Grand Canyon National Park and Grand Canyon National Park Foundation

Fall 2006 Report

Management & Control of Tamarisk and Other Invasive Vegetation at Backcountry Seeps, Springs and Tributaries in Grand Canyon National Park

(Phase II-A, First Year of Phase II of Comprehensive Project)

Arizona Water Protection Fund Contract Number 05-131WPF

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Please Note: The data and photographs for this report have all been entered into the project database. The database, without the links to the photographs, is included in a zip file on the CD enclosed with this report. The full and final version of the database, including all of the photographs, will be included with the final report on a DVD or is available upon request. Upon review and acceptance from AWPF, this report will be available on Grand Canyon National Park's website (www.nps.gov/grca) in the .pdf format.

I. Abstract

Grand Canyon National Park Foundation (GCNPF) received a grant from the Arizona Water Protection Fund (AWPF) to control invasive plants in selected riparian areas within Grand Canyon National Park (GRCA), allowing native plant communities to recover and persist. The grant supports a partnership between GCNPF the National Park Service (NPS) and funds this project through December 31, 2007, with work occurring in 35 areas within GRCA. This report contains the details from the invasive plant control efforts completed to date, with a focus on accomplishments from fall 2006. The AWPF Commission has funded all or a portion of this report.

This work is Phase II-A of a large-scale backcountry invasive plant management project. The primary objectives of this phase of the overall project are to remove tamarisk and other invasive exotic plants from 35 tributaries of the Colorado River in Grand Canyon National Park and to monitor the success of the tamarisk management through pre- and post-removal monitoring. This project will significantly reduce invasive plant distribution within the treated areas and allow native vegetation to reestablish without exotic plant competition. This work is a follow up of the very successful Phase I, also funded by the AWPF, in which crews removed 70,616 tamarisk trees from 70 project areas. The lessons learned during the implementation of Phase I have allowed the project manager to improve upon the management and monitoring portions of the project.

To date, crews have removed 122,880 tamarisk trees including 86,126 seedlings, 27,823 saplings, and 8,931 mature trees from over 324 hectares in 34 of the 35 project sites of Phase II-A. Crews have removed 38,396 square meters of tamarisk canopy cover from the project sites, allowing native vegetation access to critical resources such as nutrients, sunlight and water. This report includes all of the data from the backcountry trips completed in the fall of 2006.

II. Introduction

a. Overview of project status

Grand Canyon National Park's backcountry seeps, springs and tributaries of the Colorado River are among the most pristine watersheds and desert riparian habitats remaining in the coterminous United States. These riparian systems deserve a high level of protection from invasive exotic plants. Grand Canyon National Park Foundation (GCNPF) received a grant from the Arizona Water Protection Fund (AWPF) to control invasive plants at selected riparian areas within Grand Canyon National Park (GRCA), allowing native plant communities to recover and persist. The grant funds a project through December 31, 2007, with work occurring in 35 areas within GRCA. The grant supports a partnership between GCNPF the National Park Service (NPS). This report contains the details from the invasive plant control efforts completed to date. The AWPF Commission has funded all or a portion of this report.

This work is Phase II-A of a landscape-level backcountry invasive plant management project. The primary objectives of this phase of the overall project are to remove tamarisk and other invasive exotic plants from 35 tributaries of the Colorado River in GRCA and to monitor the success of the management actions through pre- and post-removal plant monitoring. This project will significantly reduce invasive plant distribution within the treated areas, allowing native vegetation to reestablish without exotic plant competition. This work is a follow up of the very successful Phase I, also funded by the AWPF, in which crews removed 70,616 tamarisk trees from 70 project areas. The re-treatment data from that phase showed that only 7% of the initially treated trees required follow-up control. The vegetation transect data showed tamarisk cover and frequency reduction by 100% from 2000 (before tamarisk removal) to 2004 (after tamarisk removal) in 20 of the 22 transects installed. The remaining two canyons showed a lower rate of tamarisk cover reduction, one with 93% and the other with 65%. The lessons learned during the implementation of Phase I have allowed the project manager to improve upon the management and monitoring portions of the project.

In February 2002, prior to the initiation of Phase I, the NPS released an Environmental Assessment/ Assessment of Effect for this overall project. Staff received and analyzed public comments and prepared a Finding of No Significant Impact Statement (FONSI), signed by the regional office on June 18, 2002. These documents remain valid and still guide the implementation of this project. The park received a written response to the informal consultation with the U.S. Fish and Wildlife Service (USFWS) on January 25, 2001. That letter, along with the incorporation of their recommended changes, completed the Section 7 consultation required for this project. On April 8, 2002, the State Historic Preservation Officer (SHPO) provided the park with written concurrence on the project moving forward.

Prior to initiation of Phase II-A, Reuben Terán, AWPF project manager, consulted with the SHPO regarding this grant proposal. The response letter stated a determination of "no impact" for the grant but confirmed that the NPS should also consult with SHPO. GRCA superintendent Joe Alston submitted a letter to the SHPO to affirm continuing concurrence on the project, which SHPO confirmed through a letter. The superintendent also sent a letter to the USFWS as a follow-up on the preliminary consultation from 2001. On February 28, 2005, GRCA staff received a letter from

the USFWS stating that Phase II tamarisk management actions "are not likely to adversely affect the southwestern willow flycatcher" since they will occur in areas that are not proposed critical habitat.

By August 2005, project coordinators had acquired the necessary backcountry permits for Phase II-A, completing the final requirements of Task #1 in the grant contract. In addition, following the May 2005 monitoring river trip, the project coordinator revised the Tamarisk Monitoring and Management Plans and re-submitted them to AWPF in order to finalize the deliverables listed under Task #2 of the grant contract.

The Tamarisk Management Plan called for nine backpacking trips, with three to the Phantom Ranch/Bright Angel Creek area and the remaining six to other project sites. The AWPF grant was amended in fall of 2005 to fund an additional twelve backpacking trips, with six to Phantom Ranch/Bright Angel Creek and six to other backcountry project areas. During the fall 2006 season, crews completed eight backpacking trips and one river trip. This report includes all of the data from the backpacking and river trips completed in the fall of 2006.

b. Justification for recent work

Tamarisk (*Tamarix* spp.), commonly known as salt cedar, is an invasive exotic tree that grows in dense stands along rivers and streams in the western United States. Tamarisk, introduced to the U.S. in the 19th century as an erosion control agent, spread throughout the West and caused major changes to natural environments. Tamarisk reached the greater Grand Canyon area during the late 1920s and early 1930s, and became a dominant riparian zone species along the Colorado River following completion of Glen Canyon Dam in 1963. The impacts caused by tamarisk are well documented (refer to Reference Section of the EA/AEF and Stevens 2001). These prolific non-native trees displace native vegetation, create conditions that are inhospitable for the germination of native plant seeds, impact wildlife abundance, and increase fire frequency. Salt cedar is an aggressive competitor, often developing monoculture stands and lowering water tables, which can negatively affect wildlife and native vegetative communities (Duncan 1996). Adapted to a wide range of environmental conditions, tamarisk fills previously unoccupied niches. Once established in an area, it typically spreads and persists.

Distinctive soil types, vegetation, and hydrologic conditions characterize riparian areas, resulting in biologically diverse and productive ecosystems. In the Southwest, riparian areas account for less than 2% of the land, yet over 65% of southwestern wildlife depend on these areas. Riparian habitats are the most productive, most valuable and most threatened habitats in the American Southwest (Johnson et al. 1985). Tributaries and side canyons of the Colorado River, and seeps and springs in GRCA, are worthy of the highest level of protection from non-native plant invasion. The recent encroachment of tamarisk into these tributaries poses a significant threat to the integrity of the natural ecosystems. GRCA and GCNPF are committed to the preservation of native plant communities and native ecosystems (NPS 1995a, NPS 1995b, GCNPF Mission Statement). NPS management policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2001). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on park resources (NPS 1985, NPS 2001). GCNPF's mission is to project and preserve Grand Canyon's irreplaceable natural, cultural and

historic resources while enhancing the visitor experience. The removal of tamarisk from these tributaries protects valuable resources, increases native plant diversity, and provides an excellent opportunity for stewardship through the extensive volunteer program.

III. Methods

a. Area of interest in recent analysis

Under this contract, crews will remove tamarisk from 35 areas within Grand Canyon National Park. The numbers of tamarisk trees found during the preliminary surveys (i.e. feasibility of control at this time) and the extent of the seeps, springs, and riparian habitat found within the project areas were factors in project area selection.

High species diversity, high species density, and high productivity generally characterize riparian areas. Continuous interactions occur among riparian, aquatic, and upland terrestrial ecosystems through exchanges of energy, nutrients, and species. Warren et al. (1982) provided the following description of Grand Canyon riparian areas:

> "Riparian woodlands (or forests) characterized by cottonwood-willow associations are primarily restricted to the larger perennial streams and drainages of the Colorado Plateau region of northern Arizona. The great biological importance and floristic diversity of these cottonwood-willow riparian forests is disproportionate to their limited total area…. Riparian scrub usually occurs along ephemeral or intermittent watercourses (such as desert arroyos), or in narrow canyons which are periodically scoured by floods. Riparian scrub communities are characterized by a broad continuum of vegetative associations that range from mesic vegetation types to xeric growth along desert arroyos (Brown et al., 1980). These arroyos often contain water only one day or less each year and the resulting vegetation is commonly composed of a mixture of facultative riparian species and upland species. This is in contrast to mesic species, which are generally absent from the surrounding uplands…. Side canyons throughout the park with perennial water support riparian vegetation characterized by cottonwood (Populus fremontii) and willow (Salix spp.) which is generally very similar to that found in similar situations throughout northern Arizona (Phillips and Phillips, 1979)…."

Each stream, spring, seep, or dry wash, has a different association of species, depending on environmental features including elevation, permanence of water, substrate, frequency of flooding, and colonization (Warren et al., 1982). Riparian vegetation typically occurs in small, discrete stands or patches. The floristic diversity in wetland and riparian composition is highly variable, but is extremely high when compared to the upland vegetation. Typical stands may consist of broad-leaved deciduous trees in the overstory, with a mixture of shrubs and grasses in the understory. Species typical of drainages with perennial water sources are:

- Fremont cottonwood (*Populus fremontii*)
- Long-leaf brickellbush (*Brickellia longifolia*)
- Catclaw acacia (*Acacia greggii*)
- Willow (*Salix exigua*, *Salix goodingii*)
- Monkey flower (*Mimulus cardinalis*)
- Mesquite (*Prosopis glandulosa*)
- Seep willows (*Baccharis emoryii*, *Baccharis salicifolia*)

Species typical of drainages with dry washes or intermittent water are:

- Catclaw acacia (*Acacia greggii*)
- Baccharis (*Baccharis sergiloides, B. sarathroides*)
- Snakeweed (*Gutierrezia sarothrae*)
- Apache plume (*Fallugia paradoxa*)
- Utah agave (*Agave utahensis*)
- Mormon tea (*Ephedra* spp.)
- Four-wing saltbush (*Atriplex canescens*)
- Fremont cottonwood (*Populus fremontii*)
- Skunkbush (*Rhus trilobata*)
- Red-bud (*Cercis occidentalis*)
- Alkali goldenbush (*Isocoma acradenia*)

Upland species, described below, are also present in these dry or intermittent washes. Trees and shrubs tend to be scattered, but may also form dense thickets. Species composition varies depending on moisture availability, elevation, and geographic location in the canyon. Within the park, tamarisk occurs in the many of the side canyon and tributaries; however, the distribution and density is highly variable.

The vegetation surrounding the tributaries is generally very different from desert scrub communities, which are composed of plant species from three of the four North American desert floras. The Sonoran desert scrub has the highest plant species diversity. A two-season rainfall regime and lack of freezing temperatures characterizes the Sonoran desert. The Mojave desert scrub has higher local species diversity with shrubs as the dominant component. Winter rains and the absence of freezing temperatures characterize this desert. The Great Basin desert receives more winter rain than the Mojave and frequently has severe winter freezes and the lowest diversity of the three (Warren, et al. 1982).

The three deserts within GRCA overlap significantly in distribution, with many species shared among them; however, certain species are characteristic of each community. Big sagebrush (*Artemisia tridentata*), rabbitbrush (*Ericameria* spp.), Mormon tea (*Ephedra* spp.) and a variety of perennial grasses dominate the Great Basin desert scrub. These associations are typically found in the eastern portion of the canyon and comprise the vegetation surrounding some of the upper and middle tributaries. Typical Mojave Desert species include creosote bush (*Larrea tridentata* var. *tridentata*), white bursage (*Ambrosia dumosa*), Mormon tea (*Ephedra* spp.), blackbrush (*Coleogyne ramosissima*), turpentine broom (*Thamnosma montana*), and other species. They most often occur in the central and western portion of the canyon. The Sonoran desert species include brittlebush (*Encelia farinosa*), catclaw acacia (*Acacia greggii*), ocotillo (*Fouquieria splendens*) and desert willow (*Chilopsis linearis*). Sonoran associations occur in the lower portion of the canyons, and many of these species can grow directly in infrequently scoured drainages. The project areas for this grant occur from Colorado River Mile 8 (Badger Canyon) to Colorado River Mile 225.5, covering portions of each of the major desert ecosystems.

b. Project Logistics

Crews completed the invasive plant management work from September through December 2006. During the fall, tamarisk trees are turning golden, losing their leaves, and sending their energy into their roots for their dormancy period, thus herbicide application yields effective control results. Pending weather and logistics, crews will complete the remaining backpacking trips included in this Phase II-A contract and supplemental amendment in the spring 2007 season.

Phase II-A of the invasive plant management work brought with it many new insights and subsequent improvements from lessons learned from earlier experiences with the project. In May 2005, crews surveyed and mapped project areas for tamarisk distribution, and at the same time installed long-term photopoints. During the surveys, crews established 500 meter-long mapping sections in drainages to more consistently estimate tamarisk distribution. The standardized section length makes data collection in the control phase of the project much more straightforward and allows for more standard comparison among project areas.

This phase also marked the beginning of extensive backpacking trips to more remote work areas in addition to two river trips, which introduced a new set of unique challenges. This fall also brought the opportunity to do a third river trip, supported through the Colorado River Fund monies. Tamarisk crew leaders joined with GRCA archeologists to create an itinerary which included tamarisk removal at several key project areas that had not been finished on the previous spring 2006 trip due to their difficult access and heavy tamarisk infestation.

