for most of their length.

Downtown Sacramento-North Natomas-Airport Light Rail Line

Since the early 1990s, the Sacramento Regional Transit District has been considering a light rail line that would connect downtown Sacramento, North Natomas, and the Sacramento International Airport (SACOG 2000). The route proposed for this rail line would pass through areas permitted for development in North Natomas, cross the Greenbriar site, the Metro Air Park, and then run along Interstate 5, and enter the Sacramento International Airport. This project would affect only a small area of habitat for covered species because most of this route is within existing development, areas permitted for development by the NBHCP, or the likely footprint of other proposed projects.

Assuming a 100-foot wide corridor of habitat was lost along this route, the project would eliminate roughly 21 acres outside of areas permitted for development by the NBHCP. About half of this acreage (10 acres) would be on the Greenbriar site, and a portion of the remainder may be within areas considered for development under the recommended Airport Development Plan for Sacramento International Airport (PB Aviation 2004).

Because this rail line has not been designed nor has any environmental review been performed, it is not known what the effects on canals and connectivity would be. Based on the general location of the proposed route, however, these effects appear to be limited. At the Greenbriar site, the rail line would cross Lone Tree Canal on the Meister Way Road crossing proposed by the Greenbriar project. On the north side of Interstate 5 between MAP and Sacramento International Airport, the only canal is adjacent to the off ramp from the interstate, and this canal is currently unsuitable as habitat for giant garter snake.

West Lakeside

An application for development within the Joint Vision area is on file for the West Lakeside project. No other applications for the Joint Vision area have been filed and its future development potential is in its early consideration stage by the City and County. As such, development of the Joint Vision is considered separately in this analysis. The West Lakeside project is a proposal located approximately 0.25 mile south of the project site adjacent to the eastern border of West Main Drain Canal. This project would develop 133 acres resulting in 524 residential units, a 10-acre elementary school, and approximately 33 acres of open space land uses (e.g., parks and detention basins). Thus, this project could eliminate up to 133 acres of habitat for species covered by the NBHCP. These effects could include habitat along canals that subsequently drain in to the West Drainage Canal.

FUTURE POTENTIAL CUMULATIVE PROJECT: CITY/COUNTY JOINT VISION

Joint Vision

The Joint Vision Plan is a collaborative effort between the City and County of Sacramento to develop a vision for the 10,000-acre area of the County between the northern city limits and Sutter County. Concepts for development have been considered and include a mixture of residential densities, an industrial park (in addition to Metro Air Park), and open spaces throughout, including most extensively in the northern extent separating development from the Sutter County boundary. In fact, a large amount of open space is anticipated to be dedicated (for habitat preservation and farmland retention) in this area. To date, no land use plans have been adopted, and all considerations to date have been conceptual.

The ultimate development scenario that will be proposed for the Joint Vision area is not known and likely will not be known within the time that this analysis and development are being considered. However, because the development potential of the area is large and it is being actively studied, the Greenbriar EIR and this analysis includes disclosure of the plan to the extent it can be known. It is considered as future potential cumulative development, and because this is a speculative development proposal at this time, it is considered separately and less extensively than the cumulative development that is currently planned and proposed (i.e., specific development proposals have been submitted). The Joint Vision plan will be the subject of extensive CEQA review and consideration by the City and County, neighboring jurisdictions, regulatory agencies including DFG and USFWS, local service providers and the Sacramento County Local Agency Formation Commission (LAFCO), and its likely implementation is best described as unknown.

CUMULATIVE EFFECTS OF PROPOSED AND POTENTIAL PROJECTS

Because the extent of habitat prior to conversion to agriculture is unknown, and the location and design of proposed projects has not been fully determined, the total percentage reduction in habitat acreage for covered species cannot be calculated. But, the percentage of the Natomas Basin that has been converted to developed land uses provides a rough approximation of the percentage of habitat for covered species that has been lost.

In 2001, 21% (11,243 acres) of the Basin was in developed uses. By 2004, developed land cover had increased to 24% (12,849 acres). Under the future condition permitted by the NBHCP, 50% (26,769 acres) of the Natomas Basin would be developed or otherwise unsuitable for providing habitat for covered species (e.g., canals and open space inside urban areas). Estimated changes in habitat acreage from 2001 to this future condition are provided by CH2M HILL (2002) and in Section 3.3 *Habitat Acreage in the Natomas Basin*.

In addition to the development permitted by the NBHCP, other projects proposed in the Natomas Basin (and described in the section *Other Proposed Projects Contributing to Cumulative Effects*) would increase the extent of developed land cover in the Natomas Basin (Table 7-1). These projects would likely increase developed land cover from 50% (26,769 acres) of the Natomas Basin (under the NBHCP) to 51.8–52.1% (27,733–27,893 acres) of the Natomas Basin. With the Greenbriar project, this change would increase to 52.9– 53.2% (28,322–28,482 acres).

Concurrent with this change in developed land cover, would be an increase in the area preserved and managed for covered species. Assuming that the mitigation ratio for the proposed projects would be between 0.5 and 3 acres preserved for each acre developed, the extent of preserved habitat would increase from 16% (8,566 acres) of the Natomas Basin under the NBHCP to 17.5–24.2% (9,369–12,956 acres) with mitigation land from the additional proposed projects (not including the Greenbriar project). With the additional proposed projects and the Greenbriar project, the portion of the Natomas Basin preserved as habitat for covered species would be 18.3– 25.0% (9,797–13,385 acres).

Because design, and even the location, of some proposed projects has not been determined, and the quantity, location, and type of mitigation land (e.g., agricultural land, managed marsh) are not known, detailed assessments of their effects on habitat for each covered species would be somewhat speculative, and possibly misleading.

It is important to note that proposed projects would be required to comply with the federal Endangered Species Act and the California Endangered Species Act. Both of these acts require that impacts to endangered species are minimized and fully mitigated. This minimization and mitigation would lessen the impacts of the proposed projects on biological resources, to the extent that they are not considerable. These projects, therefore, would not be expected to contribute substantially to a cumulatively significant impact on these biological resources.

Table 7-1 Potential Loss of Agricultural and Natural Vegetation Due to Additional Proposed Projects[1, 2]		
Project	Acres[3]	Notes
Sacramento International Airport Development Plan	900	Based on recommended Airport Development Plan in the Sacramento International Airport Master Plan; does not include drainage and stormwater projects outside of development areas.
Sacramento Area Flood Control Levee Upgrade Project	8–133	Based on project description in SAFCA 2006, supplemental information in EDAW 2005, and an assumed 175-foot wide footprint for the secondary levee considered as an alternative in this project.
Natomas Mutual Company American Basin Fish Screen and Habitat Improvement Project (ABFSHIP)	—	Most components of this project were included in the acreages estimated for the Sacramento River Water Reliability Study.
Sacramento River Water Reliability Study	179–209	Based on USBR 2005, and an assumption of a 100-foot wide corridor of permanent habitat loss along pipelines, and 100 acres of habitat loss due to facilities at diversions.
Downtown Sacramento-North Natomas-Airport Light Rail Line	21	Based on SACOG 2000, and an assumed 100-foot wide corridor of permanent habitat loss along sections of the route outside of areas permitted for development by the NBHCP or under consideration for development by Sacramento International Airport.
West Lakeside	133	Acreage is the proposed project footprint.
Subtotal	1,241–1,396	
Greenbriar	546	This is the acreage of the Greenbriar site minus the 30.6 acre preserve proposed along Lone Tree Canal
Total	1,794–1,949	

Notes:
[1] – Proposed projects outside of areas authorized for development by the NBHCP.
[2] – Proposed projects do not include the Joint Vision, which was considered a potential proposed project.
[3] – Permanent loss of agricultural and natural vegetation based on estimates of project footprints.

Similarly, the Greenbriar project also must minimize and fully mitigate impacts to biological resources to comply with the federal Endangered Species Act and California Endangered Species Act. Because this minimization and mitigation would lessen the Greenbriar project's impacts on biological resources, to the extent that they are not considerable, the Greenbriar project would not contribute substantially to a cumulatively significant impact on these biological resources.

In addition to the development authorized by the NBHCP and additional proposed projects, the development in the Joint Vision area represents a potential proposed project. Development within the Joint Vision area could result in the conversion of several thousand acres of open space land that provides various levels of habitat for Swainson's hawk, giant garter snake, and other species that are currently covered by the NBHCP. It would create a landscape in which it would be more difficult to maintain connectivity among TNBC reserves and to sustain the habitat quality of TNBC reserves. It also would create the need to preserve most other privately owned agricultural land in the Natomas Basin as mitigation for species covered by the NBHCP.

It is very likely, and expected, that any development within this area would require a new habitat conservation plan, consistent with the federal Endangered Species Act and the California Endangered Species Act. As stated above, compliance with these laws requires that impacts to endangered species are minimized and fully mitigated.

