NIOBRARA AMBERSNAIL (*Oxyloma h. haydeni*) HABITAT AT INDIAN GARDENS, GRAND CANYON NATIONAL PARK: FINAL REPORT

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INTRODUCTION

A small population of Niobrara ambersnail (NAS; Succineidae: *Oxyloma h. haydeni*) persists at Indian Gardens, Grand Canyon National Park's most heavily visited inner canyon site. This landsnail population was discovered by the author in the mid-1990's, and exists in bulrush (*Schoenoplectus (Scirpus) americanus*) and cattail (*Typha domingensis*) habitat along a tiny spring system with several outflow points in upper Garden Creek. This is one of only two natural populations of NAS known in Arizona; the other population exists at a spring at Colorado River Mile –9L upstream from Lees Ferry. The Indian Gardens population is one of only three natural populations of the genus *Oxyloma* known in Arizona. This population is genetically distinct, but is the most closely related taxon to the endangered Kanab ambersnail (*O.h. kanabensis*; Miller et al. 2000); however, the snail population is not presently protected as a federally listed endangered species.

We conducted a land survey of NAS habitat at Indian Gardens to assist Grand Canyon evaluate habitat impacts related to maintenance, development and non-native Himalaya berry (*Rubus procerus*) control at Indian Gardens. This land survey was conducted on 14 January 2001, with survey expertise provided by Mr. Chris Brod of the Northern Arizona University Geography Department. The author conducted the periphery and habitat identification and was assisted by Ms. Margaret Erhart.

METHODS

After notifying NPS Dispatch of our presence and intent, we established a total station survey instrument location on the west side of Garden Creek Canyon, overlooking upper Indian Gardens on 14 January 2001. The survey instrument location and backsight are included in Appendix A. Because the surveyed landscape is virtually flat, a topographic map was not needed for this analysis of snail habitat area. Therefore, we restricted our survey measurements to a 2-dimensional plane. As much of the vegetation at Indian Gardens is deciduous, conducting a land survey in January was appropriate, allowing us to survey points that would have been impossible to capture through dense foliage during the growing season.

The author ran perimeter shots around all patches of wetland vegetation from the lower end of the overnight campground down to the mule barn. These patches are considered to be secondary habitat, as they are dominated by native and non-native grasses and Himalaya berry. Secondary habitat surrounds patches of primary snail habitat, which are dominated by wetland cattail, bullrush, sedge (*Carex hystricina*),

coyote willow (*Salix exigua*), and watercress (*Nasturtium officinale*). The author identified all plant species detected in each habitat patch, and recorded the information in his field book, and also noted details about the survey points. The taxonomy follows that of Phillips et al. (1987).

Land survey and habitat composition and cover data were compiled in the laboratory. A detailed map of the site was prepared and analyzed for habitat patch surface area.

RESULTS AND DISCUSSION

The author's previous analysis of Niobrara ambersnail distribution at this site revealed that snails are restricted to specific habitat configurations, particularly bullrush, cattail, and watercress dominated patches. The Indian Gardens land survey revealed that the total primary snail habitat was 708 m^2, 24% of the total wetland habitat area (2241.5 m^2). The primary habitat occurs in five patches lying between the overnight campground and the mule barn: "UP1", "MP1", "MP2", "MP3, and "LP" (Table 1; Figs. 1, 2; Appendix A). In addition, the author detected some snails in Patch "CP" in 1997. This patch is dominated by non-native grasses and watercress, and is included here as primary habitat. These primary habitat patches lie just upstream and downstream from the Search and Rescue Supply (SARS) cabins along the central and western side of the floodplain (Figs. 1, 2). Other wetland habitat patches ("UP", "MP A and B", in Table 1 and Figs.1 and 2) are considered as secondary habitat because the snails have not been detected there, although they may provide marginally suitable habitat.

During the summer of 1998, the author assisted Dr. Vicky Meretsky (Indiana University) with a snail survey at Indian Gardens. Because flooding had not occurred in the drainage for nearly a year, watercress-dominated habitat extended nearly 100 m downstream from the mule barn, and in the main drainage parallel to the Bright Angel Trail nearly up to the gabian walls. Snails were found throughout the watercress-dominated habitat, indicating that during some periods, the snail population and habitat greatly expands. However, this expansion is temporary, as natural flooding removes both the additional habitat and snails. The survey conducted here involves the core habitat, that to date has not been much affected by natural flooding.