The project leader prepared trip schedules and river trip itineraries, reviewed and approved by park management, prior to each trip (please refer to Table 1. Phase II-A Project Area List, Table 2. Fall 2006 Backpacking Trip Itinerary, Table 3. Fall 2006 Colorado River Fund River Trip Participant List, Table 4. Fall 2006 Colorado River Fund River Trip Itinerary, Table 5. Spring 2007 Proposed Field Schedule for additional Phase II-A areas). The goal of the control work was to target 5 tributaries on fall 2006 river trips (Upper Lava Chuar, Upper Unkar Creek, Boucher and Crystal Creeks and 225 Mile Canyon). Clear and Crystal Creeks are scheduled for work from the river during spring 2007 trip (funded through Phase II-B), and the remaining 6 from trails via backpacking trips (South Canyon Papago, Hance, Grapevine, and Bright Angel Creeks, and Copper Canyon (See Table 5 for Spring Proposed Field Schedule).

The field crew supervisor organized the fall logistics and schedule consisting of seven backpacking trips (one which served as a crew leader training/removal trip) and a 20-day river trip all during a 12-week period. In addition, five other people served as crew leaders (Loren Bell, Steve Till, Melissa McMaster, Kari Malen and Hillary Hudson), all of which were funded by the grant. A sixth crew leader position was an intern, Kelly McGrath, funded by the Grand Canyon National Park Foundation's Eugene Polk Internship. All of the crew leaders that worked on the project last year returned to the project after summer seasonal field work in various places on the Colorado Plateau, and continued to build on their expertise and project knowledge. The fall season kicked off with a crew leader training trip which included a day of orientation to and organization of the program's field gear on the South Rim and three days of tamarisk removal work in Hance Creek. The field crew supervisor organized the training with input from the crew leaders. Training topics included project overview details, data collection updates, crew leader peer evaluations, evacuation and injury reporting, backcountry check-in policy, leave no trace practice, volunteer supervision, and

climbing safety. In addition to program staff, Paul Austin, a GRCA Backcountry Ranger, joined the trip and provided critical training on search and rescue and evacuation protocols, as well as climbing safety. With Paul's help, crew members were able to access additional areas of the Hance Creek drainage with ropes and identify safe routes to access tamarisk populations. During the training, the crew leaders discussed the need for a structured peer evaluation technique in order to facilitate constructive criticism from co-leaders and the field supervisor about their performance (Appendix D. Project forms).

The backpacking trips were seven to eight days long and consisted of eight people, including six volunteers and two crew leaders. The backpacking tamarisk control trips continue to pose great challenges for the crew. The first is carrying the tools and herbicide required to perform tamarisk control in remote locations in addition to the standard 40 pounds of gear needed for a standard backpacking trip. The second is finding a constant supply of 6 hearty volunteers to share the heavy work load for a week at a time. For project areas in the main trail corridor (i.e. Bright Angel Creek, Pipe Creek), NPS and Xanterra mule strings transported tools, food, and herbicide, which cut down on the weight that individuals had to carry. At Grapevine, Hance and Clear Creeks, all accessed via remote trails, crews were able to stash gallons of herbicide from the river, or via packing operations, cutting down on the distance that crew leaders had to carry jugs of herbicide and tools. Despite efforts to cut down on tools and gear, the main challenge of the backpacking trips is the extremely heavy packs that crew leaders and volunteers must carry in order to make the project possible. Trips are generally eight days long, which in most cases allows for only four and sometimes five solid days of work, including hiking and driving time. Days begin early with breakfast at 6:30 and crews heading off to work by 7:30. The workdays ended at about 4:30 or 5:00, leaving the crew the task of making dinner in the rapidly approaching darkness and cold. The long workdays and extensive trail commutes did not hamper the spirits of the volunteer participants, as they are a stalwart, dedicated cadre of individuals.

Due to the remoteness of Grand Canyon's terrain, it is necessary to access the majority of the project areas from the Colorado River. The original funding called for two 20-day river trips, however there were areas that remained unfinished, due largely to the long distance from the river and the extent of tamarisk infestation. The Colorado River Fund sponsored an additional 14-person November 2006 river trip that launched from Lees Ferry and took out at Diamond Creek, with boatman and gear provided by Arizona River Runners (ARR). AWPF funds covered the cost of the field crew leaders, but none of the other river trip related expenses. The 19-day trip length was to allow for sufficient time to access and work in canyons on the itinerary, including two overnight spike camps.

The ARR crew provided excellent meals and logistical support, as well as physically helping to get the work done. Accomplishments include removing tamarisk from six side canyons including Upper Lava Chuar, Upper Unkar, Boucher, Crystal from the Phase II-A project list and Topaz and Granite Park from the Phase II-B project list. The weather was great and allowed the crews to visit all scheduled project areas. The crews also accessed the upper portions of Lava and Unkar Canyons through overnight spike camps 6 miles from the river, from where they completely removed every tamarisk tree from the spring below Angel's Window in Unkar. The hard-working spike crew was rewarded with the magical experience of waking up in the darkness to boil water, watching the sun rise and ignite the rock walls in shades of rose, and sipping coffee as the waning full moon set

behind Angel's Window. The November 2006 CRF crew removed 1,017 seedlings, 2,080 saplings and 1,082 mature trees on the trip, an enormous accomplishment! Two seasoned tamarisk backpacking volunteers joined the ranks on the upper half, ARR paid two workers who cut tamarisk full time, and most work days we had the entire help of the boatmen as well. The trip was one of the more successful as all participants enjoyed each other, the project, and their time in the Grand Canyon.

Table 1. Phase II-A Project Areas List and Status of Completion

			Preliminary Tamarisk Survey Numbers						
River Mile	River Side	Canyon Name	Seedling	Sapling	Mature	SW IFL Habitat Assessment Complete	Transect Area	Work Done	Work Scheduled 2007
8	R	Badger Canyon	3	18	25	X		X	
31.6	R	South Canyon - Lower	Unknown	Unknown	Unknown	X			X
31.6	R	South Canyon - Upper	100+	100+	100+	X	X	X	
36.5	R	36.5 Mile wash	65	50	30	X		X	
47.2	R	Saddle Canyon	0	67	0	X		X	
51.8	R	Little Nankoweap Creek	0	0	0	X		X	
52	R	Nankoweap Creek – Lower	372	609	486	X	X	X	
52	R	Nankoweap Creek - Middle	100+	100+	100+	X	X	X	
52	R	Nankoweap Creek - Upper	100+	100+	100+	X		X	
56.2	R	Kwagunt Creek - Upper	100+	100+	100+	X		X	
64.7	R	Carbon Creek – Upper	100+	100+	100+	X	X	X	
65.5	R	Lava Chuar– Upper	100+	100+	100+	X		X	
70.2	L	Cardenas Hillside Spring	Unknown	Unknown	Unknown	X		X	
70.8	L	70.8 Mile Drainage	Unknown	Unknown	Unknown	X		X	
72.3	R	Unkar Creek – Lower	641	262	270	X	X	X	
72.3	R	Unkar Creek – Upper	100+	100+	100+	X		X	
76	L	Papago Creek	0	1	0	X			X
76.6	L	Red Canyon	Unknown	Unknown	Unknown	X		X	
78.6	L	Hance Creek	Unknown	Unknown	Unknown	X			X
80.5	L	Cottonwood Creek	Unknown	Unknown	Unknown	X		X	
81.5	L	Grapevine Creek	Unknown	Unknown	Unknown	X			X
82.8	L	Boulder Creek	Unknown	Unknown	Unknown	X		X	
84	R	Clear Creek – Upper	Unknown	Unknown	Unknown	X		X	
88	R	Bright Angel Creek and Phantom Creek	100+	100+	100+	X	X		X
88	R	Transept Canyon	Unknown	Unknown	Unknown	X		X	
89	L	Pipe Creek	1	173	244	X		X	
89	L	Pipe Creek – Upper	Unknown	Unknown	Unknown	X		X	
89	L	Garden Creek	4	0	1	X		X	
96.7	L	Boucher - Upper	Unknown	Unknown	Unknown	X		X	
98	R	Crystal Creek	100+	1000+	100+	X	X		X
110	L	Copper Canyon	19	5	10	X			X
112	L	112 Mile Wash	0	3	0	X		X	
130	R	130 Mile Creek	0	8	15	X		X	
219	R	Trail Canyon	50	25	275	X	X	X	
225.5	R	225 Mile Canyon	Unknown	Unknown	Unknown	X		X	

Table 2. Fall 2006 Backpacking Trip Itinerary

Trip Dates	Trip Leaders	# of Volunteers	Project Area
September 8-11	Crew leader training	0	Hance Creek
September 27-October 1	Melissa, Kelly	3	Grapevine Creek
October 9-16	Melissa	6 EPMT[1]	Upper Bright Angel Creek
October 24-31	Steve and Loren	6	Upper Bright Angel Creek
October 30-November 6	Melissa	6 EPMT[1]	Upper Bright Angel Creek
November 8-14	Steve	4	Upper Clear Creek
December 6-12	Steve, Kelly	6	Bright Angel Creek / Phantom Canyon

[1]EPMT = Exotic Plant Management Team, NPS funded crew

Table 3. November 2006 Colorado River Fund Trip Participant List

Role	Upper Half	Lower Half
ARR boatman	Mark Pillar	Mark Pillar
ARR boatman	David Sherman	David Sherman
ARR boatman	Lyndsay Hupp	Lyndsay Hupp
ARR boatman	Travis Vercammen	Travis Vercammen
ARR boatman	Christina Parker	Christina Parker
Cook	Ken Gouff	Ken Gouff
Veg. project leader	Kate Watters	Kate Watters
Veg. project leader	Kelly McGrath	Kelly McGrath
Veg. project leader	Rachel Stanton	Rachel Stanton
Veg. volunteer	Dean Wadsworth	Vacant
Veg. volunteer	Jess Page	Vacant
Arch. project leader	Jen Dierker	Vacant
ARR worker	Josh Macnaughton	Josh Macnaughton
ARR worker	Deanna Sanderson	Deanna Sanderson

Table 4. November 2006 Colorado River Fund Trip Itinerary

Date	Day	River Mile	Work Location	Project(s) (Reference RPT Projects and Impacts Table)	Camp (mile)
Nov 1	1		Various	Arch Site Monitoring	20.5 North Canyon
2	2		Various	Arch Site Monitoring	44 Eminence
3	3		Various	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	65.5 Lava Chuar
*4	4	65.5	Upper Lava Chuar	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Lava Chuar Spike camp
5	5	"	Upper Lava Chuar	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Lava Chuar
6	6	"	Upper Unkar	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Unkar
*7	7	69	Upper Unkar	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Upper Unkar Spike camp
8	8		Transit Stop at Papago	PHANTOM RANCH - EXCHANGE	Salt Creek
9	9	96.5	Boucher	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	96.5 Boucher
10	10	"	Boucher Creek	"	Boucher
11	11	"	Crystal Creek	"	Crystal (99 mile)
12	12		Crystal Creek	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Crystal (99 mile)
13	13	123	Copper Canyon (110 L)	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	123 Mile

Date	Day	River Mile	Work Location	Project(s) (Reference RPT Projects and Impacts Table)	Camp (mile)
14	14	151		“	151 Upper Ledges
15	15	183	“	“	183 mile
16	1\6	202	Various	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	202
17	17	209	Ravenna removal: Spring and 205 mile (right)	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	209
18	18	225	Granite Park	Camp and attraction site monitoring, arch site inventory and monitoring and some mitigation, invasive plant management, vegetation inventory and survey, photodocumentation	Diamond Creek
19	19			TAKE OUT	

Table 5. Spring 2007 Proposed Field Schedule

Trip Dates	Trip Leaders	Project Area	Work Project	Total Participants
January 17-23	Steve*, Kelly	Phantom Canyon	Invasive Plant Mgmt, Photodocumentation	6 volunteers, 2 crew leaders
January 31-February 7	Steve*, Loren	Bright Angel Creek	Invasive Plant Mgmt, Photodocumentation	6 volunteers, 2 crew leaders
February 8-14	Melissa	Grapevine Creek	Invasive Plant Mgmt, Photodocumentation	4 volunteers, 1 crew leader
February 17-24	Kate,*Melissa	Papago Canyon	Invasive Plant Mgmt, Photodocumentation	6 volunteers, 2 crew leaders
March 6-12	Melissa	Hance Creek	Invasive Plant Mgmt, Photodocumentation	4 volunteers, 1 crew leader
February 16 – March 7	Loren, Kari, Steve, Kelly	Clear Creek, Crystal Creek	Invasive Plant Mgmt, Photodocumentation	10 NPS, 4 Hualapai, 2 volunteers
March 11-17	Loren*, Kelly	Copper Canyon	Invasive Plant Mgmt, Photodocumentation	6 volunteers, 2 crew leaders
March 12-16	Steve*	South Canyon-Lower	Invasive Plant Mgmt, Photodocumentation	4 volunteers, 1 crew leader

* Indicates overall leader responsible for project data and logistics

c. Invasive plant management methods and conditions

After incorporation of public comments into the Environmental Assessment / Assessment of Effect (EA/AEF) document, which is required under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA), project managers selected the final control methods. For this project, staff use a combination of methods including mechanical, chemical, and cultural (i.e. seeding). The field crew leaders selected the methods for each project location based on site characteristics and weather conditions. A brief description of each method follows:

Manual Removal

Crews use this method to remove tamarisk seedlings (and sometimes larger trees) in washes, streambeds, and non-sensitive areas, and to control other invasive species such as horehound (*Marrubium vulgare*), Himalaya blackberry (*Rubus discolor*), Ravenna grass (*Saccharum ravennae*), Sahara mustard (*Brassica tournefortii*), puncture vine (*Tribulus terrestris*), silverleaf nightshade (*Solanum elaeagnifolium*), sowthistle (*Sonchus* spp.), and prickly lettuce (*Lactuca serriola*). Workers use geology picks and shovels to loosen the soil surrounding the plants and then remove the entire root system, or at least to below the root crown.

Girdle Method

Crews use hand saws, bow saws or hatchets to cut several centimeters into the water-conducting tissue (phloem) of standing trees, with the cut within one meter of the ground surface (usually within 20 cm) and fully meeting at the ends. Using hand-pressurized sprayers, herbicide applicators then apply the chemical directly into the cut and onto the bark from the cut to the base of the tree.