However, it must be recognized that this level of additional development would be expected to have residual environmental impacts to the various species in the area.

While the extent of potential mitigation for development within this area is not currently known, there is the potential that mitigating all of the effects of the Joint Vision on populations of covered species in the Natomas Basin may not be feasible, and some other means of mitigation could be proposed for consideration. For example, sufficient land may not be available in the Natomas Basin to preserve and enhance as mitigation for the effects of developing the Joint Vision, and out of basin mitigation could be proposed for consideration. However, this possibility is entirely speculative and cannot be evaluated until development of the Joint Vision area is actually proposed. To date, and as described above, there are no formal proposals for development of the Joint Vision area, and there are no proposals to consider for mitigation of species under the ESA or CESA.

7.2 CUMULATIVE EFFECTS UNDER ESA

For the purposes of Federal Endangered Species Act compliance, cumulative effects include the effects of future state, tribal, or private actions that are reasonably certain to occur in the action area considered in this biological opinion (USFWS and NMFS 1998). Future Federal actions that are unrelated to the proposed action are not considered because they require separate consultation pursuant to Section 7 of the Endangered Species Act. In addition, once the Section 7 consultation for a Section 10(a)(1)(B) permit has been completed, non-Federal proposals for development within that Section 10(a)(1)(B) planning area are considered part of the environmental baseline for future consultations. Therefore, for this analysis of cumulative effects, as defined for the Endangered Species Act, development projects within those portions of the Natomas Basin that were authorized for development by the NBHCP are considered part of the environmental baseline. The other currently planned and proposed projects described in the cumulative effects analysis in the Greenbriar DEIR and in the NEPA cumulative effects analysis (presented in the preceding section) will require Federal actions and therefore are also not considered in this ESA cumulative effects analysis. (For example, these potential future projects would require a permit to fill wetlands under Section 404 of the Clean Water Act.)

An undetermined number of future State or private actions could occur in the Natomas Basin without a 404 permit to fill wetlands or an ITP through Section 10 of the ESA. Future state or private actions that could potentially affect species covered by the NBHCP include actions that affect:

- herbicide or pesticide applications,
- vegetation management along canals or drains,
- agricultural practices (including crop types cultivated, and fallowing or abandonment of land),
- discharge of contaminants into waterways,
- presence of humans along waterways or on agricultural lands,
- canal flow regimes, or
- traffic levels on local roads.

All of these activities can degrade habitat or cause the injury or death of covered species. Changes in these activities can be caused by state and private actions on agricultural lands. Such changes regularly occur, for example, in response to market conditions and new technologies. For example, the recent increase in water prices in the Natomas Basin is likely to result in changes in crop acreages in the Natomas Basin. Also, in anticipation of development, rice may be fallowed (although land use changes during 2001-2004 do not indicate this has occurred during that time period [Appendix B]). However, attempting to predict the changes in agricultural practices that are likely to occur in the Natomas Basin over long periods of time, and their consequences for species covered by the NBHCP, would be speculation.

Similarly, numerous state and private actions in developed areas also could affect covered species through the same set of mechanisms (herbicide or pesticide applications, vegetation management along canals or drains, etc.), and not all of these actions would involve a federal action and future consultation under Section 7 of the ESA.

Yet, attempting to predict the changes in activities in developed areas that are likely to occur in the Natomas Basin, and their consequences for species covered by the NBHCP, also would be speculation. We are not aware of any state or private actions (for which there is no related federal actions) that are reasonably certain to occur in developed areas of the Natomas Basin and whose effects will significantly affect covered species.

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Appendix A

Assessment of Avoidance and Minimization of Construction-Related Effects and Human Wildlife Conflicts

APPENDIX A
ASSESSMENT OF AVOIDANCE AND MINIMIZATION OF CONSTRUCTION-RELATED EFFECTS AND HUMAN-WILDLIFE CONFLICTS

The effects analysis evaluates the overall effect of the Greenbriar project on the viability of species covered by the NBHCP, on the effectiveness of the NBHCP conservation strategy, and on the attainment of the goals and objectives of the NBHCP. As part of that evaluation, this appendix evaluates the effectiveness and completeness of the Greenbriar project's avoidance and minimization measures.

The NBHCP includes a goal and objective that address avoidance and minimization of direct impacts and of human wildlife conflicts. These are listed below.

Overall Goal 4. Ensure that direct impacts of Authorized Development upon Covered Species are avoided or minimized to the maximum extent practicable. (NBHCP, page I-16)

Overall Objective 1. Minimize conflicts between wildlife and human activities, including conflicts resulting from airplane traffic, roads and automobile traffic, predation by domestic pets, and harassment by people. (NBHCP, page I-16).

To attain this goal and this objective, the NBHCP includes a set of avoidance and minimization measures to be implemented where applicable. For these measures, we assessed the effects of the Greenbriar Project on their effectiveness as avoidance and minimization measures for activities covered by the NBHCP. We also used this set of measures from the NBHCP to assess the effectiveness and completeness of the Greenbriar project's avoidance and minimization measures.

EFFECTIVENESS OF NBHCP MEASURES WITH THE GREENBRIAR PROJECT

For each of the NBHCP's land use agency's conservation measures, the potential for the Greenbriar project to reduce the measure's effectiveness as a means of avoiding or minimizing construction-related effects or human-wildlife conflicts was evaluated. The Greenbriar project would not alter the effectiveness of any of these measures. Most of these NBHCP measures are seasonal avoidance or exclusion zone measures based on the ecology of the species and the nature of construction activities. Because no individual construction project alters this basis, there are few means by which one construction project could affect the effectiveness of these measures. For example, the effectiveness of pre-construction surveys for a particular species is largely unaffected by the extent or location of development. Similarly, the effectiveness of requiring that developers consult with the USFWS regarding covered species observed during preconstruction surveys also is unaffected by development on other sites. Similarly, the ability to apply these measures to a development project in general would not be altered by the effects of another development project.

It is possible, however, that by fragmenting habitat, a development project can create barriers to animal movement to and from a future development site. In this instance, the effectiveness measures that reduce construction-caused mortality by allowing animals to leave construction sites would likely be reduced because animals may no longer be able to move to habitat outside of the construction site. For example, NBHCP measures 3 and 7 are intended to increases the movement of giant garter snakes off of construction sites. If a construction site is isolated from other giant garter snake habitat, these measures would be ineffective. The Greenbriar project is not more likely to cause this set of circumstances than are projects permitted by the NBHCP. The Greenbriar site is isolated from the development authorized by the NBHCP by Interstate 5 and SR 99, and development of the Greenbriar site therefore would not reduce the connectivity of areas authorized for development by the NBHCP to habitat in the remainder of the Natomas Basin.

The assessment of all of the land use agency's conservation measures of the NBHCP is summarized below.

MEASURES FOR PRE-CONSTRUCTION SURVEYS

The effectiveness of pre-construction surveys is based on each species' ecology and on the attributes of the site being surveyed and the biologist's conduct of the survey. The Greenbriar project would not affect this basis of the effectiveness of pre-construction surveys, nor would it affect the ability to implement pre-construction surveys for development authorized by the NBHCP.

MEASURE FOR PRESERVATION OF THE AREA ADJACENT TO FISHERMAN'S LAKE

This measure consists of the City agreeing to initiate a North Natomas Community Plan amendment to potentially widen the agricultural buffer along the City side of Fisherman's lake to 800 feet wide. The Greenbriar site is not in or adjacent to this zone. The project would, however, preserve the Natomas 130 site, which is in and adjacent to this zone. The preservation of the Natomas 130 site is unlikely to affect the City's initiation of an amendment to potentially widen an agricultural buffer along Fisherman's Lake. The project also would not otherwise affect the City's initiation of an amendment to potentially widen an agricultural buffer at this site.

GENERAL MEASURES TO MINIMIZE TAKE

The NBHCP includes four general measures to minimize take. These measures are to 1) protect large trees, 2) incorporate native plants into buffers, developed areas and parks, 3) schedule construction activities to avoid the raptor nesting season, and 4) conduct pre-construction surveys at an appropriate time of year. The Greenbriar project would not affect the ability to implement these measures. But, development at the Greenbriar site might affect the habitat value of protected trees or native vegetation incorporated into landscaping.

In general, additional development could affect the value for wildlife of preserved trees and natural vegetation incorporated into landscaping by increasing the isolation of these features from natural or agricultural vegetation that provides habitat. To do so, additional development would have to reduce connectivity between the preserved tree or native vegetation inside a developed area and habitat outside of the developed area. Because Interstate 5 and SR 99 already separate the Greenbriar site from the City of Sacramento, this potential effect would be limited to possible consequences for Swainson's hawks nesting in a preserved tree within the City of Sacramento adjacent to the Greenbriar site. While this effect is conceivable, no Swainson's hawk nests are known within 1 mile to the east of the Greenbriar site, and a future nest in this portion of the City of Sacramento, while possible is unlikely and would not have limited access to foraging habitat even if the Greenbriar site remained undeveloped.