MANAGEMENT RECOMMENDATIONS

The landsnail habitat surveyed here has been substantially affected by NPS management activities, including: maintenance of several trails, a presently abandoned day-use picnic area, water pipelines for three drinking fountains, two search and rescue cabins, stream channel modification, occasional "weed-whacking" of the lower portion of the "UP1" patch, and expansion of non-native grass and Himalaya berry populations. Despite the small amount of primary habitat (0.07 ha), the Niobrara ambersnail population has demonstrated great resilience over the past five years, and shows no apparent sign of a recent genetic "bottleneck" (Miller et al. 2000). Therefore, with

Table 1: Indian Gardens Niobrara ambersnail habitat survey results, 14 January 2001. These data, including habitat patch names, are based on total station land survey analysis and indicated on Figs. 1 and 2, and in Appendix A. Percent cover was visually estimated for ground, shrub and tree (canopy) layers in the wetland habitats at this site. Trace cover = 0.01%; S = plant species richness.

	Habitat Patch:							
	"UP"	**"UP1"**	**"CP"**	**"MP"**	**"MP1"**	**"MP2"**	**"MP3"**	**"LP"**
1° Patch Area (m^2):		178.2	24.9		96	131.4	143.4	134.1
2° Patch Area (m^2):	483.5			1758				
Plant Species								
Ground Cover								
Aster sp.	10			1				
Carex hystricina				5			10	
Cynodon dactylon	5			5				
Equisetum hybrid				30	15	20		
Nasturtium officinale		0.5	0.01	0.01	2	2	5	
Calamagrostis sp?	80	20	100	40	3	20		35
Shrub Cover								
Baccharis emoryi	10	1		20	15	10	15	5
Baccharis salicifolius	30	25	75	15	5	10	10	3
Brickellia longifolia	1							
Nolina microcarpa	2							
Phragmites australis	7	20		5			16	
Rubus himalanayana				3	8	18	5	2
Salix exigua				10		25	75	
Schoenoplectus americanus	7	70		10		50		
Typha domingensis	5	10		10	80	10	25	55
Yucca baccata	0.01							
Tree Cover								
Celtis reticulata								8
Cercis occidentalis				2				
Fraxinus velutina	10	10		2				
Populus fremontii	10		80	20	5	20		12
%Ground Cover, S	95	21	100	81	20	42	15	35
Ground Cover S	3	2	2	6	3	3	2	1
%Shrub Cover, S	62	126	75	73	108	123	146	65
Shrub Cover S	8	5	1	7	4	6	6	4
%Tree Cover, S	20	10	80	24	5	20	0	20
Tree Cover S	2	1	1	3	1	1	0	2
Total Species Richness	**13**	**8**	**4**	**16**	**8**	**10**	**8**	**7**