Cut Stump Method

Crews cut the tree trunks near ground level with handsaws and then spray the cut surface with herbicide. The tree's phloem absorbs the mixture and transports it to the roots, with quick application increasing the effectiveness. Pressurized hand sprayers allow precision herbicide application with minimum overspray or drift risk. Crews extensively use this method alone and in combination with girdling.

Basal Bark Application

With this method, herbicide applicators spray the entire stem from near ground level up to about 40 cm. They apply the herbicide with hand held pressurized sprayers, which have small nozzles and coarse spray settings that allow for direct spraying with minimal drift or overspray. This method is much less labor intensive, but is less effective on mature trees so limited use on smaller saplings and seedlings occurs, often in combination with other methods.

Mitigation Measures

The following specific measures apply to all methods used for the project:

- Debris is disposed of to minimize visual impact (i.e. off trail, out of the drainage).
- Cut stumps are hidden from view to the extent possible.
- Soil is tamped where manual removal is used to help minimize establishment of other invasive exotic species and to minimize visual impact.
- Tree cuts are made on tree sides least visible to backcountry users.
- When pruning, a minimal number of branches are cut to minimize visual impact.

Much of the debris remains on site to decompose and provide habitat for wildlife. Crews minimize the visual impacts of the project by employing a combination of control methods at each project site and being aware of the visibility of the cuts and girdles.

Herbicide Use

The herbicides used for control were triclopyr-based general use herbicides. Crews used Garlon® 4 and Tahoe® 4E in a mixture of 25% with 75% methylated soybean oil (MOC). They used Garlon® 3a mixed with 50% water in treatment areas in close proximity to water. The application tool is a 32-ounce stainless steel sprayer, pressurized with bicycle pumps. These sprayers are virtually indestructible, easy to repair in the field, and are light and well suited for the backcountry conditions the Grand Canyon offers.

Pesticide certification is not required for the application of any of these herbicides; however, park vegetation staff adopted the policy of having trained and certified applicators on site during application. During these trips, the project leader and all field crew leaders had Arizona State pesticide certification. All project participants received herbicide orientation and training from the project leader. Project participants understood and abided by the established Personal Protective Equipment (PPE) requirements and rules outlined in the safety plan for the project. Rubber gloves, long sleeve shirts, long pants, and eye protection were part of the PPE necessary for this project. All

project participants reviewed the job hazard analyses (JHAs) for exotic plant removal and herbicide application.

Project participants followed all information and instructions on the herbicide label. All herbicide containers were leak- and spill resistant. This year the field crew supervisor purchased fluorinated high density polyethylene plastic jugs in various sizes to cut down on the chance of leaks and spills, especially since the containers are hauled in backpacks, on boats and by mules. All application equipment and chemicals were stored in sealed ammunition cans or large silver boxes during transport on rafts and pack mules, and all storage containers had the product's specimen label and the Material Safety Data Sheet (MSDS) clearly displayed underneath a waterproof plastic sheet. The MSDS contains fire and explosive hazard data, environmental and disposal information, health hazard data, handling precautions, and first aid information. All trip participants reviewed the MSDS with the project leader and understood the first aid instructions described on the MSDS. One boat contained all herbicide and application equipment, herbicide containers, and PPE disposal containers, isolated from food and personal items. On backpacking trips, herbicide containers are only carried by crew leaders in heavy duty plastic dry bags which are strapped to the outside of backpacks.

d. Analysis of methods and tests

Although current scientific literature documents successful control methods for tamarisk, refinement to the methods continue to occur in Grand Canyon's remote backcountry areas. Please refer to Appendix A (Representative Project Photographs) for visual examples of methods and field crews at work. Other parks, agencies and non-profit organizations learn about these methods through outreach and education.

During the fall of 2006, the field crew leaders continued to improve upon the South Rim storage area where all of the project equipment, herbicide and gear are stored in a locked trailer. Although the methods and tools are paramount to completing tamarisk removal, the quality of food eaten while working is also crucial to the project's success. The crew supervisor created packing lists, menus, and food purchase lists with feedback from crew leaders and volunteers in order to streamline the trip preparation process. The field crew supervisor also purchased bulk food for backpacking trips in order to supplement the backpacking trip menus. The Polk Intern vastly improved the backpacking trip menu during her tenure as well as organized the bulk food area. The volunteers rave about the food provided on the backpacking trips!

The biggest challenge with the control methods continues to be the lack of availability of good, inexpensive sturdy replacement blades for the hand saws. Despite fact that the experimentation with various qualities of hand saws, the winner every time is the little green folding saw. The replacement blades are almost as expensive as the saw itself, and they bend and break easily. It is not possible to sharpen the blades, so we had to purchase new saws this fall, as well as countless blades. The productivity and morale of volunteer workers plummets in the face of dull blades, so the project tries to keep spares on hand on every trip.

IV. Results

a. Results of recent data collection

Tamarisk Control Results

During the fall of 2006, crews removed 12,529 tamarisk trees including 5,088 seedlings, 5,008 saplings, and 2,433 mature trees (Table 6. Tamarisk Control Summary, Figure 1. Tamarisk Treatment by Size Class). On each trip and at each project site, crew leaders analyzed the site and determined which control methods to use (Figure 2. Tamarisk Treatment by Method). Crews removed 9,799 square meters of tamarisk canopy from a total of 76 hectares of infested lands within the project sites.

Table 6. Tamarisk Control Summary

	SIZE CLASS			CONTROL METHOD					AREA TREATED	
Canyon Name	Seedlings	Saplings	Mature	Pulled	Cut / Girdle Combo	Girdle	Basal Bark	Cut Stump	Canopy Cover (m2)	Area Infested (m2)
225 Mile	91	112	23	92	0	0	0	134	75	25000
Boucher Creek	196	183	69	16	0	0	0	432	105	32500
Bright Angel Creek	429	792	442	43	2	0	0	1618	2004	246800
Clear Creek	14	59	36	0	0	0	0	109	250	65000
Crystal Canyon	128	1058	605	38	1	0	0	1752	1944	45000
Grapevine	165	61	72	154	0	0	0	144	365	50800
Hance	2449	197	85	2602	1	0	0	128	540	15900
Lava Chuar	66	80	83	27	0	0	0	202	318	37500
Monument Creek[1]	451	294	20	448	0	0	0	314	162	10000
North Canyon[1]	3	0	0	3	0	0	0	0	1	5000
Phantom Canyon	121	224	90	0	0	0	0	435	454	15000
Transept	753	1521	665	0	3	0	0	2946	2819	143000
Unkar Creek	222	427	243	0	0	0	0	892	742	72000
TOTALS	5088	5008	2433	3423	7	0	0	9106	9779	763500

[1] Monument Creek and North Canyon are Phase I project areas; crews with extra time revisited these sites and completed follow-up maintenance of the areas.

Figure 1. Tamarisk Treatment by Size Class

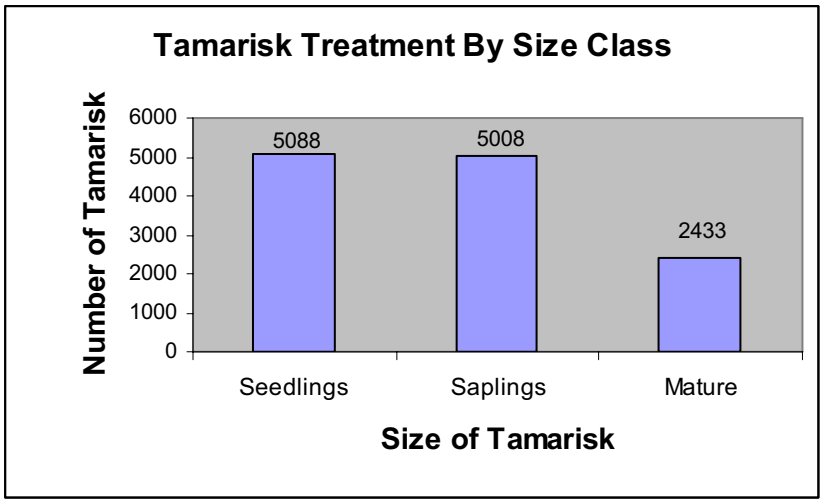
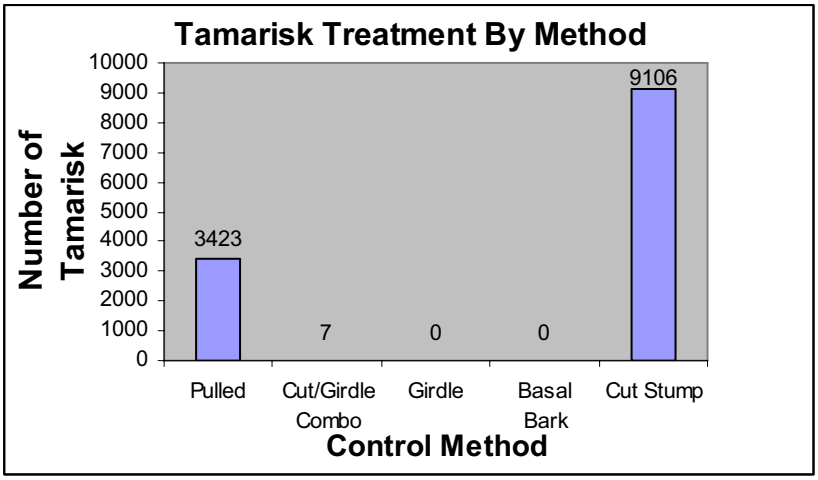


Figure 2. Tamarisk Treatment by Method



During the fall of 2006 crews worked in 11 of the 35 project areas for Phase II-A and completed work at 4 areas (Lava Chuar, Unkar Creek, Transept Canyon, 225 Mile Canyon). Refer to Appendix C, Project Mapping, for maps of these work locations. With extra time in nearby areas, crews also visited Monument Creek and North Canyon, both Phase I project areas, and retreated the sites. The final report will include detailed maps displaying the work completed in each project area, the transect locations, a complete suite of photopoint locations, and supplemental project data.

Crews have completed follow-up control work in many areas, yet in several areas, the work required much more labor than predicted. Most of the sites, regardless of level of completion will require follow-up work in the form of seedling control, which will be completed with supplemental funding sources. The following sites, due to extensive populations, weather, or lack of time, will require additional visits and control implementation, which are scheduled for spring 2007:

- Clear Creek
- Upper Bright Angel Creek / Phantom Canyon
- South Canyon
- Hance Creek
- Grapevine Creek
- Crystal Creek
- Papago Creek
- Copper Canyon

Crews were able to complete work in Upper Lava Chuar and Unkar Creeks, both of which required a 6 mile hike up the drainage one way to an overnight spike camp. Crews were able to finish 225 Mile on the fall Phase II-B Hualapai Partnership river trip because the other project areas were finished early with a day left until takeout. The entire upper section of Clear Creek is finished, leaving one day of work from the river in the lower portion, which will be completed by a small crew of boatmen and field crew leaders on the February 2007 Hualapai Partnership river trip before meeting the project participants at Phantom Ranch. Upper Bright Angel Creek is nearing completion with the entire upper section above Cottonwood Campground finished, as well as several major tributaries including Transept, Wall, and Manzanita Creeks. One trip is scheduled to complete the area between Cottonwood downstream to where crews worked from Phantom Ranch last fall. One additional trip is scheduled to complete the upper portion of Phantom Creek, which will be reached via backpacking from the Phantom Ranch Bunkhouse. Hance and Grapevine Creeks were revisited this fall, but work was not completed. Both areas require a 4 mile hike one way from the base camp in order to access the last sections with tamarisk. Both canyons are scheduled for spring 2007 trips and crews should be able to finish the work. South Canyon is also scheduled for spring 2007, as an evacuation of a participant last spring hampered efforts to complete it at the time. Crystal Creek is an enormous undertaking due to the extensive tamarisk distribution, the length of the canyon, and its accessibility only by river. On the November 2006 river trip, crews worked two long days at Crystal and were able to complete the first 500 meter section, which was the densest in the entire drainage. Crews were not able to access the upper portion of Papago Creek, but will revisit the lower portion during spring 2007 via a backpacking trip. Crews have already removed sowthistles from the lower portion of Copper Canyon, but were not able to get above steep pourovers, so tamarisk distribution is unknown. During the fall 2006 river trip they attempted to access the upper portion of this drainage to remove tamarisk, but it was unsafe to access via the river. A spring backpacking trip via the Bass trail and Tonto trails, with herbicide stashed at the river, will hopefully allow crews to finish this canyon.

Herbicide Use

The amount of herbicide used during the fall of 2006 was a total of 22.48 gallons of mixed herbicide applied in the project sites and only 6.57 gallons of actual herbicide product used (Table 7. Herbicide Use).

Table 7. Herbicide Use

Common Name	Scientific Name	Herbicide Type	Mixed Herbicide Used (gallons)	% Herbicide in Mixture	Actual Herbicide Used (gallons)
Tamarisk	*Tamarix ramosissima*	Garlon ® 3a	3.85	50	1.92
Tamarisk	*Tamarix ramosissima*	Garlon ® 4	18.07	25	4.51
Tamarisk	*Tamarix ramosissima*	Tahoe ® 4E	0.56	25	0.14
Herbicide Totals			22.48		6.57

Volunteer Summary

Volunteers are crucial to project's success and accomplishments. Volunteers donated a total of 1,592 hours to the tamarisk and invasive species management portion of this project during the fall of 2006 (Table 8. Volunteer Contribution to Project). The hours are broken down into 1406 hours during the backpacking trips and 186 hours to the river trips. These hours are valued at $17.50 per hour according to NPS guidelines, for a total matching contribution to the management portion of this project of $27,860.

During the fall of 2006, great strides were made in the realm of volunteer recruitment, as GCNPF hired Terra Crampton as the volunteer coordinator in May 2006. Terra is very meticulous and has made significant contributions to the volunteer recruitment and paperwork process and has also improved communications with the park's volunteer coordinator, Lisa Collins. Terra and the crew supervisor worked to refine and downsize the amount of paperwork volunteers have to complete before each trip, based on input from volunteers and crew leaders. All but two of our trips were full to capacity with prepared and enthusiastic volunteers, which was a vast improvement from last spring. Terra was also able to recruit several college groups for backpacking trips. Terra will be moving into a fundraising position with GCNPF this winter/spring and her efforts and dedication will be missed. GCNPF will be utilizing the talents of a new person who will take on the time intensive duties of recruiting, contacting and preparing volunteers for backpacking trips this spring.