Conversely, the Greenbriar project's preservation, enhancement, and restoration of the Natomas 130 and Spangler sites, which are adjacent to areas authorized for development under the NBHCP, could increase the effectiveness of the measures to preserve large trees in developed areas and to incorporate native vegetation into buffers and landscaping. Because trees may not be preserved and native species may not be planted in the vicinity of these sites, this effect may not occur.

MEASURES TO MINIMIZE TAKE OF VERNAL POOL SPECIES

The Greenbriar project would not affect vernal pool habitat, is not near vernal pool habitat, and would not affect the ability to implement the measures in the NBHCP. Therefore, the Greenbriar project would not alter the effectiveness of measures for minimizing the take of vernal pool-associated species or alter the effectiveness of these measures.

MEASURES TO REDUCE TAKE FOR INDIVIDUAL SPECIES

MEASURES TO REDUCE TAKE OF GIANT GARTER SNAKE

The NBHCP includes twelve measures to reduce take of giant garter snake by construction activities. Construction of the Greenbriar project will not reduce the effectiveness of these measures at sites authorized for development by the NBHCP. These measures include a seasonal restriction on site preparation and grading, preconstruction surveys, dewatering of canals prior to excavation, minimization of grading, construction monitoring, a restriction on the use of materials that could entangle giant garter snakes, and measures for fences and barriers along the North Drainage Canal and the East Drainage Canal to restrict the movement of giant garter snake into adjacent development.

The effectiveness of seasonal restrictions, preconstruction surveys and of restrictions on materials that could entangle snakes are based on the ecology of giant garter snakes, site attributes, how the conduct of the survey is conducted, and the nature of construction activities. Individual construction projects, including the Greenbriar project, would not alter this basis, or otherwise affect the effectiveness of these measures.

Measures for dewatering of canals or to cease development if a construction monitor locates a giant garter snake on-site also, in general would not be affected by other development projects. But, if another development project were to fragment habitat and thus reduce the ability of a snake to move from a construction site to suitable habitat off-site, then the effectiveness of these measures would be reduced. The Greenbriar project is not likely to cause this situation for development projects authorized by the NBHCP. The Greenbriar site is isolated from the development authorized by the NBHCP by I-5 and SR 99, and development of the Greenbriar site therefore would not reduce the connectivity of areas authorized for development by the NBHCP to habitat in the remainder of the Natomas Basin. Thus, the effectiveness of these measures would not be reduced.

The Greenbriar site is not adjacent to the North Drainage Canal or the East Drainage Canal. Therefore, it is unlikely to affect the effectiveness of measures for fences and barriers along these waterways.

MEASURES TO REDUCE TAKE OF SWAINSON'S HAWK

The NBHCP includes a measure to reduce cumulative effects on Swainson's hawk foraging habitat, five measures to reduce disturbance of nest trees, and seven measures to prevent or mitigate the loss of nest trees.

The measure to reduce cumulative effects established a 1 mile-wide Swainson's hawk zone along the Sacramento River along within which there would be no development. This zone was established because Swainson hawk nests are concentrated along the Sacramento River. The Greenbriar project is not in or adjacent to this zone, and thus it would not alter its effectiveness.

The measures to reduce disturbance of nest trees are based on the ecology of Swainson's hawk and the nature of construction activities; this basis would not be altered by the Greenbriar project. The Greenbriar project also would not affect the ability to implement these measures.

MEASURES TO REDUCE TAKE TO VALLEY ELDERBERRY LONGHORN BEETLE (VELB)

These measures include the avoidance of VELB habitat, and measures for the transplanting of elderberry bushes and for the planting and monitoring of elderberry bushes. The Greenbriar project would not affect the ability to avoid, transplant, plant, or monitor elderberry bushes, nor would it affect the effectiveness of those measures for reducing the take of VELB. (The project does not affect VELB habitat except for preserving a small area of land [at the Natomas 130 site] at which planting or natural establishment of elderberry could provide suitable habitat for VELB at a desirable location.)

MEASURES TO REDUCE TAKE ON TRICOLORED BLACKBIRD

Measures for pre-construction surveys and exclusion zones around nesting colonies are included in the NBHCP as measures to reduce the take of tricolored blackbird. The Greenbriar project would not affect the ability to conduct pre-construction surveys or establish exclusion zones at construction sites in areas that were authorized for development by the NBHCP.

MEASURES TO REDUCE TAKE ON ALEUTIAN CANADA GOOSE

Measures for pre-construction surveys and consultation with USFWS and CDFG (if Aleutian Canada goose is present) are included in the NBHCP as measures to reduce the take of Aleutian Canada goose. The Greenbriar project would not affect the ability to conduct pre-construction surveys at construction sites in areas that were authorized for development by the NBHCP or to consult with USFWS or CDFG if Aleutian Canada goose is present.

MEASURES TO REDUCE TAKE ON WHITE-FACED IBIS

Measures for pre-construction surveys and a seasonal restriction on construction activities within a ¼ mile of active nests were included in the NBHCP. The Greenbriar project would not affect the ability to conduct pre-construction surveys at construction sites in areas that were authorized for development by the NBHCP or to seasonally restrict construction at sites authorized for development by the NBHCP.

MEASURES TO REDUCE TAKE ON LOGGERHEAD SHRIKE

Measures for pre-construction surveys and exclusion zones around active nests are included in the NBHCP as measures to reduce the take of loggerhead shrike. The Greenbriar project would not affect the ability to conduct pre-construction surveys or establish exclusion zones at construction sites in areas that were authorized for development by the NBHCP.

MEASURES TO REDUCE TAKE OF BURROWING OWL

Several measures to reduce the take of burrowing owls are included in the NBHCP. These measures include, pre-construction surveys, establishment of exclusion zones, seasonal restrictions on the disturbance of occupied nests, relocation of owls, and mitigation for disturbed nests. The Greenbriar project would not affect the ability to conduct preconstruction surveys, restrict activities, or establish exclusion zones at construction sites in areas that were authorized for development by the NBHCP. The Greenbriar project also would not affect the feasibility or potential benefits of relocating owls or of mitigating effects on burrowing owls. Therefore, the Greenbriar project would not affect the effectiveness of measures for reducing the take of burrowing owl.

MEASURES TO REDUCE TAKE ON BANK SWALLOW

Pre-construction surveys and establishment of an exclusion zone (if a bank swallow colony is present) are included in the NBHCP as measures to reduce the take of bank swallow. The Greenbriar project would not affect the ability to conduct pre-construction surveys or establish exclusion zones at construction sites in areas that were authorized for development by the NBHCP.

MEASURES TO REDUCE TAKE ON NORTHWESTERN POND TURTLE

The only measure included in the NBHCP to reduce take of northwestern pond turtle is the canal dewatering requirement that was included for giant garter snake. The Greenbriar project would not affect the dewatering of canals in areas authorized for development by the NBHCP, or the ability of animals to move from dewatered canals to suitable habitat off-site. (The Greenbriar site is only directly connected to areas authorized for development through the Lone Tree Canal crossing of I-5, and the ability of turtles to use this crossing and to move up Lone Tree Canal would not be reduced by the Greenbriar project.)

MEASURES TO REDUCE TAKE ON CALIFORNIA TIGER SALAMANDER

The Greenbriar project would not affect California tiger salamander habitat, is not near California tiger salamander habitat, and would not affect the ability to implement the measures in the NBHCP. Therefore, the Greenbriar project would not alter the effectiveness of measures for minimizing the take of California tiger salamander.

MEASURES TO REDUCE TAKE ON WESTERN SPADEFOOT TOAD

The Greenbriar project would not affect western spadefoot toad habitat, is not near western spadefoot toad habitat, and would not affect the ability to implement the measures in the NBHCP. Therefore, the Greenbriar project would not alter the ability to implement measures for minimizing the take of western spadefoot toad.

MEASURES TO REDUCE TAKE OF VERNAL POOL FAIRY SHRIMP, VERNAL POOL TADPOLE SHRIMP, AND MIDVALLEY FAIRY SHRIMP

The Greenbriar project would not affect habitat for these branchiopod species, is not near habitat for these branchiopod species, and would not affect the ability to implement the measures in the NBHCP. Therefore, the Greenbriar project would not alter the effectiveness of measures for minimizing the take of vernal pool fairy shrimp, vernal pool tadpole shrimp, and midvalley fairy shrimp.