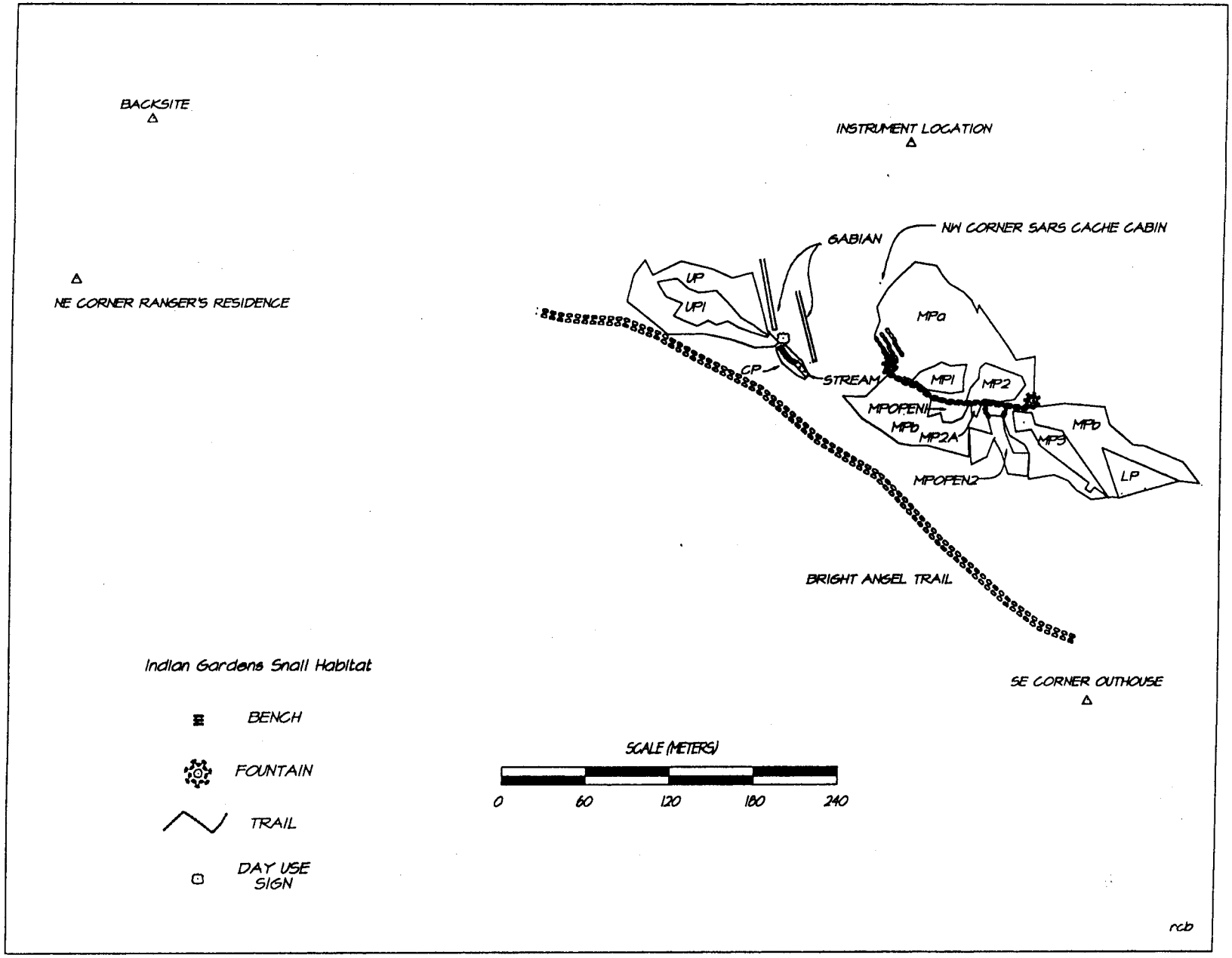

Fig. 1: Overall map of the primary and secondary NAS habitat at Indian Gardens on 14 January 2001.