Vast improvements continue to be made in the shared GCNPF and Grand Canyon Trust (GCT) website (http://www.gcvolunteers.org), which has information about each trip and allows volunteers to apply online. The grant provided funds to give uniquely designed tee shirts to volunteers who donated their time on backpacking or river trips, as a small token of the many hours of hard labor they contributed. The dedication and perseverance of all of the volunteers was amazing and contributed to the overall success of the project. GRCA staff and crew leaders are constantly amazed by the positive influence volunteers have on the Backcountry Vegetation Program. Besides

the fact that this daunting project would not be feasible without them, volunteers also provide endless support emotionally and sometimes financially to the success of our program. Here are a few quotes from Backcountry Vegetation Program Volunteers from the fall 2006 season:

"Steve did a wonderful job with the tamarisk project this past week and I wanted to let you know how knowledgeable and energetic he was in providing the group with a well rounded and very rewarding experience. He is a great asset to the program. I finally made a tammy trip and it was well worth it." — Dan Shein

"The trip was GREAT! Even day one, which was a bit of a chore getting from the rim to the upper end of Grapevine, was enjoyable. First off, Melissa and Kelly were excellent. There were very competent, hardworking (our meals were very good), and a lot of fun to work with. I had not been in the GC for any length of time before this trip, and thoroughly enjoyed getting a bit 'off trail' during our work days in Grapevine Canyon. It was a beautiful canyon to work in.

We got a lot of tamarisk cleared, but one more day, I think, would have allowed us to completely clear Grapevine. Due to the location of the work, a lot of time was spent going to and from the work site. Still, we got down to the final pour-over above the river and worked back, so the lower, more difficult section to access, is cleared. I think it was a pretty successful trip, tammy-wise.

So... again, it was a great trip and I'd love to go back for another in the spring, if possible. Extend my sincere thanks to Melissa and Kelly for the work they did to make this such a fun experience." — Lou Lorber

"Loren and Steve interacted very well, professionally and personally with our group of volunteers. They were polite, friendly, inclusive and fair with us in every way I observed. They are both bright and knowledgeable, and they taught and led us well in how and why we were doing what we did. As a plant/riparian biologist, I have performed tamarisk research resulting in my co-authoring several peer-reviewed scientific publications. I tried, but don't believe I added any information of substance beyond what Loren and Steve presented to the group about the species, its biology and management. They explained the eradication activities well, and emphasized safety. Loren and Steve are upbeat people who really appear to enjoy their work. Their enthusiasm and ability to pass that to others helped make the time very enjoyable. The tamarisk eradication program in the Grand Canyon appears to me to be successful and in excellent hands." — Scott Miles

Table 8. Volunteer Contribution to Project

Name	Work Project	Start Date	End Date	Hours
Joel Barnes	Tamarisk River	9/5/2006	9/22/2006	9
Jason Sather	Tamarisk River	9/5/2006	9/22/2006	6
Crystal Winn	Tamarisk River	9/5/2006	9/22/2006	6
Will Nunez	Tamarisk River	9/5/2006	9/22/2006	6
Jordan Ford	Tamarisk River	9/5/2006	9/22/2006	6
Sam Haverstock	Tamarisk River	9/5/2006	9/22/2006	6
Adele Wiejaczka	Tamarisk River	9/5/2006	9/22/2006	9
John Dietrich	Tamarisk River	9/5/2006	9/22/2006	6
Laura Prosseda	Tamarisk River	9/5/2006	9/22/2006	6
McNeill Mann	Tamarisk River	9/5/2006	9/22/2006	6
Alexandra Suahara	Tamarisk River	9/5/2006	9/22/2006	9
Robert McGillicuddy	Tamarisk River	9/5/2006	9/22/2006	9
Jared Silverman	Tamarisk River	9/5/2006	9/22/2006	6
Sam Tischler	Tamarisk River	9/5/2006	9/22/2006	6
Rian Ashford	Tamarisk River	9/5/2006	9/22/2006	9
Jess Page	Tamarisk River	11/4/2006	11/7/2006	39
Dean Wadsworth	Tamarisk River	11/4/2006	11/7/2006	42
Dawn Goldman	Tamarisk Backpacking	9/27/2006	10/1/2006	49
Lou Lorber	Tamarisk Backpacking	9/27/2006	10/1/2006	54
Danny Miller	Tamarisk Backpacking	9/27/2006	10/1/2006	54
Kelly McGrath	Tamarisk Backpacking	9/26/2006	10/2/2006	57
Bob Cheesman	Tamarisk Backpacking	10/9/2006	10/13/2006	47
Kelly McGrath	Tamarisk Backpacking	10/8/2006	10/16/2006	87
Olivia Rathbone	Tamarisk Backpacking	10/24/2006	10/31/2006	74
Anne Madsen	Tamarisk Backpacking	10/24/2006	11/1/2006	76
Scott Miles	Tamarisk Backpacking	10/23/2006	11/1/2006	82
Lisa Neiro	Tamarisk Backpacking	10/23/2006	11/1/2006	76
Bob Cheesman	Tamarisk Backpacking	11/4/2006	11/6/2006	32
Talise Dow	Tamarisk Backpacking	11/8/2006	11/14/2006	69
Susan McIntyre	Tamarisk Backpacking	11/8/2006	11/14/2006	69
Dan Shein	Tamarisk Backpacking	11/8/2006	11/14/2006	69
Val Malutin	Tamarisk Backpacking	11/8/2006	11/14/2006	69
Robert Koppe	Tamarisk Backpacking	12/6/2006	12/12/2006	82
Travis Wiggins	Tamarisk Backpacking	12/6/2006	12/12/2006	62
Kenneth	Tamarisk Backpacking	12/6/2006	12/12/2006	62
Gouff	Tamarisk Backpacking	12/5/2006	12/13/2006	82
Kristine Klewin	Tamarisk Backpacking	12/5/2006	12/13/2006	72
Dean Wadsworth	Tamarisk Backpacking	12/5/2006	12/13/2006	82
	Total Volunteer Hours Backpacking Total			1406
	Total Volunteer Hours River			186
	Total Volunteer Hours Combined Total			1592
	Value of Donated Volunteer Hours			$27,860.00

Project Monitoring

A large element of this project is the long-term monitoring, which will help to display the success of this project. Please refer to the revised and approved monitoring plan for the overall design and implementation scheme. Skilled crews installed the majority of the monitoring components on the May 2005 river trip, with a few follow up backpacking trips to complete this portion of the project. The monitoring components include vegetation, soil and hydrological sampling in 25% of the project areas. This spring crews revisited monitoring transects in 4 of the 7 project monitoring areas (South Canyon, Carbon Creek, Bright Angel Creek and Trail Canyon).

South Canyon and Bright Angel Creek were accessed in April 2006 via backpacking trips with one leader and 2-3 volunteers each. Carbon Creek and Trail Canyon were reread on the May 2006 river trip. NPS staff entered these data into the project database. Transects in Nankoweap, Unkar and Crystal Creeks will be revisited in May 2007. All associated transect information for Phase II-A canyons will be included in the final report.

In each project area, crews also mapped tamarisk populations, completed habitat assessment for southwestern willow flycatchers, and installed permanent photopoints. On the spring 2006 trips, crews installed additional photopoints. To date, crews have taken more than 400 distinct photographs (this does not include transect photopoints) in the project areas, each taken pre- and post-work photographs. With input of the field crew, the field crew supervisor revised and improved upon the existing photodocumentation form. Appendix B displays all of the photodocumentation for the project areas that were visited in fall 2006. A complete set of photographs will be submitted with the final report.

Wildlife Observations

During Phase II-A of the project, crews initiated the collection of wildlife activity at all of the project areas. Crews recorded observations of wildlife species (including mammals, birds, insects, reptiles and amphibians) by common name and a description of the activity (Table 9. Wildlife Observations). This qualitative data on wildlife species presence in project areas will provide distribution information to park wildlife biologists.

Table 9. Wildlife Observations

Date	Observer	Location	Wildlife Species	Activity
9/9/2006	Kate Watters	Hance Creek	Scorpion	Under tamarisk duff.
9/10/2006	Steve Till	Hance Creek	Red spotted toads	Everywhere and tadpoles too.
9/10/2006	Kari Malen	Hance Creek	Centipede	Crawling under tamarisk.
9/9/2006	Kate Watters	Hance Creek	Tarantula	Walking by the creek among the cobbles.
9/10/2006	Melissa McMaster	Hance Creek	Collared lizard	Crawling around in a Brickellia shrub.
9/10/2006	Kate Watters	Hance Creek	Bats, unknown species	Flying low catching insects at dusk above the creek.
9/29/2006	Melissa McMaster	Grapevine	Water ouzel	Dipping for food in the creek.
9/28/2006	Melissa McMaster	Grapevine	Red spotted toads	Jumping across the creek.
9/30/2006	Melissa McMaster	Tonto Trail	Raven	Stealing food. Unzipping backpacks to search for food.
10/10/2006	Melissa McMaster	Bright Angel	Kingfisher	Flying up canyon.
10/10/2006	Melissa McMaster	Roaring Springs Bunkhouse	Ringtail cat	Peeking in backpacks.
10/12/2006	Melissa McMaster	Bright Angel	Flickers (6-10)	Flitting about the creek in trees.
10/12/2006	Melissa McMaster	Roaring Springs Bunkhouse	Flicker	In a tree.
10/25/2006	Olivia Rathbone	Bright Angel	Deer	Trotting down the hill.
10/26/2006	Steve Till	Bright Angel	American dipper	Bobbing and dipping.
10/28/2006	Steve Till	Bright Angel	Fish	About 12" long and swimming.
10/31/2006	Melissa McMaster	Transept	Fish	Flopping around on a rock.
11/2/2006	Melissa McMaster	Transept	Mule deer (5-3 does, 2 bucks)	Feeding on hillside.
11/1/2006	Brennan Hauk	Bright Angel	Bighorn (2 females)	High on creek left across from the campground.
11/2/2006	Melissa McMaster	Transept	Water ouzel	Dipping for food in the creek.
11/2/2006	Melissa McMaster	Transept	Grasshopper	On a rock with little rhombuses on their backs.
11/1/2006	Melissa McMaster	Cottonwood Campground	Skunk	Hiding under a rock in camp.
11/1/2006	Melissa McMaster	Cottonwood Campground	Ringtails	Jumping from bushes on to the hanging poles and unzipping packs.
11/3/2006	Melissa McMaster	Transept	Rock wren	Calling from the creek bed.
11/4/2006	Melissa McMaster	Transept	Flicker	In a tree, diving at folks who got too close.
11/5/2006	Brennan Hauk	Transept	Beaver dams	In the creek.
11/5/2006	Kate Watters	Lava Chuar	Spotted toads	Lounging in pools.
11/6/2006	Kelly McGrath	Lava Chuar	Flickers	Flying and landing on cut stumps.
11/6/2006	Kate Watters	Lava Chuar	American dippers	Bobbing and dipping, flying and calling.
11/7/2006	Kate Watters	Unkar	Great horned owl	Sitting on a ledge, watching.
	Kate Watters	Unkar	Deer	Grazing.
11/9/2006	Kelly McGrath	Topaz	Bighorn (2)	Walking.
11/11/2006	Kate Watters	Crystal	Falcon, Centipede	Flying and hanging out in tamarisk duff.
11/10/2006	Mark Pillar	Boucher	Road runner, tarantula	Walking along the creek.
11/9/2006	Kate Watters	Topaz	Tarantulas	Cruising slowly.

All of the data, including links to the photographs, are included in the project database. As another project matching contribution, NPS personnel and contract employees continue to work on the database design and development, with completion of the final version expected by March 2007. The current version of the database and all project data, except for the photographs which increases the size to well-beyond compact disk capacity, are included on the report disk. To access the database, click on the grca.mdb file. The final report for this project will include a full complement of the data for this project and will be submitted in the DVD format so that all of the project photographs are available to AWPF staff. At this time, a full copy is available upon request, assuming that project staff can borrow a DVD burner.

b. Project Matching Contribution

In addition to the volunteer contribution, there has been in kind and financial support from the NPS. For the months of September through December 2006, a total match of $44,895 was contributed to this project.

Grand Canyon National Park provided contributions to this project by paying for the base salaries of staff members, leaving only the overtime to be paid for by this grant. The GRCA ranger division provided Paul Austin and the Trails division continues to provide supplemental packing support during their routine runs to Indian Gardens and Phantom Ranch. The NPS Exotic Plant Management Team (EPMT) provided additional field crew leadership on two trips to Upper Bright Angel Creek, in addition to the crew provided by the Coconino Rural Environmental Corps (CREC). For the first year since the project's inception, GRCA provided $25,000 of supplemental support for the Backcountry Vegetation Program projects. A portion of these funds have been used to date to support Kate Watters as the field supervisor, which, in combination with the AWPF funds, allowed Kate to have more non-field time to coordinate the project activities. The funds also partially supported Kim Fawcett, who enters all of the project data. The salaries covered by GRCA funding are as follows:

Paul Austin, Backcountry Ranger	$1,800
Jerry, Packer	$1,000
NPS EPMT Leaders	$6,070
CREC	$19,200
Kate Watters, Kim Fawcett	$15,000
Lori Makarick	$1375
Steve Mietz	$450

The Grand Canyon Science Center continues to provide critical support in the contribution of the project coordinator's time on this project. During the fall, Lori Makarick worked 40 hours on this project, valued at $34.38 / hour, totaling $1375. Steve Mietz, GIS program manager, worked about 10 hours on this project, valued at $45 / hour, totaling $450.