MEASURES TO REDUCE TAKE OF DELTA TULE PEA

The NBHCP includes a pre-construction survey and the opportunity to transplant any Delta tule pea located during the survey as measures to reduce take of Delta tule pea. The Greenbriar project would not affect the ability to conduct pre-construction surveys of sites authorized for development by the NBHCP, or to transplant Delta tule pea to suitable habitat elsewhere. Therefore, the Greenbriar project would not affect the effectiveness of these measures at reducing take of Delta tule pea.

MEASURES TO REDUCE TAKE ON SANFORD'S ARROWHEAD

The NBHCP includes a pre-construction survey and the opportunity to transplant any Delta tule pea located during the survey as measures to reduce take of Sanford’s arrowhead. The Greenbriar project would not affect the ability to conduct pre-construction surveys of sites authorized for development by the NBHCP, or to transplant Sanford’s arrowhead to suitable habitat elsewhere. Therefore, the Greenbriar project would not affect the effectiveness of these measures at reducing take of Sanford’s arrowhead.

MEASURES TO REDUCE TAKE ON BOGGS LAKE HEDGE-HYSSOP, SACRAMENTO ORCUTT GRASS, SLENDER ORCUTT GRASS, COLUSA GRASS, AND LEGENERE

The Greenbriar project would not affect habitat for these vernal pool-associated plant species, is not near vernal pool habitat, and would not affect the ability to implement the measures in the NBHCP for minimizing the take of these species. Therefore, the Greenbriar project would not alter the effectiveness of these measures.

ASSESSMENT OF AVOIDANCE AND MINIMIZATION BY THE GREENBRIAR PROJECT

For this assessment, the avoidance and minimization measures in the NBHCP were considered a comprehensive set of effective measures to avoid and minimize the construction-related effects and human-wildlife conflicts potentially resulting from the NBHCP.

Development at the Greenbriar site is comparable to the development permitted by the NBHCP, and the construction-related effects and human-wildlife conflicts potentially caused by the Greenbriar are the same as those potentially caused by the development permitted by the NBHCP.

Therefore, for comparable effects potentially caused by the Greenbriar project, incorporation of the applicable measures from the NBHCP was considered to be avoidance and minimization to the maximum extent practicable. The NBHCP's avoidance and minimization measures related to development were reviewed to determine the measures that were applicable to the Greenbriar project, and if the measure or a comparable (but more specific or stringent) measure was incorporated into the Draft Environmental Impact Report (DEIR). All applicable measures (or comparable but more stringent measures) were incorporated into the DEIR. The results of this assessment are summarized in Table A-1.

In addition, the Greenbriar project could cause other effects that differ from those addressed by the avoidance and minimization measures of the NBHCP. These effects are the construction and human-wildlife conflict-related effects on giant garter snakes and giant garter snake habitat along Lone Tree Canal. Avoiding and minimizing these effects to the maximum extent practicable requires measures in addition to the applicable measures from the NBHCP. The DEIR mitigation for the Greenbriar project contains a comprehensive set of such measures to avoid, minimize, and mitigate human disturbance and other related effects on giant garter snake use of Lone Tree Canal. These measures include:

a. To ensure that the project does not diminish habitat connectivity for giant garter snake between the southwest and northwest zones identified in the NBHCP, approximately 30.6 acres along Lone Tree Canal shall be protected and managed as giant garter snake habitat. This on-site habitat preservation shall protect an approximately 250-foot wide corridor of giant garter snake habitat that includes the canal and approximately 200 feet of adjacent uplands. Uplands within the linear open space/buffer area shall be managed as perennial grassland as described below. Additional aquatic habitat for giant garter snake shall be created along the east bank of Lone Tree Canal by construction and maintenance of a 2.7 acre tule bench. The habitat shall be managed in perpetuity as high-quality habitat for giant garter snake. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared within six months of completion of monitoring for any given year. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP.

b. To ensure that the project does not diminish giant garter snake movement along Lone Tree Canal, all new road crossings of Lone Tree Canal shall be designed to minimize obstacles to giant garter snake movement. The use of culverts under new road crossings on Lone Tree Canal shall be prohibited unless it can be demonstrated that the culverts will not diminish the potential for giant garter snake movement through the section of Lone Tree Canal protected by the setback fence and conservation easement. .

c. Upland giant garter snake habitat within the Lone Tree Canal linear open space/buffer area shall be created and managed to provide cover, basking areas, and refugia during the winter dormant period. Hibernaculae would be constructed at regular intervals by embedding concrete or coarse rock in the bank or in a berm along the Lone Tree Canal corridor to provide additional winter refugia. Upland habitat with the linear open space/buffer areas shall be converted to native perennial grassland and managed, in perpetuity, as perennial grassland habitat.

d. Aquatic habitat shall be maintained throughout the giant garter snake active season in Lone Tree Canal, in perpetuity. This is the legal responsibility and obligation of Metro Air Park property owners (MAP). The MAP HCP includes provisions for maintaining water in the canal such that the basic habitat requirements of the giant garter snake are met. The MAP HCP also provides a road map, through "Changed Circumstances", to address procedures to follow if water is not being maintained in the canal to meet these requirements. As described in the MAP HCP, the MAP is legally obligated to assure these requirements are met, and financial and procedural mechanisms are included in the MAP HCP to enforce this. It is, therefore, assumed that MAP will provide water to Lone Tree Canal, as required by the MAP HCP and ITP, in perpetuity. It is also assumed that USFWS will use all reasonable means available to it, to enforce this MAP HCP requirement. If water is not provided to Lone Tree Canal by the MAP to meet the habitat requirements of giant garter snake, as required by the MAP HCP, and USFWS exhausts its enforcement responsibilities, the project applicant shall assume the responsibility of providing suitable giant garter snake aquatic habitat throughout the section of Lone Tree Canal protected by the fence and conservation easement. However, as stated herein, the project applicant shall only assume this responsibility if it has been sufficiently demonstrated to the City that USFWS has exhausted all reasonable means to compel MAP to comply with the relevant conditions of the MAP ITP. Specific requirements related to ensuring suitable aquatic habitat in Lone Tree Canal is present, in perpetuity, throughout the giant garter snake active season shall be developed through consultation with DFG and USFWS, and included in the new or amended HCP for Greenbriar, and may include mechanisms, such as installation of a well, to assure water is provided in the canal to meet habitat requirements.

e. A barrier shall be installed between the giant garter snake habitat linear open space/buffer area and the adjacent Greenbriar development to ensure that giant garter snakes do not enter the development area, and to prohibit humans and pets from entering the giant garter snake habitat. The design of this barrier shall be subject to USFWS and CDFG review and approval. The entire length of the barrier, which shall be bordered by yards rather than roadways, shall be maintained on the preserve side by a nonprofit land trust to ensure that vegetation or debris does not accumulate near the barrier and provide opportunities for wildlife and pets to climb over the barrier. On the development side, Covenants, Codes and Restrictions (CCRs) shall prohibit accumulation of vegetation or debris adjacent to the barrier. Chain link fencing shall be placed at both ends of the corridor, with locked gates permitting entry only by RD 1000 and NMWD for channel maintenance, and by the preserve manager for habitat monitoring and maintenance purposes.

f. Specific requirements associated with the barrier shall be developed through consultation with USFWS and DFG, and may include the following and/or other specifications that DFG and USFWS consider to be equally or more effective:

  - Adequate height and below-ground depth to prevent snakes or burrowing mammals from providing a through-route for snakes by establishing burrows from one side to the other crossing;
  - Constructed using extruded concrete or block construction extending a minimum of 36-inches above ground level;
  - Maintenance to repair the barrier and to prevent the establishment of vegetation or collection of debris that could provide snakes with a climbing surface allowing them to breech the barrier;
  - A cap or lip extending at least two-inches beyond the barrier's vertical edge to prevent snakes from gaining access along the barrier's top edge; and
  - Signage to discourage humans and their pets from entering the area.

g. The Lone Tree Canal linear open space/buffer area shall be protected in perpetuity under a conservation easement and managed to sustain the value of this area for giant garter snake habitat connectivity. Compliance and biological effectiveness monitoring shall be performed and annual monitoring reports prepared. This monitoring, reporting, and adaptive management shall be performed as described in Section IV of the NBHCP or following procedures developed in formal consultation with USFWS and DFG and contained in an ESA Incidental Take Permit for the Greenbriar project.