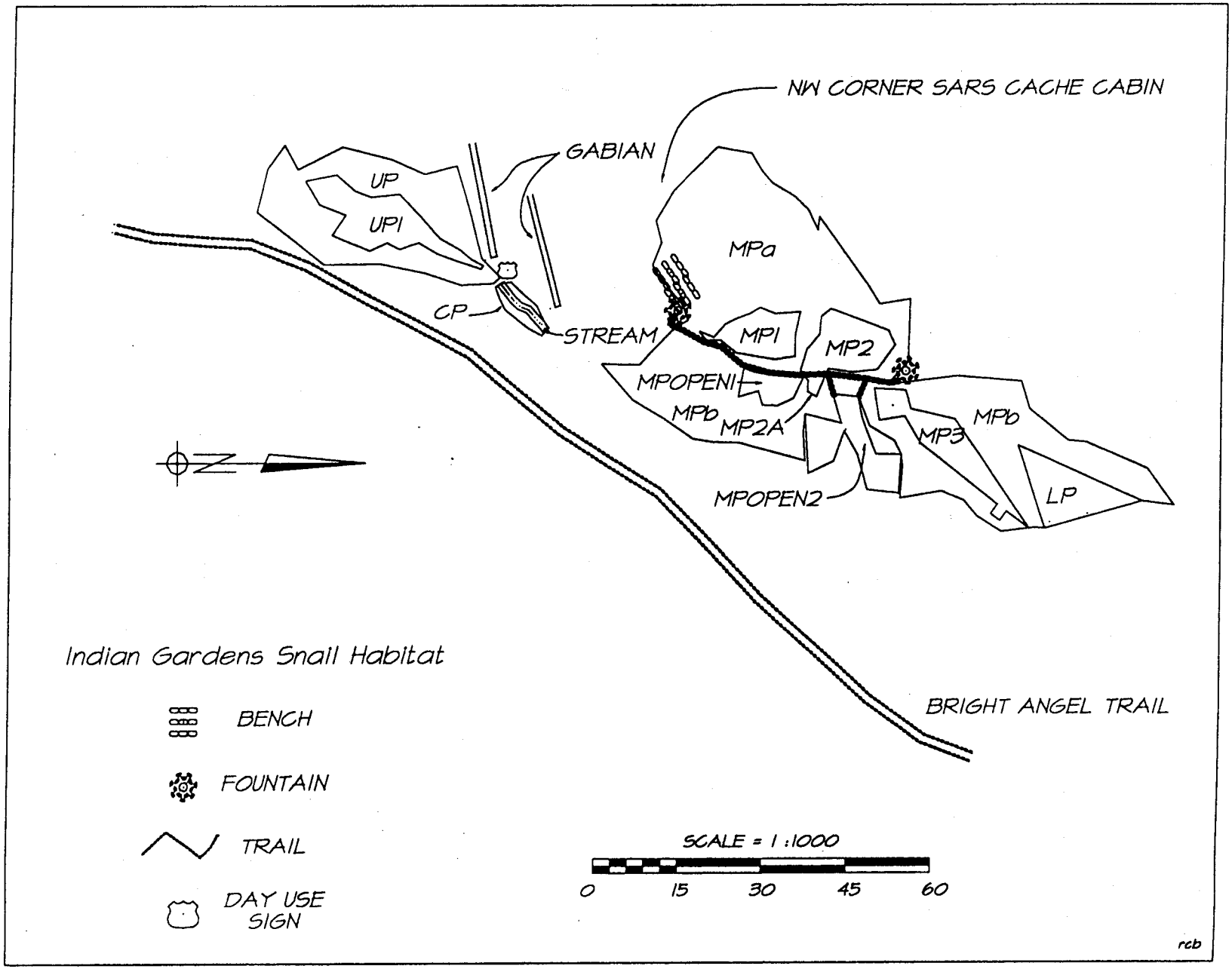

Fig. 2: Detailed map of the primary and secondary NAS habitat at Indian Gardens on 14 January 2001. Total primary habitat area = 0.07 ha, 24% of the total wetland habitat at this site (0.224 ha).

minimal attention, this snail population is likely to persist. We recommend that the NPS protect the "UP1" habitat patch. This patch of marshy bullrush vegetation is not particularly accessible to hikers, and fencing would probably provide sufficient protection. A greater threat lies in the expansion of non-native vegetation, particularly non-native grasses and Himalaya berry, which should be prevented from expanding into these patches of primary habitat.

The NPS is considering trenching in the vicinity of the snail habitat to place water pipes. The NPS may elect to evaluate the proposed trenching so as to minimize impact on the snail habitat. To achieve this, I recommend that the trenching activity remain at least 3 m (10 feet) from the edge of primary habitat patches, and care be taken to assure that the trenching does not affect spring discharge. Trenching during the rainy season should also be avoided, so as not to increase runoff and erosion on these habitat patches. These recommendations are reasonably simple, and should not interfere with the NPS's plans while still protecting this remarkably small ambersnail habitat.

Occasional monitoring of the snail and its habitat is warranted, as the State of Arizona has taken considerable interest in *Oxyloma* landsnail populations, and may consider them as sensitive species. The land survey data appended to this report provide the NPS with the opportunity to conduct repeated surveys of this site, should the agency so desire. Please contact the author if additional information is needed regarding this report or clarification of Niobrara ambersnail habitat patch location at Indian Gardens.

ACKNOWLEDGEMENTS

This project was funded by the Grand Canyon Science Center, and I thank Elaine Leslie for coordinating the work. Chris Brod provided survey expertise, and Margaret Erhart assisted in field data recording. Vicky Meretsky provided information on her prior investigations into ambersnail habitat and population distribution at Indian Gardens.