The Colorado River Fund (CRF) is generated by outfitter's fees and is managed jointly by the Grand Canyon River Outfitters Association (GCROA) and the NPS. A portion of the fees go into the Cooperative Resource Conservation Program (CRCP), which provides river outfitters, guides

and NPS personnel the opportunity to work closely together to implement priority projects within GRCA. The Backcountry Vegetation Program, along with the park's Archeology Program, developed the itinerary and work schedule for a 19 day river trip. Through this program, Arizona River Runner's provided all of the logistics, equipment, boatmen and food for the November 2006 river trip. This is a $22,000 contribution toward this project work.

c. Project Press

This project continues to receive good press coverage. Each issue of GRCA's visitor guide includes an article about this project. The field crew supervisor updated the Tamarisk Management Site Bulletin and created an informational poster about the project for the Backcountry Office at the South Rim. Loren Bell, a crew leader for the project, wrote an article for South by Southwest, and Kelly McGrath, the Polk Intern through the GCNPF wrote an article for Grand Canyon Nature Notes. Both articles are due out in Spring/Summer 2007.

V. Discussion and Conclusions

a. Discussions and conclusions about results comparing current and past control results

Many of the project areas within Phase II-A are more difficult to access than those that were in Phase I and contain dense patches of tamarisk trees. The project made great strides this fall, as two of the longer northern drainages like Lava Chuar and Unkar Creek, can be listed as complete. Upper Bright Angel Creek and all of its side drainages are within one trip of completion, which is an enormous task. By spring of 2007, barring unforeseen weather and logistical changes, all 35 of Phase II-A areas will be free of tamarisk! The challenge for the future of this project will be to secure funding for ongoing work in all 130 project areas of Phase I, II-A and II-B. The project coordinator just submitted this funding request for 2009-2013 to GRCA management for consideration. With federal funding shortfalls in the National Park Service a harsh reality, the project looks for hope toward the GCNPF, who is tirelessly fundraising through foundations and private grants.

While there are fewer project sites in Phase II-A as compared to Phase I, the sites are much more difficult to access. Completing management work in 35 project areas in one field season was definitely taking on too much. Given the remoteness of these canyons, the schedule does not always allow the crews to revisit the project areas one year later in order to complete the necessary follow-up control work that helps to make this project successful. This leaves much of the essential maintenance work unfunded but committed to by the NPS. With the current state of the NPS budget, it will be challenging to get back to these project areas in the next two years, but both GCNPF and GRCA staff are committed to doing their best to make this project continue. The field crew supervisor will be creating a maintenance schedule and five year work plan for all the project areas.

Despite these challenges, in a short period of time crews were able to remove an incredible number of invasive plants from project areas. Based on the work that was completed in 2006, crews have

removed 250,000 tamarisk trees during the implementation of the three AWPF grants, which is an amazing accomplishment in just four years.

b. Discussion and conclusions about results with relation to related literature.

This report contains the control data from the invasive plant control trips to date and information about preliminary project results. The final monitoring trip will be in May 2007 and the final report for this project will contain control conclusions and discussion.

VI. Management Recommendations

a. Overview of management options.

The monitoring results from Phase I helped to refine the control methods and management options for this project. The National Park Service (NPS) has an affirmative responsibility to protect and preserve the resources located within its units. NPS Management Policies require park managers "to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2006). Park managers are directed to give high priority to the control and management of exotic species that can be easily managed and have substantial impacts on the Park's resources (NPS 1985, NPS 2006).

This project further verified that the control of tamarisk and other invasive plant species in the park's side canyons and tributaries is feasible. A vast body of literature documents the impacts that tamarisk has on southwestern ecosystems. Stevens (2001) summarizes the impacts and ecology of tamarisk. Since the control is feasible and tamarisk poses a substantial impact on the resources located within GRCA, the continuation and expansion of this project should occur. Park management have been supportive of this project, and with continued documentation and successful implementation, the support should remain strong. Prior to future grants, the project coordinator must critically examine what is physically possible during one field season. Project leaders recommend that future phases span more than 18 months in order to allow for two preliminary visits to each project areas and one final visit.

b. Management recommendations and justification.

The EA/AEF for this overall project included three phases of tamarisk management and tributary restoration. The work completed under this grant contract is Phase II-A of the overall project. The fall 2006 control trips were very successful and project leaders anticipate that the methods used will lead to successful management of tamarisk populations in the project areas. GCNPF received a second grant to move into Phase II-B, which began in spring of 2006 and is being completed in tandem with Phase II-A. Phase II-B is being completed in partnership with GRCA and the Hualapai Tribe. We recommend that GCNPF and GRCA staff continue to work together to secure supplemental funding that would allow crews to revisit all of the previously treated project areas. Crews should systematically retake all of the photographs and re-read all of the vegetation transects during a two- to three-year period. GRCA is currently retaking photographs and completing follow-up control, but in the form of volunteer groups (e.g. Grand Canyon Youth) due to continued budget

cuts within the NPS. Project leaders continue to recommend integration of this project into the overall resource and vegetation management planning efforts.

After completion of the final monitoring trip, project leaders should prepare articles for both internal NPS publications and peer-reviewed journals. The AWPF funding and support for this project has been essential to getting this project off the ground and protecting and restoring the park's valuable riparian ecosystems. The partnership between GRCA and the GCNPF has also been integral to the success of the project. The primary recommendation at this point is to continue the work, and to expand the project to include all of the tamarisk populations in the side canyons and tributaries of the park.

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APPENDIX A

Representative Project Photographs – Fall 2006 Tamarisk Management Report Phase II-A

Management & Control of Tamarisk and Other Invasive Vegetation at Backcountry Seeps, Springs and Tributaries in Grand Canyon National Park

Picture 1. The hard working tamarisk project crewleaders

Picture 2. Crewleaders learning safe climbing techniques from Backcountry Ranger Paul Austin

Picture 3. EPMT crew at Roaring Springs in Upper Bright Angel Creek

Picture 4. Clear Creek crew enjoying lunch in the sun

Picture 5. Mighty cottonwood forests in need of protection

Picture 6. Volunteers team up to get the job done

APPENDIX A

Representative Project Photographs – Fall 2006 Tamarisk Management Report, Phase II-A

Management & Control of Tamarisk and Other Invasive Vegetation at Backcountry Seeps, Spring and Tributaries in Grand Canyon National Park

Picture 7. Bright Angel Creek crew takes a break at Ribbon Falls

Picture 8. Tools and gear carefully laid out at the bunkhouse at the start of the day

Picture 9. Hance Creek tamarisk thicket before

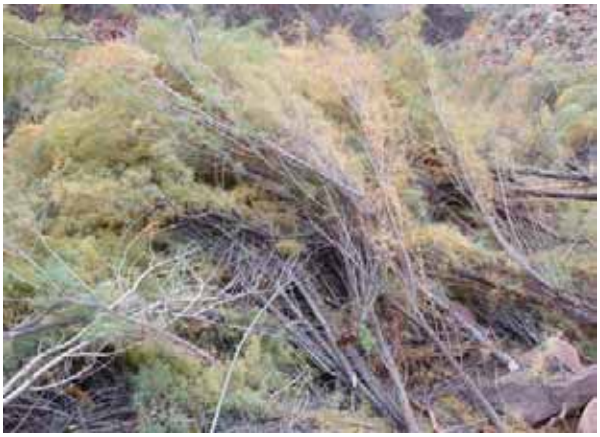
Picture 10. Hance Creek tamarisk thicket after cutting crew

APPENDIX A

Representative Project Photographs – Fall 2006 Tamarisk Management Report Phase II-A

Management & Control of Tamarisk and Other Invasive Vegetation at Backcountry Seeps, Springs and Tributaries in Grand Canyon National Park

Picture 11. ARR boatmen dwarfed by enormous tamarisk thicket at Crystal Creek



Picture 12. Slash pile before dispersal along terrace

Picture 13. Crewleaders refill herbicide sprayers

Picture 14. Early morning coffee call at Unkar spike camp

Picture 15. CRF river trip celebrates below Lava Falls

Picture 16. Hiking herbicide stash from the river for backpacking trips

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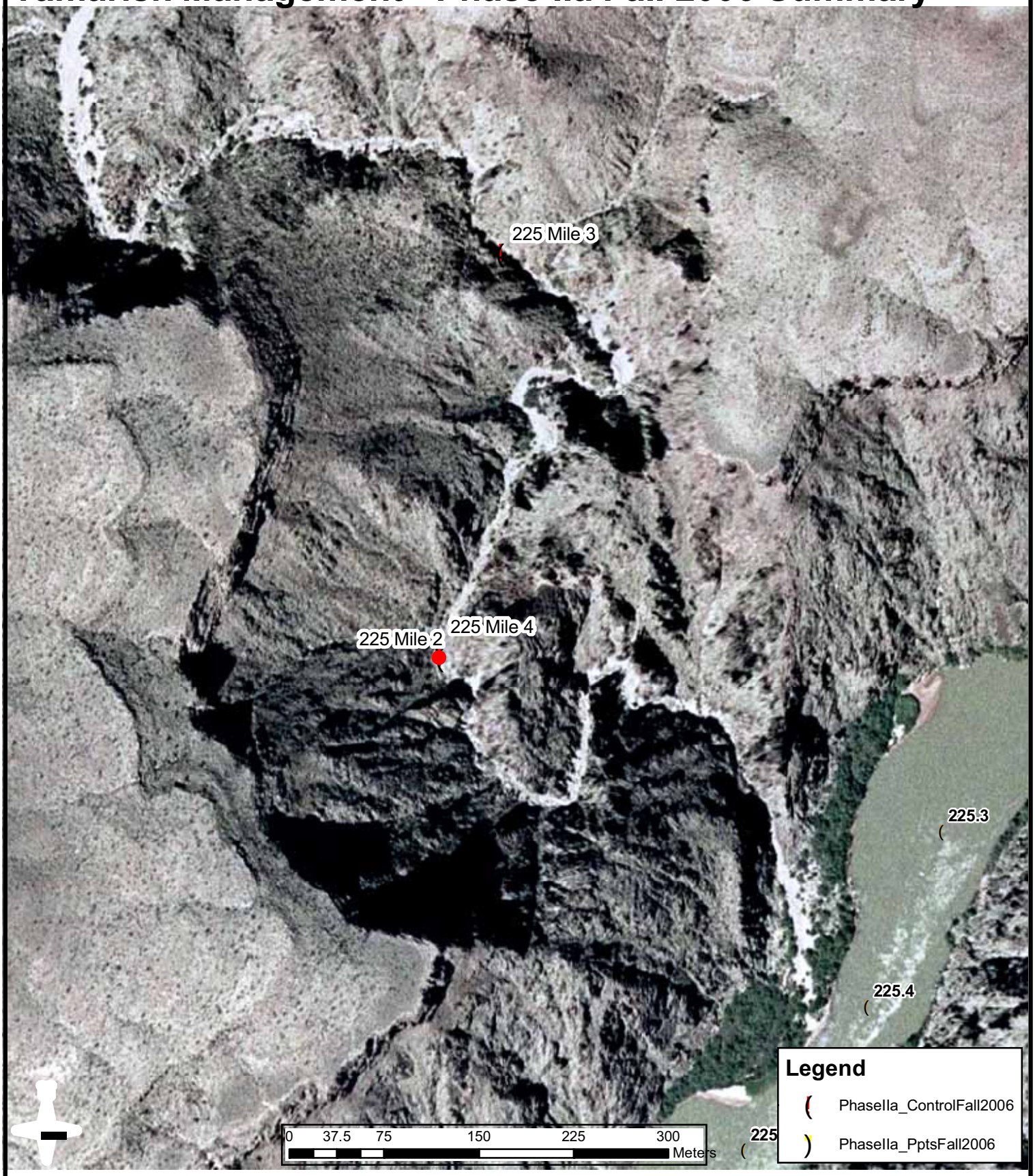

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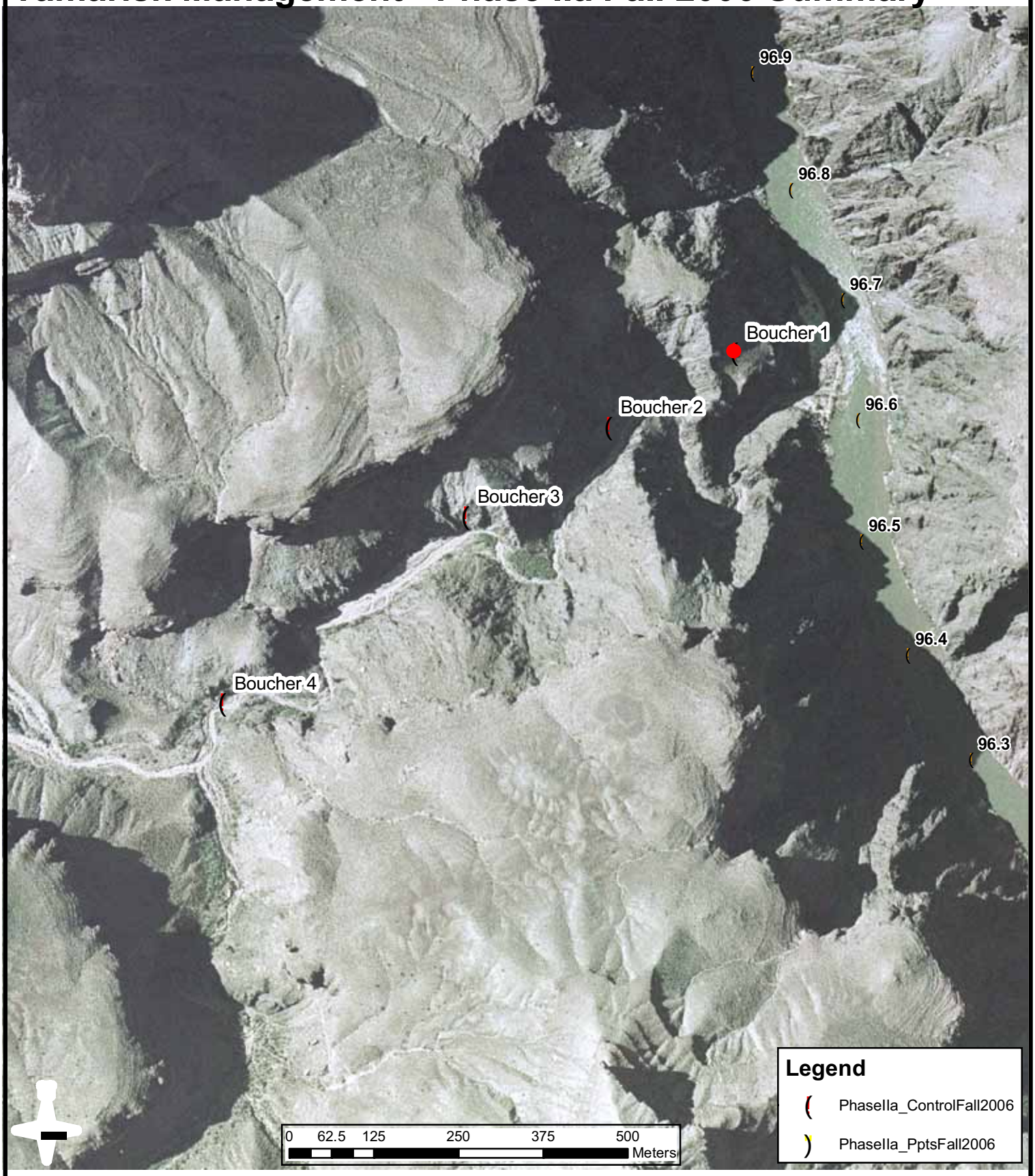