The need for, and purpose and effectiveness of, these additional measures are described in Section 3.5 *Connectivity of Habitat in the Natomas Basin* and in Section 4.1 *Giant Garter Snake*.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
1. Pre-construction Surveys (p V-1) shall be conducted not less than 30 days or more than 6 months prior to commencement of construction activities, to determine the status and presence of, and likely impacts to, all Covered Species on the site. Pre-construction surveys for an individual species may be completed up to one year in advance if the sole period for reliable detection of that species is between May 1 and December 31.	Applicable	Included	Comparable and more stringent measures have been included in the mitigation proposed in the project's DEIR for each species with potential to occur on-site.
2. Preservation of the Area Adjacent to Fisherman's Lake (p V-2): Pursuant to the Settlement Agreement, the City has agreed to initiate a North Natomas Community Plan amendment to potentially widen the agricultural buffer along the City side of Fisherman's lake to 800 feet wide.	N/A		This measure is specific to locations outside the project area.
3. General Measures to Minimize Take (p V-3)			
a. Tree Preservation: Valley oaks and other large trees should be preserved whenever possible. Preserve and restore stands of riparian trees used by Swainson's hawks and other animals for nesting, particularly adjacent to Fisherman's Lake.	N/A	Included	The Greenbriar site currently has not large trees.
b. Native Plants: Improve the wildlife value of landscaped parks, buffers, and developed areas by planting trees and shrubs which are native to the Natomas Basin and therefore are used by native animals.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
c. Protect Raptor Nests: Avoid the raptor nesting season when scheduling construction near nests. Specific avoidance criteria are set forth in the species specific measures later in this chapter.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
d. Protected Plant/Animal Species, also referred to as "Special Status Species": Search for protected plant species during flowering season prior to construction and protected animal species during the appropriate season.	Applicable	Included	Comparable and more specific measures have been included in the mitigation proposed in the project's DEIR for each species with potential to occur on-site.
4. Measures to Minimize Take of Vernal Pool Species (p V-3)	N/A		No vernal pool habitat exists on site.
a. General Biological Survey and Information Required (p V-4): In the event a biological reconnaissance survey or the pre-construction survey identifies that vernal pool resources are on-site, a vernal pool species specific biological assessment must be provided during the appropriate season (as established by USFWS) to determine the type	N/A		No vernal pool habitat exists on site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
and abundance of species present.			
1. Where site investigations indicate vernal pool species may occur, the developer shall notify the Land Use Agency regarding the potential for impacts to vernal pool species.	N/A		No vernal pool habitat exists on site.
2. USFWS and CDFG shall identify specific measures required to avoid, minimize and mitigate impacts to vernal pool species to be implemented prior to disturbance and in accordance with adopted standards or established guidelines.	N/A		No vernal pool habitat exists on site.
3. The requirement by USFWS to preserve a vernal pool within development would be based on identification of an intact vernal pool with minimal disturbance where the presence of one or more of the following species is recorded: slender orcutt grass, Sacramento orcutt grass, Colusa grass, or vernal pool tadpole shrimp. No such preservation requirement shall be made unless the vernal pool is a suitable site for TNBC Mitigation Lands.	N/A		No vernal pool habitat exists on site.
4. Such vernal pool areas, including any required buffer land dedication, shall apply toward the Land Acquisition Fee component of the development project's NBHCP mitigation obligation.	N/A		No vernal pool habitat exists on site.
b. Mitigation Strategies (p. V-5)	N/A		No vernal pool habitat exists on site.
1. Avoidance and Preservation On-Site to Minimize Impacts: In the event USFWS requires on-site preservation in accordance with Section a.3 above, on-site mitigation shall be required. In the event USFWS does not require on-site mitigation, a developer or private land owner may still propose to dedicate fee title or conservation easement for that portion of the property with vernal pool resources and an associated 250-foot buffer surrounding the vernal pool resource to the TNBC. If the dedication is accepted, a reduction in the Land Acquisition Fee portion of the habitat Mitigation Fee shall be granted the developer for the portion (calculated on an acreage basis) of the site permanently preserved by easement or dedication. However, habitat Mitigation Fees, in full, must be paid on the remaining developable acreage on the site, and all fees other than Land Acquisition Fees shall be paid	N/A		No vernal pool habitat exists on site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
for all acres on the site. Additional conditions to preserve the biological integrity of the site (such as reasonable drainage conditions) may be imposed by the Land Use Agency in consultation with TNBC and the TAC.			
2. Construction Period Avoidance and Relocation of Vernal Pool Resources (p. V-6).	N/A		No vernal pool habitat exists on site.
a. No grading, development or modification of the vernal pool site or the buffer area extending 250 feet around the perimeter of the vernal pool site may occur during the vernal pool “wet” season as identified by USFWS. Protective fencing shall be established around the perimeter of the vernal pool site and the buffer area during the vernal pool wet season.	N/A		No vernal pool habitat exists on site.
b. In consultation with TNBC and the TAC, soils and cysts from the vernal pool may be relocated as soon as practicable during the dry season to a suitable TNBC or other reserve site provided the relocation/recreation site is approved by TNBC, and the USFWS.	N/A		No vernal pool habitat exists on site.
3. Payment Into a USFWS Approved Conservation Bank (p. V-6). In the event all of the above approaches are not appropriate for the site, the Land Use Agency shall require the developer to purchase credits from a USFWS-approved mitigation bank in accordance with the following mitigation ratios: 2:1 for preservation in mitigation banks, 1:1 for creation in mitigation banks, 3:1 for preservation in acres outside of mitigation banks, 2:1 for creation in acres outside of mitigation banks.	N/A		No vernal pool habitat exists on site.
5. Measures to Reduce Take for Individual Species (p. V-7)			
a. Measures to Reduce Take of Giant Garter Snake (p. V-7)			
1. Within the Natomas Basin, all construction activity involving disturbance of habitat, such as site preparation and initial grading, is restricted to the period between May 1 and September 30. This is the active period for the giant garter snake and direct mortality is lessened, because snakes are expected to actively move and avoid danger.	Applicable	Included	A comparable and more detailed measure has been included in the mitigation proposed in the project’s DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
2. Pre-construction surveys for giant garter snake, as well as other NBHCP Covered Species, must be completed for all development projects by a qualified biologist approved by USFWS. If any giant garter snake habitat is found within a specific site, the following additional measures shall be implemented to minimize disturbance of habitat and harassment of giant garter snake, unless such project is specifically exempted by USFWS.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR, combined with measure 4 below.
3. Between April 15 and September 30, all irrigation ditches, canals, or other aquatic habitat should be completely dewatered, with no puddled water remaining, for at least 15 consecutive days prior to the excavation or filling in of the dewatered habitat. Make sure dewatered habitat does not continue to support giant garter snake prey, which could detain or attract snakes into the area. If a site cannot be completely dewatered, netting and salvage of prey items may be necessary. This measure removes aquatic habitat component and allows giant garter snakes to leave on their own.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
4. For sites that contain giant garter snake habitat, no more than 24-hours prior to start of construction activities (site preparation and/or grading), the project area shall be surveyed for the presence of giant garter snake. If construction activities stop on the project site for a period of two weeks or more, a new giant garter snake survey shall be completed no more than 24-hours prior to the re-start of construction activities.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
5. Confine clearing to the minimal area necessary to facilitate construction activities. Flag and designate avoided giant garter snake habitat within or adjacent to the project as Environmentally Sensitive Areas. This area shall be avoided by all construction personnel.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
6. Construction personnel completing site preparation and grading operations shall receive USFWS approved environmental awareness training. This training instructs workers on how to identify giant garter snakes and their habitats, and what to do if a giant garter snake is encountered during construction activities. During this training an on-site biological monitor shall be	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
designated.			
7. If a live giant garter snake is found during construction activities, immediately notify the USFWS and the project's biological monitor. The biological monitor, or his/her assignee, shall do the following:	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
a. Stop construction in the vicinity of the snake. Monitor the snake and allow the snake to leave on its own. The monitor shall remain in the area for the remainder of the work day to make sure the snake is not harmed or if it leaves the site, does not return. Escape routes for giant garter snake should be determined in advance of construction and snakes should always be allowed to leave on their own. If a giant garter snake does not leave on its own within one working day, further consultation with USFWS is required.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
8. Upon locating dead, injured or sick threatened or endangered wildlife species, the Permittees or their designated agents must notify within one working day the Service's Division of Law Enforcement and Sacramento Fish and Wildlife Office. Written notification to both offices must be made within 3 calendar days and must include the date, time, and location of the finding of a specimen and any other pertinent information.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
9. Fill or construction debris may be used by giant garter snake as an over-wintering site. Therefore, upon completion of construction activities remove any temporary fill and/or construction debris from the site. If this material is situated near undisturbed giant garter snake habitat and it is to be removed between October 1 and April 30, it shall be inspected by a qualified biologist to assure that giant garter snake are not using it as hibernaculae.	Applicable	Included	A comparable and more stringent measure has been included in the mitigation proposed in the project's DEIR.
10. No plastic, monofilament, jute, or similar erosion control matting that could entangle snakes will be placed on a project site when working within 200 feet of snake aquatic or rice habitat. Possible substitutions include coconut coir matting, tactified hydroseeding compounds, or other material approved by the Wildlife Agencies.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
11. Fences will be constructed along the shared boundary of urban development and the North Drainage Canal and the East Drainage Canal within Sutter County's Permit Area.	N/A		This measure is specific to locations outside the project area.
a. A minimum of 100 feet will be provided from fence-to-fence and access to the canals shall be limited by gates.	N/A		This measure is specific to locations outside the project area.
b. A snake deterrent will be placed along the fences on the North Drainage Canal and the East Drainage Canal (i.e., fence construction that restricts snake movement or an appropriate vegetative barrier either inside or outside of the boundary fence). The design of the deterrent shall be subject to approval by the Wildlife Agencies.	N/A		This measure is specific to locations outside the project area.
c. The specific fence/snake barrier design adjacent to a given development will be determined within Sutter County's review of the proposed development and the fence/barrier shall be installed immediately after site grading is completed.	N/A		This measure is specific to locations outside the project area.
12. At the time of urban development along the North and East Drainage Canals, Sutter County shall consult with the Wildlife Agencies to determine design strategies that would enhance conditions for giant garter snake movement through the North and East Drainage Canals. Possible strategies may include expanded buffer areas and modified canal cross sections if such measures are, in the determination of Sutter and the Water Agencies, found to be feasible.	N/A		This measure is specific to locations outside the project area.
b. Measures to Reduce Take of Swainson's Hawk (V-9)			
1. Measures to Reduce Cumulative Impacts to Foraging Habitat (V-9): Sutter County and the City of Sacramento will not will not grant development approvals within the one-mile wide Swainson's Hawk Zone adjacent to the Sacramento River.	N/A		This measure is specific to locations outside the project area.
2. Measures to Reduce Nest Disturbance (V-10)			
1. Pre-construction surveys shall be completed by the respective developer to determine whether any Swainson's hawk nest trees will be removed on-site, or active Swainson's hawk nest sites occur on or within ½ mile of the	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
development site.			
2. If breeding Swainson's hawks (i.e. exhibiting nest building or nesting behavior) are identified, no new disturbances (e.g., heavy equipment operation associated with construction) will occur within ½ mile of an active nest between March 15 and September 15, or until a qualified biologist, with concurrence by CDFG, has determined that young have fledged or that the nest is no longer occupied. Routine disturbances such as agricultural activities, commuter traffic, and routine facility maintenance activities within ½ mile of an active nest are not restricted.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
3. Where disturbance of a Swainson's hawk nest cannot be avoided, the nest tree may be destroyed during the non-nesting season. For purposes of this provision the Swainson's hawk nesting season is defined as March 15 to September 15. If a nest tree (any tree that has an active nest in the year the impact is to occur) must be removed, tree removal shall only occur between September 15 and February 1.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
4. If a Swainson's hawk nest tree is to be removed and fledglings are present, the tree may not be removed until September 15 or until the California Department of Fish and Game has determined that the young have fledged and are no longer dependent upon the nest tree.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
5. If construction or other project related activities which may cause nest abandonment or forced fledgling are proposed within the 1/4 mile buffer zone, intensive monitoring (funded by the project sponsor) by a Department of Fish and Game approved raptor biologist will be required. Exact implementation of this measure will be based on specific information at the project site.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
3. Measures to Prevent the Loss of Nest Trees	Section heading		
1. Valley oaks, tree groves, riparian habitat and other large trees will be preserved wherever possible, particularly near Fisherman's Lake and elsewhere where large oak groves,	N/A		There are currently no large trees at the Greenbriar site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
tree groves and riparian habitat have been identified.			
2. The raptor nesting season shall be avoided when scheduling construction near nests in accordance with applicable guidelines published by the Wildlife Agencies or through consultation with the Wildlife Agencies.	Applicable	Included	A comparable and more detailed measure has been included in the mitigation proposed in the project's DEIR, combined with measure 2.2 above.
4. Measures to Mitigate the Loss of Nest Trees (V-11)			
1. Fifteen trees (five gallon container size) must be planted, maintained and monitored within the habitat reserves for every Swainson's hawk nesting tree anticipated to be impacted by Authorized Development.	N/A		No Swainson's hawk nesting trees exist on site.
2. The Land Use Agency Permittee approving a project that impacts an existing Swainson's hawk nest tree shall provide funding sufficient for monitoring survival success of trees for a period of 5 years. For every tree lost during this time period, a replacement tree must be planted immediately upon the detection of failure. Trees planted to replace trees lost shall be monitored for an additional 5-year period to ensure survival until the end of the monitoring period. A 100% success rate shall be achieved. All necessary planting requirements and maintenance (i.e., fertilizing, irrigation) to ensure success shall be provided. Trees must be irrigated for a minimum of the first 5 years after planting, and then gradually weaned off the irrigation in an approximate 2-year period. If larger stock is planted, the number of years of irrigation must be increased accordingly. In addition, 10 years after planting, a survey of the trees shall be completed to assure 100% establishment success. Remediation of any dead trees shall include completion of the survival and establishment process described.	N/A		No Swainson's hawk nesting trees exist on site.
3. Of the replacement trees planted, a variety of native tree species will be planted to provide trees with differing growth rates, maturation, and life span. This will ensure that nesting habitat will be available quickly (5-10 years in the case of cottonwoods and willows), and in the long term (i.e., valley	N/A		No Swainson's hawk nesting trees exist on site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
oaks, black walnut and sycamores). Trees shall be sited on reserves in proximity to hawk foraging areas. Trees planted shall be planted in clumps of 3 trees each. Planting stock shall be a minimum of 5-gallon container stock for oak and walnut species.			
4. In order to reduce temporal impacts resulting from the loss of mature nest trees, the City of Sacramento will fund mitigation planting within 14 months of permit of the NBHCP and ITP's, to be reimbursed by private developers at the time of approval of their development projects that impact mature nest trees.	N/A		No Swainson's hawk nesting trees exist on site.
5. For each additional nesting tree removed by Land Use Agencies' Covered Activities, the Land Use Agency shall fund and provide for the planting of 15 native sapling trees of suitable species with differing growth rates at suitable locations on TNBC preserves. Funding for such plantings shall be provided by the applicable Permittee within 30 days of approving a Covered Activity that will impact a Swainson's hawk nesting tree.	N/A		No Swainson's hawk nesting trees exist on site.
c. Measures to Reduce Take to Valley Elderberry Longhorn Beetle (VELB) (p. V-13): developers must comply with conservation practices for VELB set forth in the conditions of the "USFWS Compensation Guidelines for the Valley Elderberry Longhorn Beetle," dated 1999. This policy assumes that any elderberry bushes found within the range of the species are likely to provide beetle habitat, and any destruction or loss of such elderberry shrub habitat must be mitigated according to the Guidelines. The principle conditions of the Guidelines are summarized below.	N/A		No elderberry shrubs exist on site.
1. Any direct or indirect impacts to VELB habitat will be avoided whenever possible. To the maximum extent practicable, projects will be designed to avoid stands of elderberry bushes and to avoid isolation of the plants from other nearby populations. Pre-construction surveys at the construction impact site will be conducted to assess the appropriate amount of mitigation.	N/A		No elderberry shrubs exist on site.
2. If elderberry plants cannot be avoided, they shall be transplanted	N/A		No elderberry shrubs exist on site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
during the dormant season (November 1 to February 15) to an area protected in perpetuity and approved by the USFWS.			
3. Replacement seedling plants will be provided at a ratio between 2:1 and 5:1 depending on the extent of beetle utilization of the plants moved or lost. A 1,800-square-foot area will be provided for each transplanted elderberry shrub or every five elderberry seedling plants.	N/A		No elderberry shrubs exist on site.
4. Annual monitoring of VELB habitat will be provided in the planted mitigation sites for a ten year period.	N/A		No elderberry shrubs exist on site.
5. Replacement elderberry shrubs will meet a 60% survival rate by the end of the ten year period and the 60% survival rate shall be required for the term of the applicable permit.	N/A		No elderberry shrubs exist on site.
d. Measures to Reduce Take on Tricolored Blackbird (V-13)	Section heading		
1. A pre-construction survey is required for potential nesting habitat and presence of nesting tricolored blackbirds.	Applicable		Suitable tricolored blackbird nesting habitat does not exist on site.
2. If surveys determine tricolored blackbirds are present, the following measures shall be implemented in accordance with the Migratory Bird Treaty Act, to avoid disturbance to occupied nesting colonies during the nesting season. A boundary shall be marked by brightly colored construction fencing that establishes a boundary 500 feet from the active colony. No disturbance associated with Authorized Development shall occur within the 500 foot fenced area during the nesting season to July 1, or while birds are present. A qualified biologist, with concurrence of USFWS, must determine young have fledged and nest sites are no longer active before the nest site may be disturbed.	Applicable		Suitable tricolored blackbird nesting habitat does not exist on site.
e. Measures to Reduce Take on Aleutian Canada Goose (V-14)			
1. A pre-construction survey for Aleutian Canada geese will be required. If geese are present, the developer must consult with USFWS and CDFG to determine appropriate measures to avoid and minimize take of individuals. Such measures shall be appropriate for the use (e.g., foraging, roosting, etc.) and activity of the species, since this species is a seasonal visitor to the Basin.	Applicable		This subspecies is not expected to occur on site.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
f. Measures to Reduce Take on White-faced Ibis (V-14)			
1. Prior to approval of an Urban Development Permit, a pre-construction survey will be required.	N/A		Suitable white-faced ibis nesting habitat does not exist on site.
2. If surveys determine the presence of active nest sites of White-faced ibis, disturbance by Authorized Development within 1/4 mile of nests will be avoided within the nesting season of May 15 through August 31 or until a qualified biologist, with concurrence of Wildlife Agencies, has determined that young have fledged or that the nest is no longer occupied.	N/A		Suitable white-faced ibis nesting habitat does not exist on site.
g. Measures to Reduce Take on Loggerhead Shrike (V-14)			
1. Prior to approval of an Urban Development Permit, a pre-construction survey will be required.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project’s DEIR.
2. If surveys identify an active loggerhead shrike nest that will be impacted by Authorized Development, the developer shall install brightly colored construction fencing that establishes a boundary 100 feet from the active nest. No disturbance associated with Authorized Development shall occur within the 100 foot fenced area during the nesting season of March 1 through July 31. A qualified biologist, with concurrence of USFWS must determine young have fledged or that the nest is no longer occupied prior to disturbance of the nest site.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project’s DEIR.
h. Measures to Reduce Take of Burrowing Owl (V-15)			
1. Prior to the initiation of grading or earth disturbing activities, the applicant/developer shall hire a CDFG approved qualified biologist to perform a pre-construction survey of the site to determine if any burrowing owls are using the site for foraging or nesting. The preconstruction survey shall be submitted to the Land Use Agency with jurisdiction over the site prior to the developer’s commencement of construction activities and a mitigation program shall be developed and agreed to by the Land Use Agency and developer prior to initiation of any physical disturbance on the site.	Applicable	Included	A comparable and more stringent measure has been included in the mitigation proposed in the project’s DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
2. Occupied burrows shall not be disturbed during nesting season (February 1 through August 31) unless a qualified biologist approved by the CDFG verifies through noninvasive measures that either: 1) the birds have not begun egg-laying and incubation; or 2) that juveniles from the occupied burrows are foraging independently and are capable of independent survival.	Applicable	Included	A comparable and more stringent measure has been included in the mitigation proposed in the project's DEIR.
3. If nest sites are found, the USFWS and CDFG shall be contacted regarding suitable mitigation measures, which may include a 300 foot buffer from the nest site during the breeding season (February 1 - August 31), or a relocation effort for the burrowing owls if the birds have not begun egg-laying and incubation or the juveniles from the occupied burrows are foraging independently and are capable of independent survival. If on-site avoidance is required, the location of the buffer zone will be determined by a qualified biologist. The developer shall mark the limit of the buffer zone with yellow caution tape, stakes, or temporary fencing. The buffer will be maintained throughout the construction period.	Applicable	Included	A comparable and more stringent measure has been included in the mitigation proposed in the project's DEIR.
4. If relocation of the owls is approved for the site by USFWS and CDFG, the developer shall hire a qualified biologist to prepare a plan for relocating the owls to a suitable site. The relocation plan must include: (a) the location of the nest and owls proposed for relocation; (b) the location of the proposed relocation site; (c) the number of owls involved and the time of year when the relocation is proposed to take place; (d) the name and credentials of the biologist who will be retained to supervise the relocation; (e) the proposed method of capture and transport for the owls to the new site; (f) a description of the site preparations at the relocation site (e.g., enhancement of existing burrows, creation of artificial burrows, one-time or long-term vegetation control, etc.); and (g) a description of efforts and funding support proposed to monitor the relocation. Relocation options may include passive relocation to another area of the site not subject to disturbance through one way doors on burrow openings, or construction of artificial burrows in accordance with the CDFG's October 17, 1995, Staff Report on Burrowing Owls Mitigation (see Appendix	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
D)).			
5. Where on-site avoidance is not possible, disturbance and/or destruction of burrows shall be offset through development of suitable habitat on TNBC upland reserves. Such habitat shall include creation of new burrows with adequate foraging area (a minimum of 6.5 acres) or 300 feet radii around the newly created burrows. Additional habitat design and mitigation measures are described in the CDFG's October 17, 1995, Staff Report on Burrowing Owl Mitigation (see Appendix D).	Applicable	Included	A comparable and more stringent measure has been included in the mitigation proposed in the project's DEIR.
i. Measures to Reduce Take on Bank Swallow (V-16)			
1. Disturbance to bank swallows nesting colonies will be avoided within the nesting season of May 1 through August 31 (or until a qualified biologist, with concurrence of USFWS and CDFG, has determined that young have fledged or that the nest is no longer occupied) during all Authorized Development activities conducted in the Permit Areas.	N/A		Suitable bank swallow nesting habitat does not exist on site.
2. If surveys identify an active bank swallow nesting colony that will be impacted by Authorized Development, the developer shall install brightly colored construction fencing that establishes a boundary 250 feet from the active nesting colony. No disturbance associated with Authorized Development shall occur within the 250 foot fenced area during the nesting season of May 1 through August 31. Additionally, disturbance within ½ mile upstream or downstream of the colony will be avoided if the colony is located upon a natural waterway.	N/A		Suitable bank swallow nesting habitat does not exist on site.
j. Measures to Reduce Take on Northwestern Pond Turtle (V-16)			
1. Take of the northwestern pond turtle as a result of habitat destruction during construction activities, including the removal of irrigation ditches and drains, and during ditch and drain maintenance, will be minimized by the dewatering requirement described above for giant garter snake (see Section 5.a.(3)).	Applicable		The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
k. Measures to Reduce Take on California Tiger Salamander (V-16)			
1. Prior to approval of an Urban Development Permit, the involved	N/A		Suitable California tiger salamander