LITERATURE CITED

Miller, M.P., L.E. Stevens, J.D. Busch, J.A. Sorensen, and P. Keim. 2000. Amplified fragment length polymorphism and mitochondrial sequence data detect genetic differentiation and relationships in endangered southwestern U.S.A. ambersnails (*Oxyloma* spp.). Canadian Journal of Zoology 78:1845-1854.

Phillips, B.G., A.M. Phillips III, and M.A. Schmidt Bernzott. 1987. Annotated checklist of vascular plants of Grand Canyon National Park. Grand Canyon Natural History Association, Grand Canyon.

APPENDIX A:

INDIAN GARDENS SURVEY DATA

SURVEY DATE: 14 JANUARY 2001
INSTRUMENT OPERATOR: CHRIS R. BROD
RODMAN: LAWRENCE E. STEVENS
FIELD ASSISTANT: MARGARET H. ERHART

SURVEY DATA:

```
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LS,HI1.737,HR3.287
SS,OP1,FP137,AR266.3925,ZE107.5723,SD70.250,--MP1
LS,HI1.737,HR3.290
SS,OP1,FP138,AR264.4901,ZE108.4225,SD68.199,--MP1
SS,OP1,FP139,AR262.5055,ZE109.0546,SD67.526,--MP1
SS,OP1,FP140,AR260.5347,ZE109.2246,SD67.067,--MP1
SS,OP1,FP141,AR259.0339,ZE109.4048,SD66.312,--MP1
SS,OP1,FP142,AR256.5000,ZE109.2005,SD67.771,--MP1
SS,OP1,FP143,AR252.5154,ZE109.2505,SD68.589,--MP1
SS,OP1,FP144,AR254.2520,ZE108.2618,SD72.113,--MP1
LS,HI1.737,HR1.835
SS,OP1,FP145,AR255.0715,ZE108.4303,SD75.936,--MP1
LS,HI1.737,HR1.840
SS,OP1,FP146,AR257.5744,ZE108.4052,SD75.731,--MP1
SS,OP1,FP147,AR263.2143,ZE108.4117,SD73.676,--MP1
SS,OP1,FP148,AR265.3802,ZE109.0158,SD71.221,--MP1
LS,HI1.737,HR3.287
SS,OP1,FP149,AR267.4849,ZE107.4948,SD70.659,--MP1
LS,HI1.737,HR1.835
SS,OP1,FP150,AR268.5013,ZE109.1407,SD69.676,--MP1
-- BS angle check: 0.0003, Circle error= 0.0003
LS,HI1.737,HR1.840
SS,OP1,FP151,AR253.0913,ZE109.0846,SD75.274,--MP2
SS,OP1,FP152,AR254.4915,ZE108.2300,SD78.555,--MP2
SS,OP1,FP153,AR254.0654,ZE108.0218,SD80.497,--MP2
LS,HI1.737,HR1.500
SS,OP1,FP154,AR254.2611,ZE107.4720,SD82.395,--MP2
LS,HI1.737,HR3.287
SS,OP1,FP155,AR253.3128,ZE106.2658,SD83.077,--MP2
LS,HI1.737,HR3.290
SS,OP1,FP156,AR251.0801,ZE107.3110,SD79.221,--MP2
SS,OP1,FP157,AR248.1052,ZE107.1809,SD81.204,--MP2
SS,OP1,FP158,AR245.0520,ZE107.2023,SD82.476,--MP2
LS,HI1.737,HR1.835
SS,OP1,FP159,AR241.4112,ZE108.5301,SD80.559,--MP2
LS,HI1.737,HR2.240
SS,OP1,FP160,AR241.3629,ZE109.0911,SD77.799,--MP2
LS,HI1.737,HR1.835
SS,OP1,FP161,AR247.0607,ZE110.3601,SD71.539,--MP2
LS,HI1.737,HR2.100
SS,OP1,FP162,AR248.1421,ZE109.3119,SD69.864,--MP2