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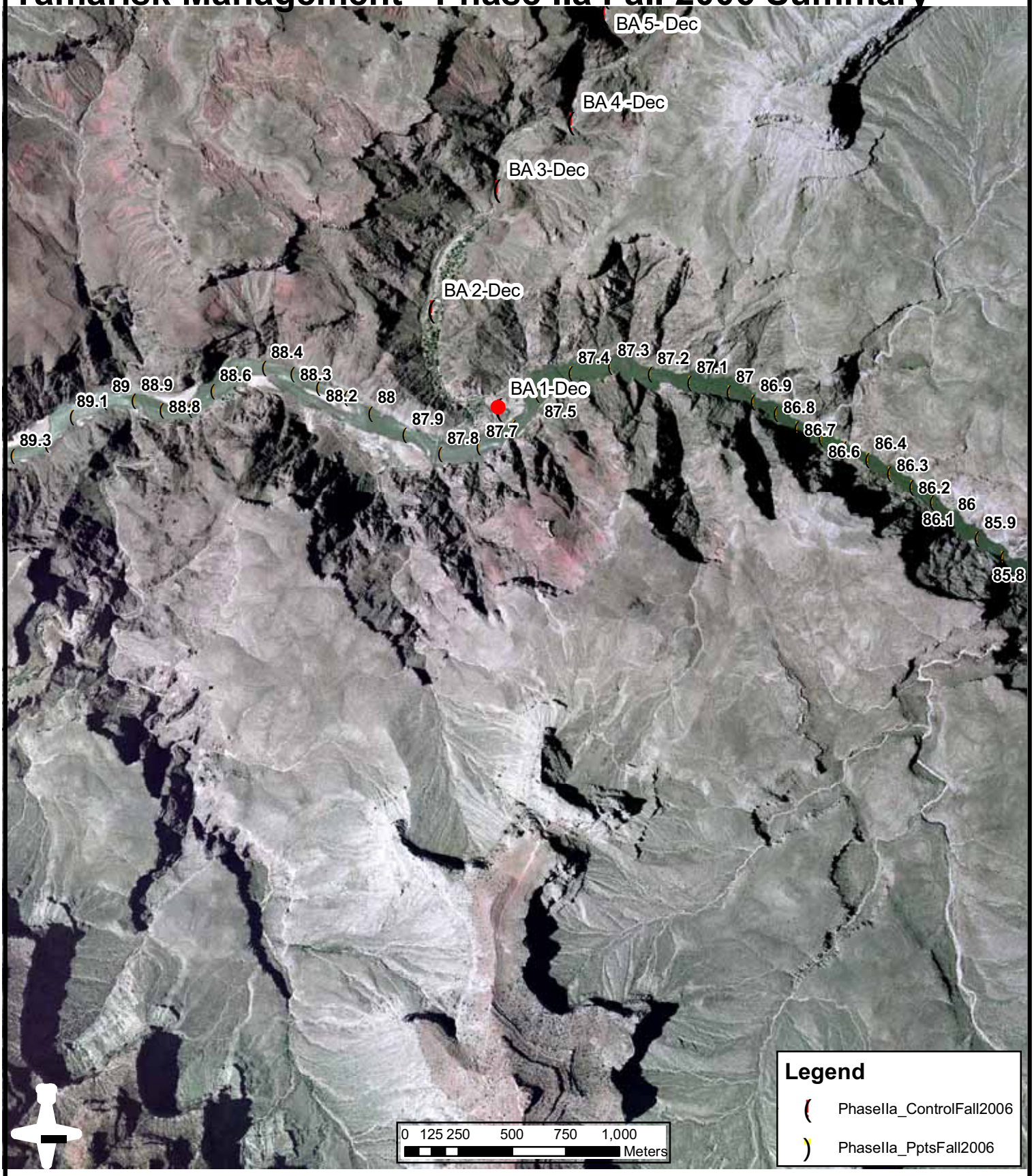

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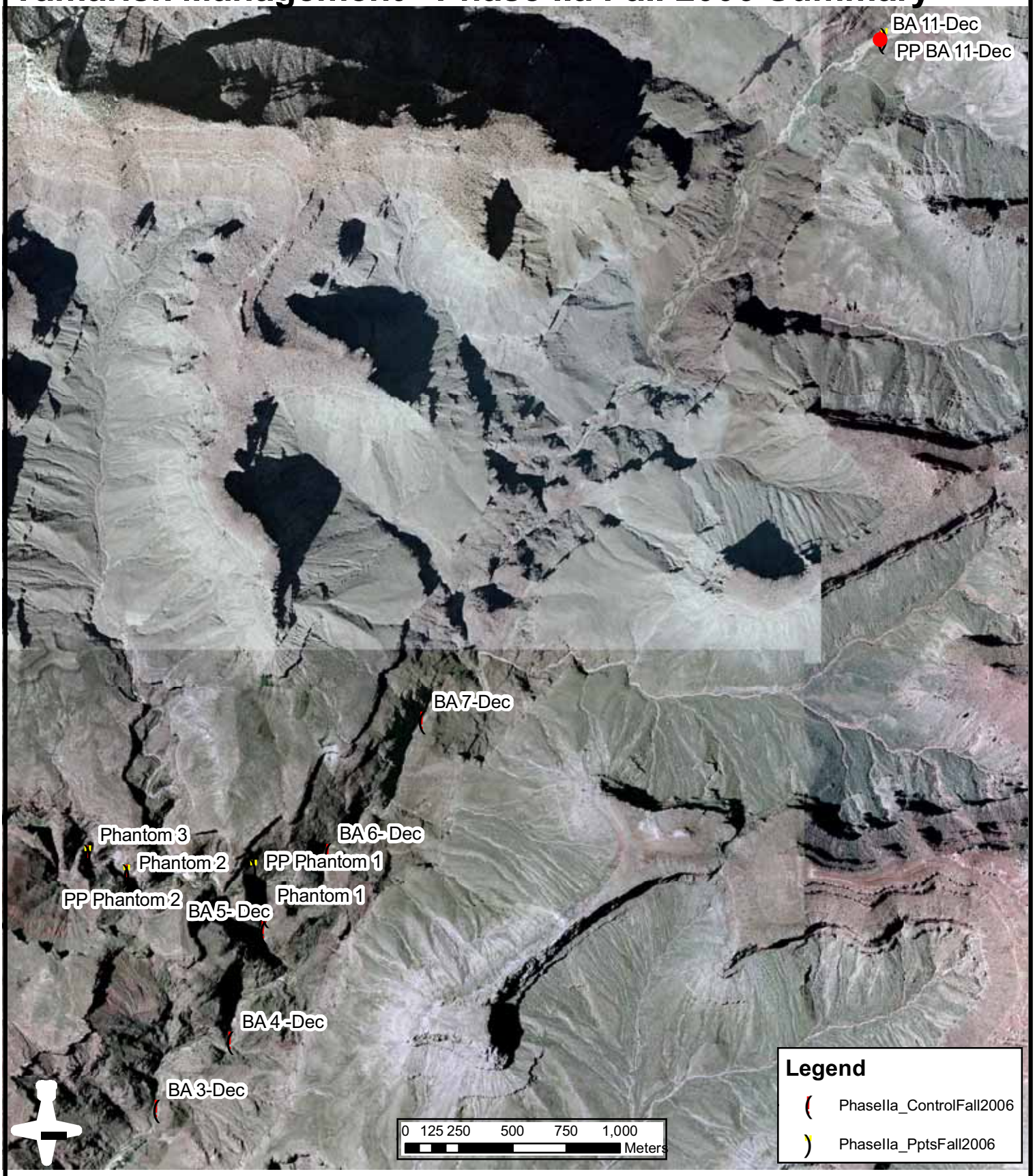

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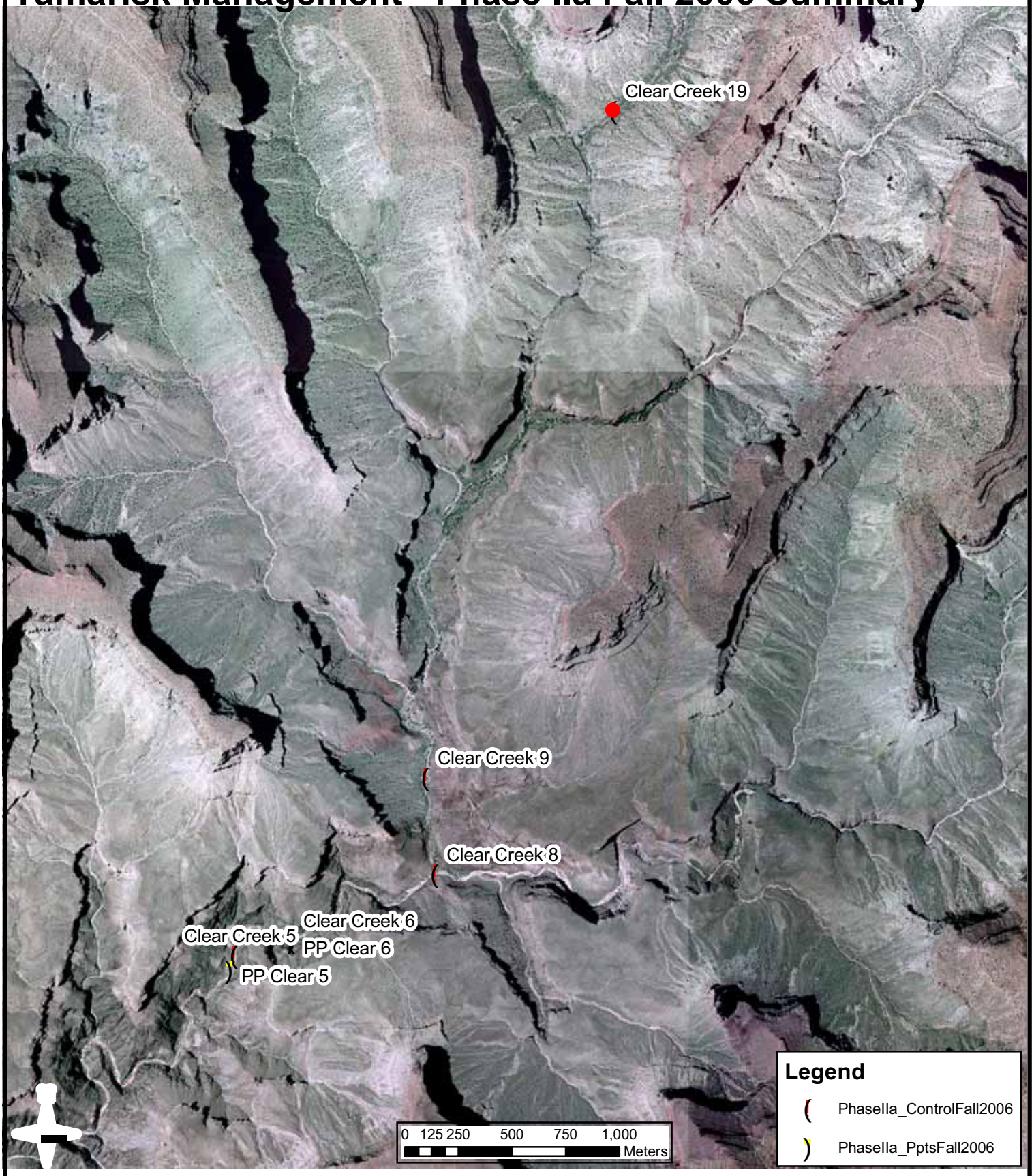

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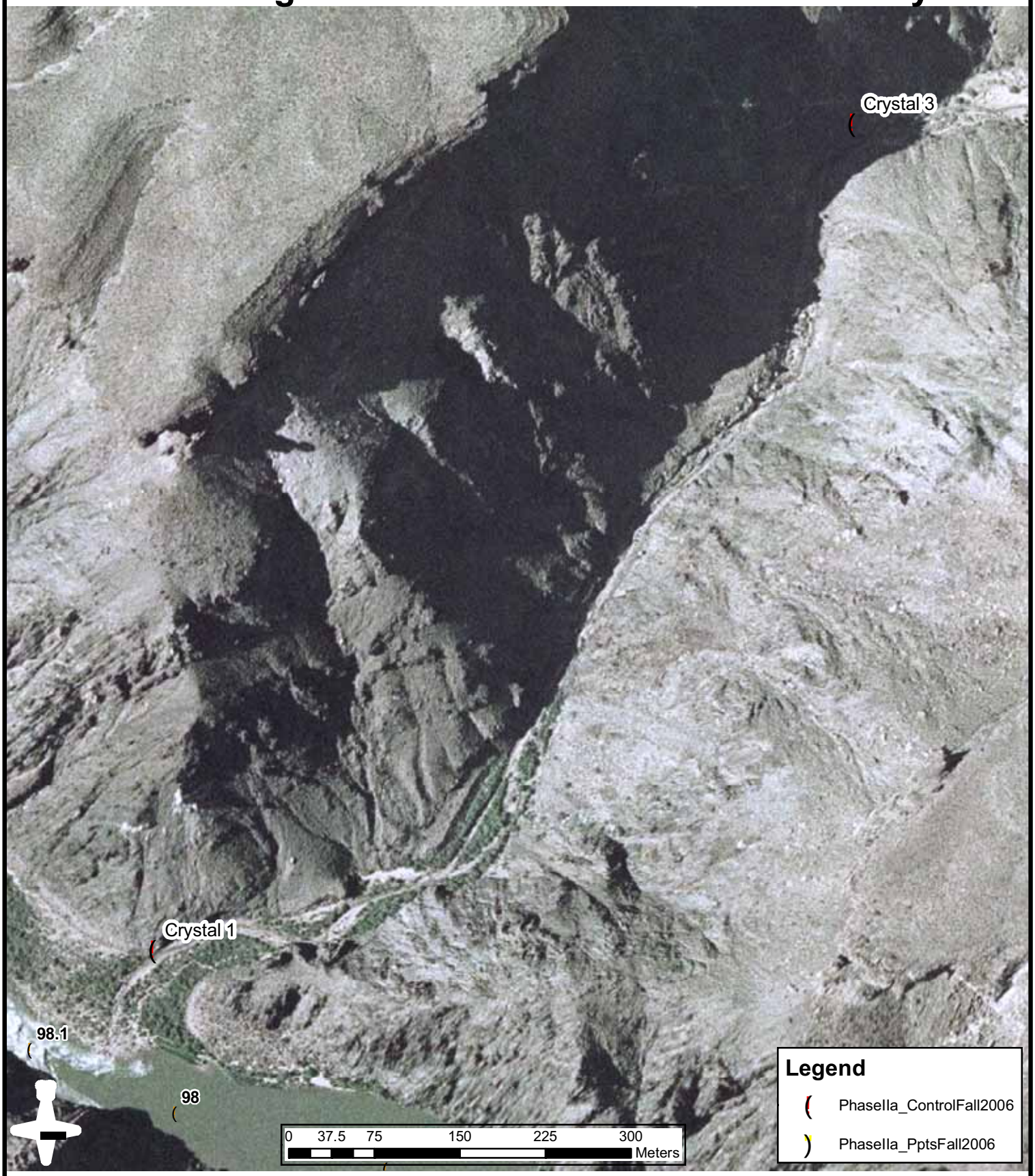