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
Land Use Agency shall require a pre-construction survey. If a future survey determines the presence of California tiger salamander, the Land Use Agency shall require the developer to consult with USFWS and CDFG to determine appropriate measures to avoid and minimize take of individuals.			habitat does not exist on site.
l. Measures to Reduce Take on Western Spadefoot Toad (V-16)			
1. Prior to approval of an Urban Development Permit, the involved Land Use Agency shall require a pre-construction survey. If such survey determines western spadefoot toad are present, the Land Use Agency shall require the developer to consult with CDFG and USFWS to determine appropriate measures to avoid and minimize take of individuals.	N/A		Suitable western spadefoot toad habitat does not exist on site.
m. Measures to Reduce Take of Vernal Pool Fairy Shrimp, Vernal Pool Tadpole Shrimp, and Midvalley Fairy Shrimp (V-17)			
1. Prior to approval of an Urban Development Permit, the involved Land Use Agency shall require a pre-construction survey. If such survey determines vernal pool fairy shrimp, vernal pool tadpole shrimp, and midvalley fairy shrimp are present, the Land Use Agency shall require the developer to consult with USFWS to determine appropriate measures to avoid and minimize take of individuals. Procedures for reviewing projects that could affect vernal pools and vernal pool species are discussed under Section V.A.4 above.	N/A		No vernal pool habitat exists on site.
n. Measures to Reduce Take of Delta Tule Pea (V-17)			
1. If Delta tule pea plants are identified through a pre-construction survey, the involved Land Use Agency shall provide notice to USFWS, CDFG and the California Native Plant Society. Under such circumstances, the development proponent shall allow the transplantation of plants prior to site disturbance.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
o. Measures to Reduce Take on Sanford's Arrowhead (V-17)			