-- BS angle check: 0.0008, Circle error= 0.0008
--RZ

BK,OP1,BP2,BS181.4806,BC0.0000
LS,HI1.737,HR3.287
SS,OP1,FP163,AR249.5727,ZE109.2630,SD70.624,--MP2
LS,HI1.737,HR3.290
SS,OP1,FP164,AR250.5608,ZE108.5116,SD73.373,--MP2
LS,HI1.737,HR1.835
SS,OP1,FP165,AR253.0112,ZE109.0840,SD75.314,--MP2
LS,HI1.737,HR1.840
SS,OP1,FP166,AR262.2838,ZE108.1745,SD76.370,--MPOPEN1
SS,OP1,FP167,AR260.5601,ZE108.1018,SD77.244,--MPOPEN1
SS,OP1,FP168,AR258.5310,ZE108.0649,SD78.204,--MPOPEN1
SS,OP1,FP169,AR256.4122,ZE108.0736,SD79.025,--MPOPEN1
LS,HI1.737,HR2.440
SS,OP1,FP170,AR254.2758,ZE107.4951,SD79.494,--MPOPEN1
LS,HI1.737,HR1.835
SS,OP1,FP171,AR256.2641,ZE107.1938,SD82.720,--MPOPEN1
LS,HI1.737,HR1.840
SS,OP1,FP172,AR258.3336,ZE107.0701,SD83.403,--MPOPEN1
SS,OP1,FP173,AR260.3022,ZE107.0509,SD82.848,--MPOPEN1
SS,OP1,FP174,AR260.4838,ZE107.3105,SD80.385,--MPOPEN1
SS,OP1,FP175,AR263.3400,ZE107.1054,SD80.885,--MPOPEN1
SS,OP1,FP176,AR262.3057,ZE108.1802,SD76.357,--MPOPEN1
SS,OP1,FP177,AR251.1224,ZE107.3607,SD84.022,--MPOPEN2
SS,OP1,FP178,AR248.2757,ZE107.2503,SD85.757,--MPOPEN2
SS,OP1,FP179,AR248.4928,ZE106.4303,SD89.350,--MPOPEN2
SS,OP1,FP180,AR248.3931,ZE105.4453,SD95.844,--MPOPEN2
LS,HI1.737,HR3.287
SS,OP1,FP181,AR246.0615,ZE104.5212,SD97.136,--MPOPEN2
LS,HI1.737,HR3.290
SS,OP1,FP182,AR247.4438,ZE105.0221,SD103.440,--MPOPEN2
--1.835
LS,HI1.737,HR1.835
SS,OP1,FP183,AR247.4441,ZE105.0250,SD103.394,--MPOPEN2
LS,HI1.737,HR1.840
SS,OP1,FP184,AR250.4029,ZE105.1059,SD100.960,--MPOPEN2
SS,OP1,FP185,AR250.3840,ZE105.5239,SD94.877,--MPOPEN2
LS,HI1.737,HR0.900
SS,OP1,FP186,AR251.1803,ZE107.0336,SD90.663,--MPOPEN2
LS,HI1.737,HR0.080
SS,OP1,FP187,AR253.2211,ZE106.4032,SD95.131,--MPOPEN2
LS,HI1.737,HR0.600
SS,OP1,FP188,AR256.2531,ZE106.1440,SD95.968,--MPOPEN2
LS,HI1.737,HR1.835
SS,OP1,FP189,AR255.2224,ZE106.5046,SD85.694,--MPOPEN2
LS,HI1.737,HR0.080
SS,OP1,FP190,AR251.2310,ZE107.4327,SD89.529,--MPOPEN2

LS,HI1.737,HR1.835
SS,OP1,FP191,AR251.2414,ZE107.4010,SD83.639,--MPOPEN2
LS,HI1.737,HR1.840
SS,OP1,FP192,AR241.4902,ZE107.3057,SD84.971,--FOUNTAIN
SS,OP1,FP193,AR243.0511,ZE107.4717,SD86.350,--TRAIL
LS,HI1.737,HR3.287
SS,OP1,FP194,AR244.0700,ZE106.5443,SD85.546,--TRAIL
LS,HI1.737,HR3.290
SS,OP1,FP195,AR246.4509,ZE107.0547,SD83.144,--TRAIL
LS,HI1.737,HR1.835
SS,OP1,FP196,AR248.2742,ZE107.2317,SD85.884,--TRAIL
LS,HI1.737,HR3.287
SS,OP1,FP197,AR251.2025,ZE107.2208,SD80.064,--TRAIL