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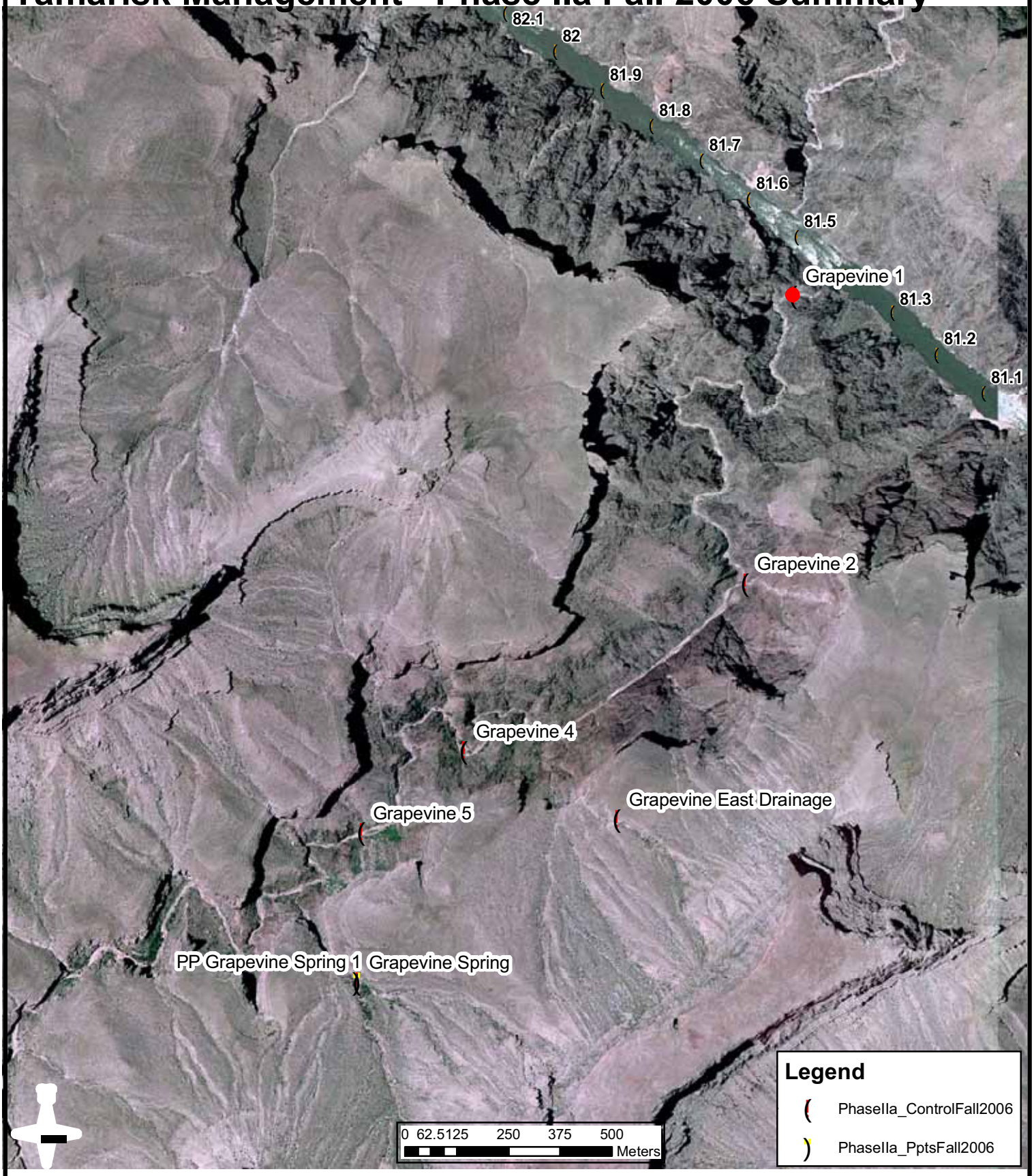

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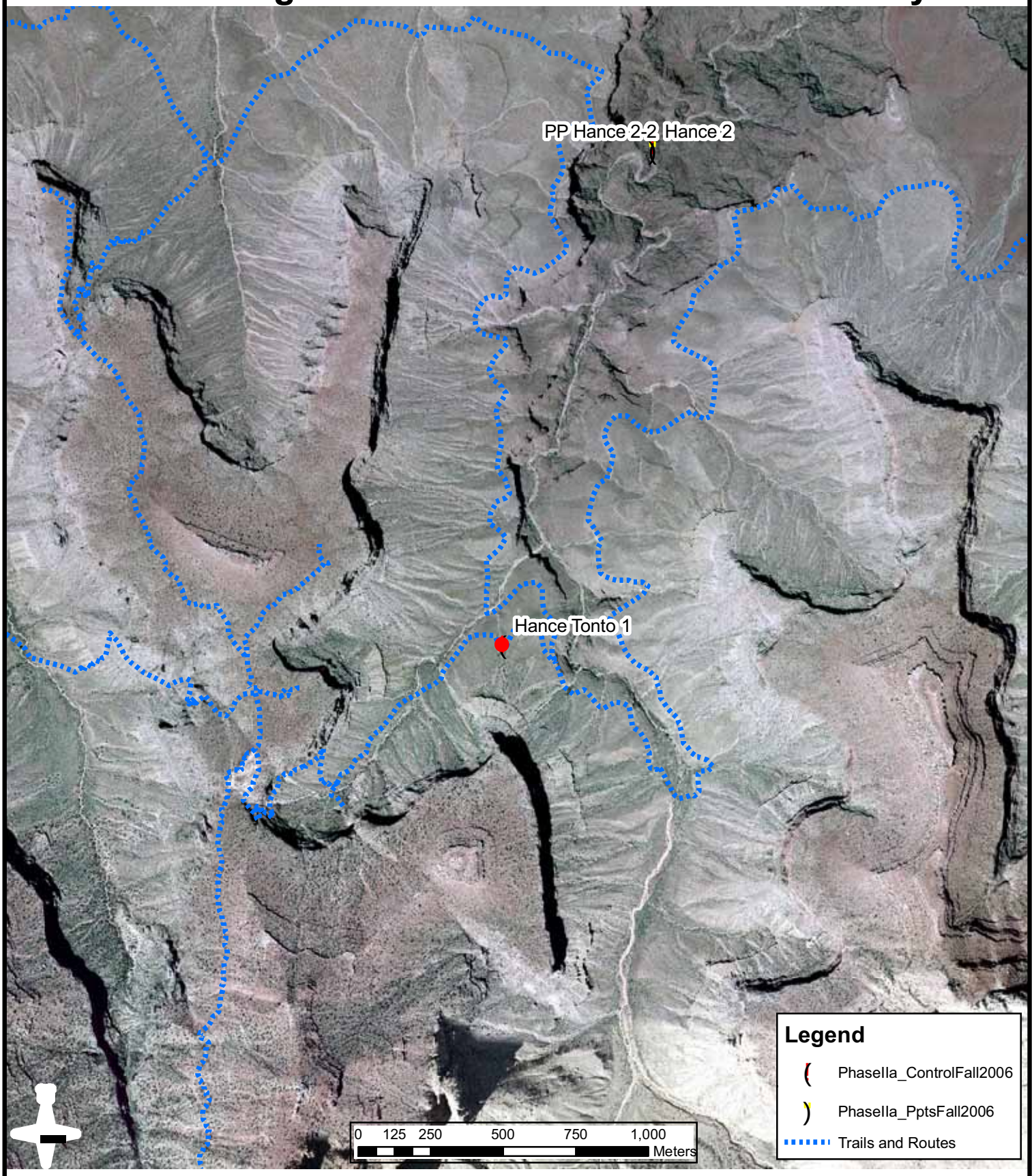

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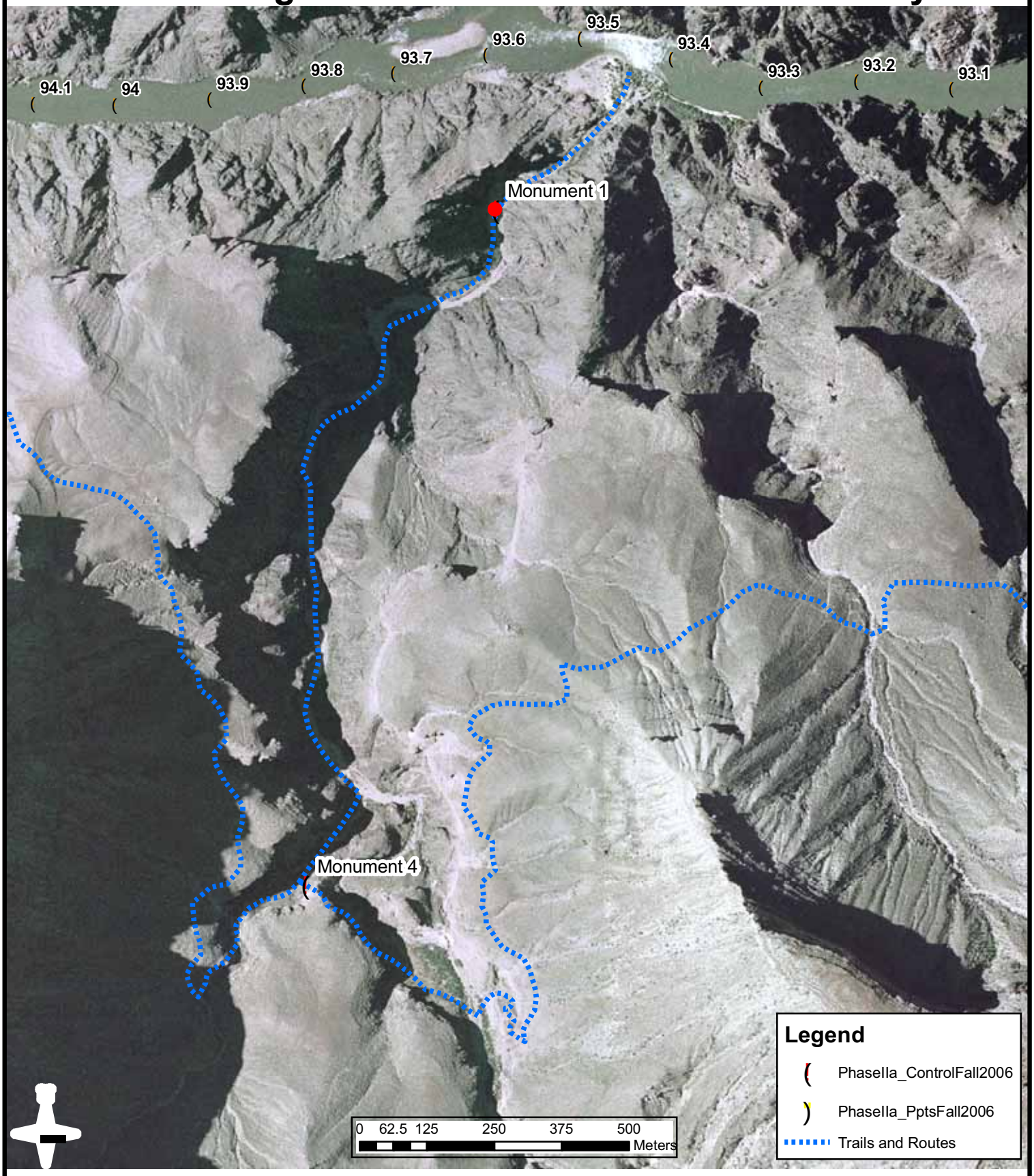