Table A-1
Inclusion of NBHCP Measures to Reduce Construction-related Effects and Human-Wildlife Conflicts in the Greenbriar Project or the DEIR Mitigation for the Project

Natomas Basin HCP Measure	Applicability	Inclusion	Rationale
1. If Sanford's arrowhead plants are identified through a pre-construction survey, the involved Land Use Agency shall provide notice to USFWS, CDFG and the California Native Plant Society. Under such circumstances, the development proponent shall allow the transplantation of plants prior to site disturbance.	Applicable	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.
p. Measures to Reduce Take on Boggs Lake Hedge-Hyssop, Sacramento Orcutt Grass, Slender Orcutt Grass, Colusa Grass, and Legenere (V-17)			
1. Prior to approval of an Urban Development Permit, the involved Land Use Agency shall require a pre-construction survey. If such survey determines Boggs Lake hedge-hyssop, Sacramento orcutt grass, Slender orcutt grass, Colusa grass, or legenere are present, the Land Use Agency shall require the developer to consult with USFWS to determine appropriate measures to avoid and minimize loss of individuals. If Authorized Development is proposed for areas containing vernal pools, the applicant will be required to complete additional review, permitting and mitigation as described under Section V.A.4.	N/A	Included	The NBHCP measure has been included in the mitigation proposed in the project's DEIR.