LS,HI1.737,HR1.835
SS,OP1,FP198,AR251.2124,ZE107.3201,SD84.317,--TRAIL
LS,HI1.737,HR1.840
SS,OP1,FP199,AR255.2034,ZE108.1642,SD79.170,--TRAIL
SS,OP1,FP200,AR258.5806,ZE108.1540,SD77.758,--TRAIL
SS,OP1,FP201,AR262.3730,ZE108.2551,SD75.808,--TRAIL
SS,OP1,FP202,AR265.3253,ZE108.4845,SD72.437,--TRAIL
SS,OP1,FP203,AR268.1007,ZE108.4717,SD71.416,--TRAIL
SS,OP1,FP204,AR271.1938,ZE108.5024,SD69.503,--TRAIL
SS,OP1,FP205,AR273.3140,ZE108.5722,SD68.534,--TRAIL
SS,OP1,FP206,AR272.3115,ZE109.0032,SD65.932,--END AT FOUNTAIN
-- BS angle check: 359.5956, Circle error= 359.5956
LS,HI1.737,HR3.287
SS,OP1,FP207,AR246.1421,ZE106.4735,SD85.118,--MP3
LS,HI1.737,HR3.290
SS,OP1,FP208,AR244.5601,ZE106.2100,SD89.096,--MP3
LS,HI1.737,HR2.290
SS,OP1,FP209,AR243.0645,ZE106.3524,SD91.180,--MP3
LS,HI1.737,HR4.534
SS,OP1,FP210,AR243.4111,ZE104.4358,SD96.738,--MP3
LS,HI1.737,HR7.580
SS,OP1,FP211,AR237.5408,ZE101.3406,SD117.821,--MP3
LS,HI1.737,HR0.000
SS,OP1,FP212,AR249.2618,ZE97.2757,SD165.366,--SE.COR OUTHOUSE
--AT MULE BARN
LS,HI1.737,HR0.850
SS,OP1,FP213,AR248.5307,ZE100.0047,SD148.423,--BA TRAIL
LS,HI1.737,HR1.835
SS,OP1,FP214,AR251.4441,ZE99.3740,SD142.655,--BA TRAIL
LS,HI1.737,HR1.840
SS,OP1,FP215,AR254.5650,ZE99.5937,SD133.528,--BA TRAIL
SS,OP1,FP216,AR258.2400,ZE100.0847,SD123.431,--BA TRAIL
SS,OP1,FP217,AR262.4434,ZE100.5212,SD113.522,--BA TRAIL

SS,OP1,FP218,AR267.1601,ZE101.3419,SD103.857,--BA TRAIL
SS,OP1,FP219,AR272.4641,ZE102.1734,SD95.238,--BA TRAIL
SS,OP1,FP220,AR279.1041,ZE102.3028,SD90.964,--BA TRAIL
SS,OP1,FP221,AR285.0521,ZE102.3513,SD87.968,--BA TRAIL
SS,OP1,FP222,AR292.4447,ZE102.3613,SD84.196,--BA TRAIL
SS,OP1,FP223,AR299.0857,ZE102.3802,SD82.307,--BA TRAIL
SS,OP1,FP224,AR306.5332,ZE102.2648,SD83.704,--BA TRAIL
SS,OP1,FP225,AR313.5631,ZE101.4041,SD86.313,--BA TRAIL
SS,OP1,FP226,AR321.0207,ZE100.4356,SD90.209,--BA TRAIL
SS,OP1,FP227,AR326.3910,ZE99.3059,SD96.230,--BA TRAIL
SS,OP1,FP228,AR329.2126,ZE98.2406,SD103.076,--BA TRAIL
SS,OP1,FP229,AR331.5956,ZE97.2726,SD110.795,--BA TRAIL
LS,HI1.737,HR0.900
SS,OP1,FP230,AR334.1935,ZE97.1359,SD116.580,--BA TRAIL
SS,OP1,FP231,AR349.0206,ZE89.4830,SD240.608,--NE.COR RES
--NE COR RANGERS RESIDENCE
-- BS point check:1-2, Horiz err: 0.019, Vert err: 0.934
LS,HI1.737,HR1.835
-- BS point check:1-2, Horiz err: 0.005, Vert err: -0.003
-- BS angle check: 0.0008, Circle error= 0.0008
--EOS