Appendix B

Change in Natomas Basin Land Cover in 2001–2004

APPENDIX B
CHANGE IN NATOMAS BASIN LAND COVER IN 2001–2004

INTRODUCTION

EDAW analyzed 2001 and 2004 land cover of the Natomas Basin to describe changing conditions in the Natomas Basin and their bearing on analyses of the Natomas Basin Habitat Conservation Plan (NBHCP) and on analyses of the Greenbriar project.

The NBHCP used 2001 land cover as a primary data source in analyses of the anticipated future condition. For example, change in habitat availability for covered species was analyzed by evaluating the change in land cover types providing suitable habitat. This was done by subtracting 2001 acreages in areas permitted for development from total 2001 acreages.

In 2004, land cover in the Natomas Basin was mapped by Jones & Stokes for TNBC (Jones & Stokes 2005). This land cover data provides useful information about more recent conditions.

A comparison of 2001 and 2004 land cover could provide useful information regarding on-going changes. Unfortunately, the mapping of 2001 land cover by CH2M Hill (CH2M Hill 2002) and the mapping of 2004 land cover by Jones & Stokes (Jones & Stokes 2005) used different land cover classifications and different mapping methods. Consequently, changes in land use and habitat availability cannot be interpreted by directly comparing them. For example, more intensively developed land was mapped as airport, highway, other, rural residential, and other in 2001; but as developed in 2004. Also, many areas mapped as urban in 2001 were mapped as natural or urban vegetation in 2004, apparently because the 2004 mapping was done with much more conservative boundaries around structures and pavement.

Therefore, EDAW processed each data set to increase their compatibility, and then evaluated changes in land cover during 2001–2004 in: 1) areas permitted for development, 2) The Natomas Basin Conservancy (TNBC) reserve system, and 3) in the remainder of the Natomas Basin.

METHODS

Data layers for the 2001 and 2004 land cover mapping were provided by CH2M Hill and Jones & Stokes, respectively. Analyses of these data layers were performed using ArcInfo 9.1.

Several steps were taken to make these two maps more comparable and to facilitate an informative comparison of land cover change from 2001 to 2004. First, we developed a cross-walk between the 2001 and 2004 land cover classifications and a derived classification. Table B-1 presents this crosswalk and the derived classification. Second, land mapped in developed land cover types in 2001 was considered to still be developed. Thus, the 2001 land cover classification of these areas was retained for 2004. Third, land cover acreages were adjusted to incorporate habitat along canals and drains as a distinct type (i.e., canal in Table B-1). This was done by transferring acreage from each land cover category to a canal category based on the acreages intersecting buffers placed around canals in a GIS analysis. (Buffer widths were based on the widths used in Table 4-3 of CH2M Hill [2002].) Canals passing through developed land cover types, however, were included in the developed category.

RESULTS AND DISCUSSION

Table B-2 provides a comparison of 2001 and 2004 land cover overall, and within development areas, TNBC reserves, and the rest of the Natomas Basin. (Development areas include the Sutter County, City of Sacramento, and MAP permit areas.) This subdivision of the Natomas Basin allows changes due to management of TNBC reserves and changing land use in areas authorized for development to be distinguished from changes in the remainder of the Natomas Basin.

Changes in land cover from 2001 to 2004 were most substantial on TNBC reserves. In areas incorporated into the TNBC reserve system, the creation of managed marshes increased the acreage of ponds, marsh, and seasonally wet areas by over 500 acres, while the acreage of rice decreased by less than 100 acres. This indicates that most managed marsh has been created from land mapped as non-rice cropland or idle in 2001. If this pattern continues more total habitat for species using marshes and wetlands will exist in the future condition than estimated because more conversion of rice to marsh was anticipated (CH2M Hill 2002). Grassland and pasture has also increased on reserve lands, while non-flooded cropland decreased by approximately 900 acres during 2001–2004 within the current TNBC reserve system. Interestingly, there has been no increase in alfalfa on reserve lands. Overall, the proportions of marsh, rice and upland land cover types are consistent with those specified by the NBHCP.

Within areas permitted for development by the NBHCP, developed land cover has increased and so has the acreage of grassland, while disturbed areas and non-flooded crops have decreased in extent. Interestingly, the acreage of rice within developed areas did not decrease during 2001–2004. This rice is primarily in the Sutter County's permit area, and to a lesser extent in the Metro Air Park. Almost no rice was present in the City of Sacramento's permit area in either 2001 or 2004. Thus, as of 2004, there is no evidence that rice has been fallowed in anticipation of development. Non-flooded cropland has been fallowed or abandoned, however. Non-flooded cropland decreased in acreage, and the corresponding increase in grassland acreage is likely due to the increase in idle cropland.

Outside of TNBC reserves and areas authorized for development, the primary change in land cover has been a 42% decrease in the acreage of non-flooded cropland, and a concurrent increase in the acreage of grassland and rice. Because both grassland and rice have increased, there has not been a substantial change in the acreage of habitat for either upland-associated or wetland-associated species covered by the NBHCP. This change in the proportions of the different agricultural land cover types outside of reserves and areas undergoing development does illustrate the dynamic nature of agricultural landscapes over short periods of time, in this case just three years. Recent concerns over water prices and the viability of rice cultivation in the Natomas Basin also indicate this dynamism.

Table B-1
Crosswalk between CH2M Hill and Jones & Stokes Land Cover Classifications and a Combined Classification

Combined Classification	CH2M Hill	Jones & Stokes
Alfalfa	Alfalfa	Alfalfa
Canal	Canal, small portions of other land cover types that canals passed through (except for developed land cover)	Open Water [in part], Riparian Scrub [in part], Grassland [in part], Rice [in part], Row Crops [in part] and small amounts of other land cover types
Developed	Airport, Highway or Major Road, Other, Urban	Developed [in part], and small portions of other land cover types
Grassland	Grassland	Grassland [in part]
Orchard	Orchard	Orchard
Pasture	Pasture	Irrigated Grassland, Grass Hay
Ponds, Marsh and Seasonally wet areas	Ponds and Seasonally Wet Areas	Fresh Emergent Marsh, Managed Marsh, Open Water [in part], Seasonal Wetland
Rice	Rice	Rice [in part]
Riparian	Riparian	Riparian Scrub [in part], Riparian Woodland
Non-rice Crops	Non-rice Crops, idle	Row Crops [in part]
Ruderal	Ruderal	Disturbed / Bare
Rural Residential	Rural Residential	Developed [in part], and small portions of other land cover types
Tree Grove	Tree Grove	Non-riparian Woodland
Valley Oak Woodland	Oak Grove	Valley Oak Woodland

Note: CH2M Hill classification used in mapping 2001 land cover as described in CH2M Hill 2002; Jones & Stokes classification used in mapping 2004 land cover as described in Jones & Stokes 2005.

Table B-2
Land Cover Change in the Natomas Basin 2001–2004

Land Cover Type	Development Areas[1]		TNBC Reserves[2]		Rest of Basin		Total	
	2001	2004	2001	2004	2001	2004	2001	2004
Alfalfa	0	0	64	67	305	529	369	596
Canal	508	436	113	111	830	833	1,451	1,380
Developed	8,353	9,766	26	42	2,931	3,173	11,311	12,980
Grassland	564	2,328	13	349	225	2,179	802	4,856
Orchard	0	0	0	0	165	145	165	145
Pasture	165	255	80	164	423	315	668	734
Ponds, Marsh and Seasonally Wet Areas	21	60	0	514	73	106	94	680
Rice	7,562	8,363	2,499	2,414	11,360	13,308	21,421	24,085
Riparian	23	24	4	12	87	86	114	122
Non-flooded Cropland	3,214	939	1,096	291	9,374	5,427	13,683	6,657
Ruderal	2,825	1,111	66	0	378	28	3,269	1,139
Tree Grove	56	8	7	1	37	48	100	56
Valley Oak Woodland	13	14	0	3	77	89	90	106
Total	23,303	23,303	3,968	3,968	26,266	26,266	53,537	53,536

Notes: All values are in acres.
1 – Areas authorized for development by the NBHCP.
2 – Areas in TNBC reserve system in 2005.