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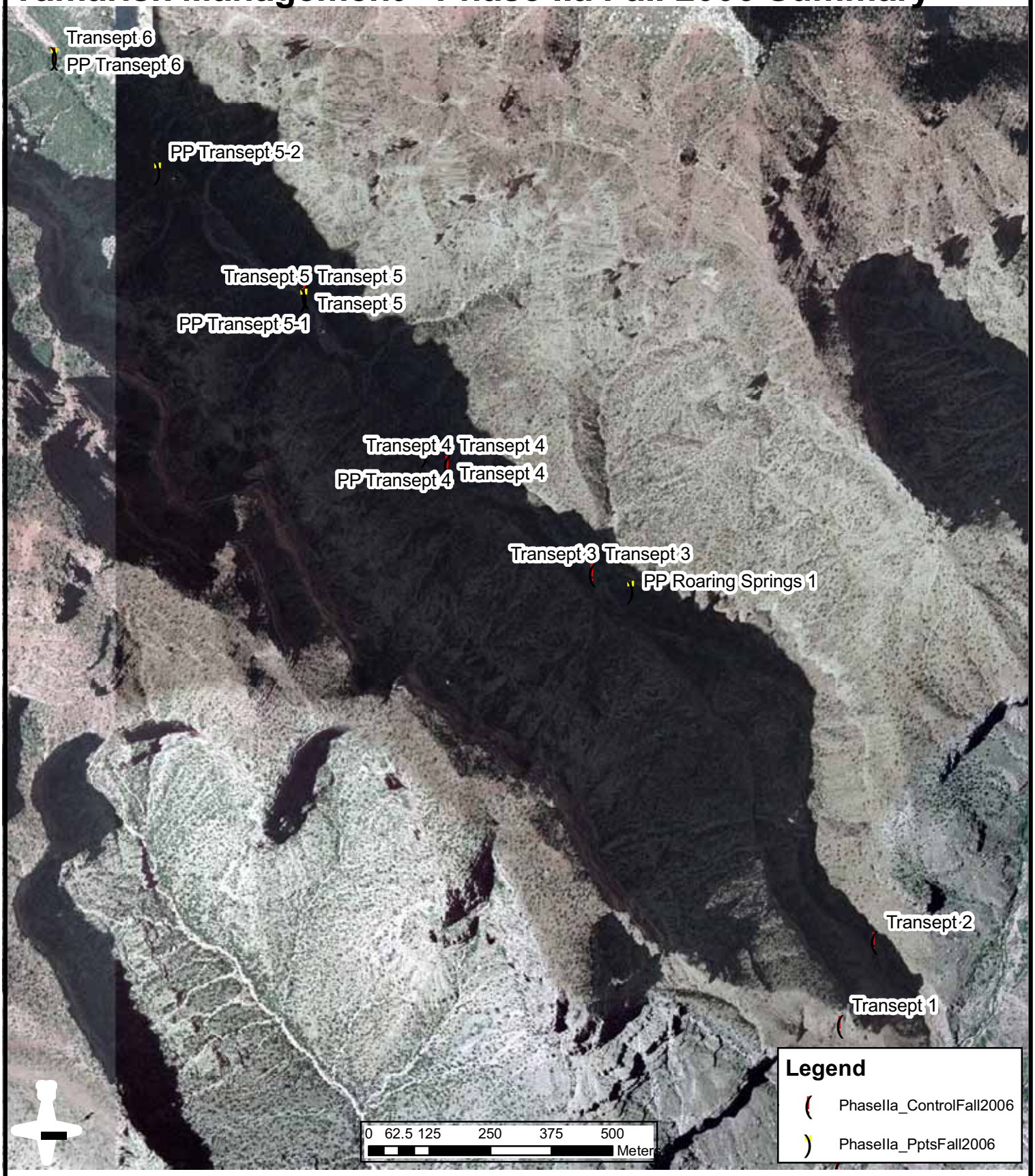

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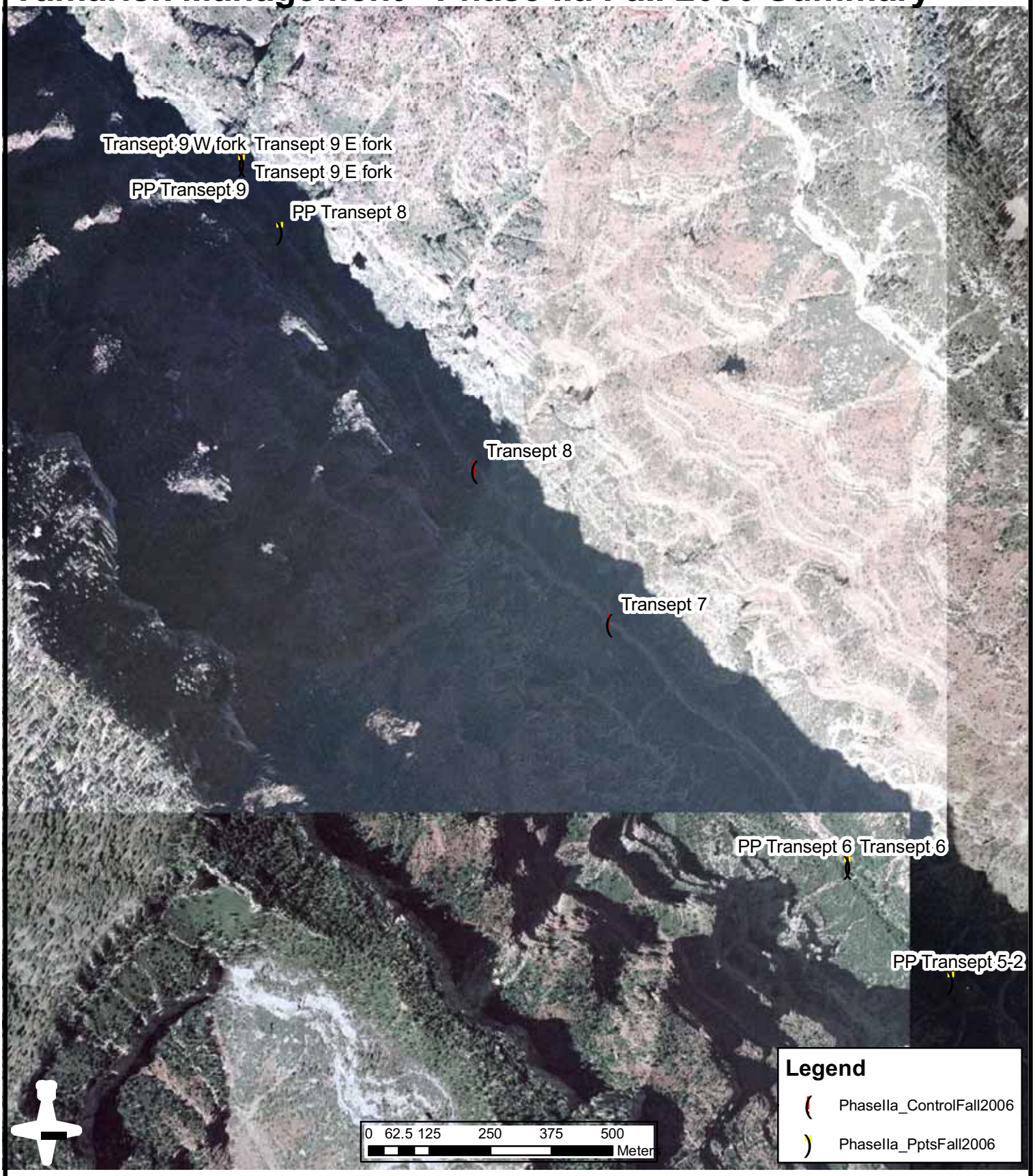

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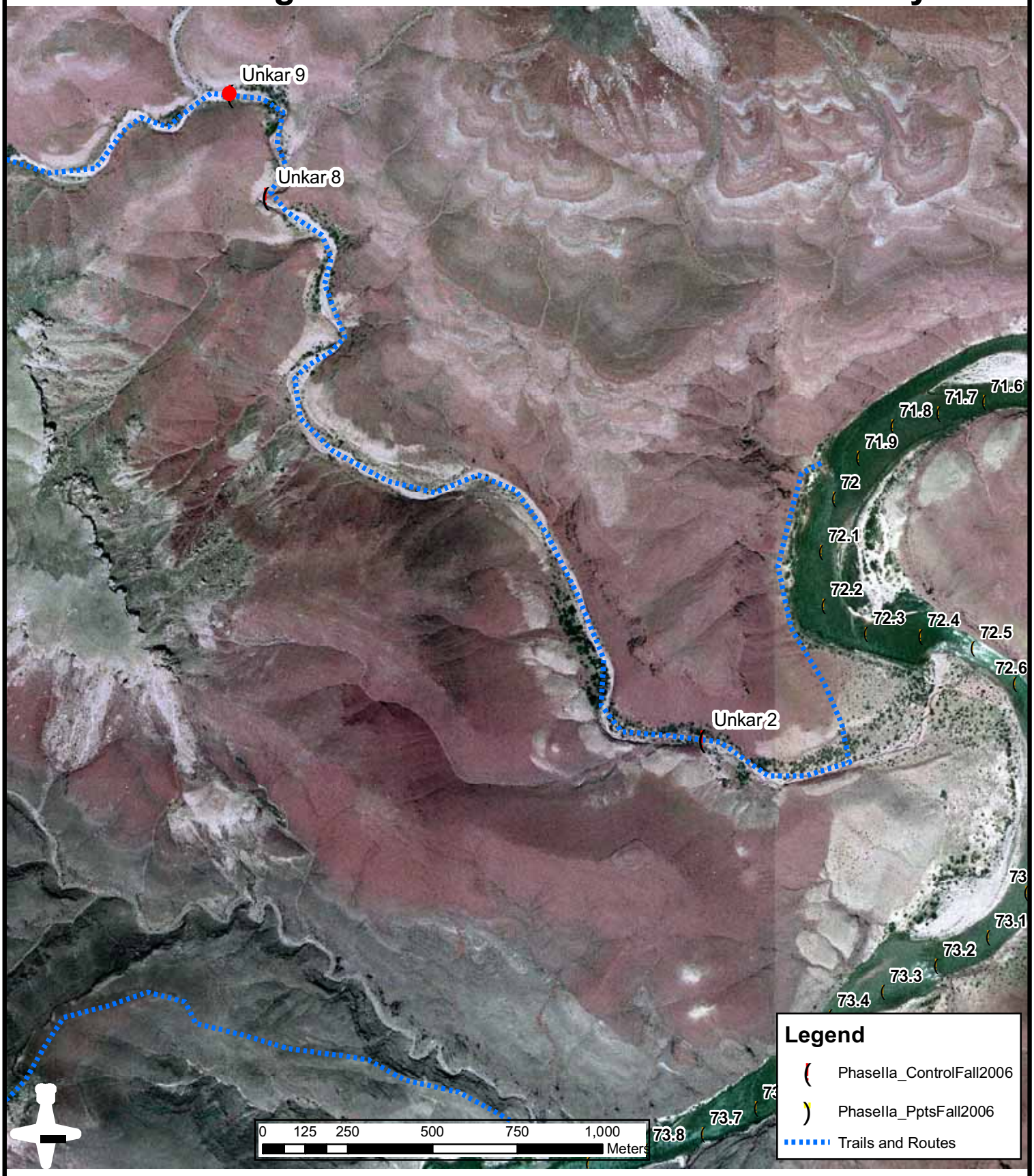

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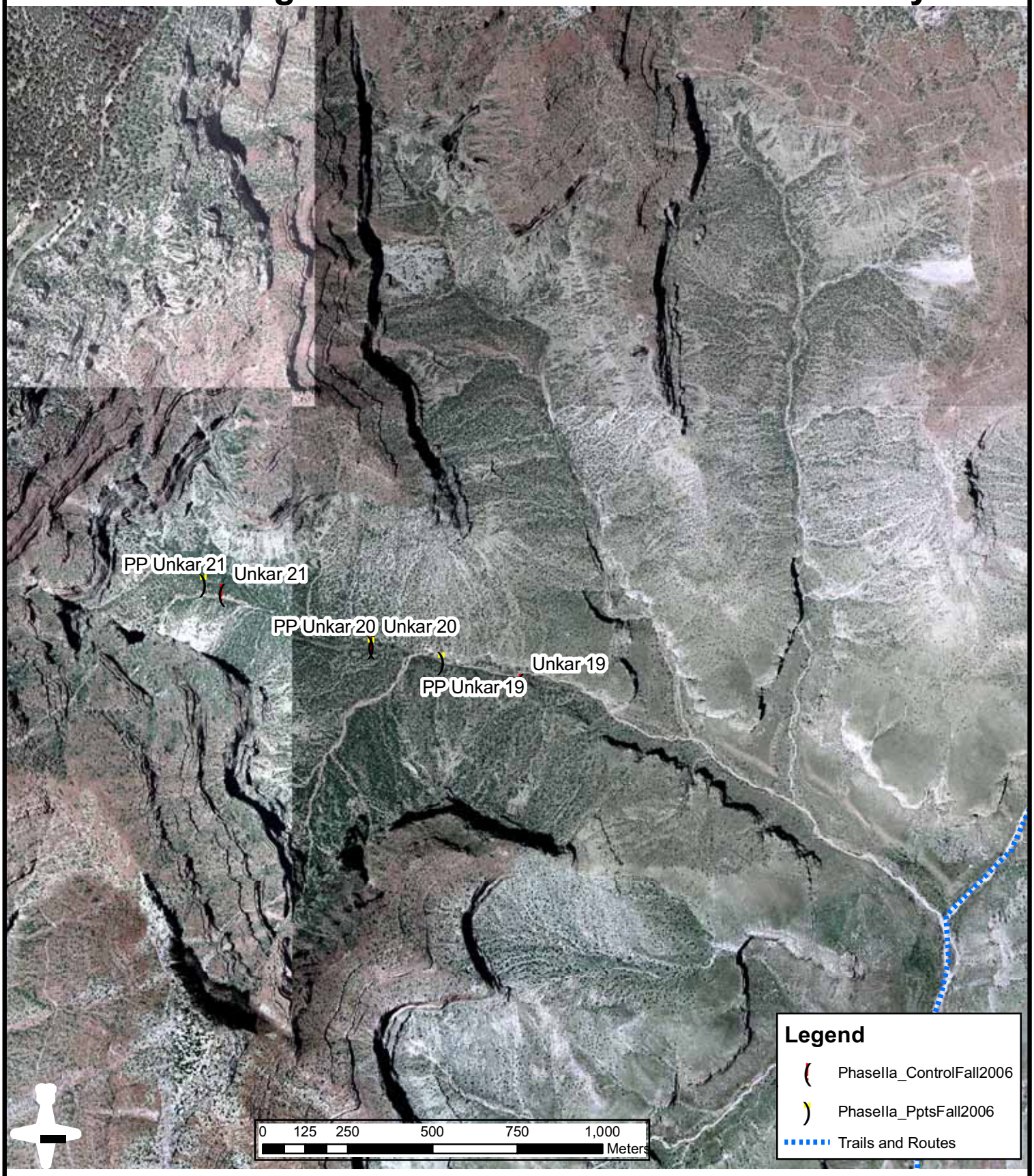

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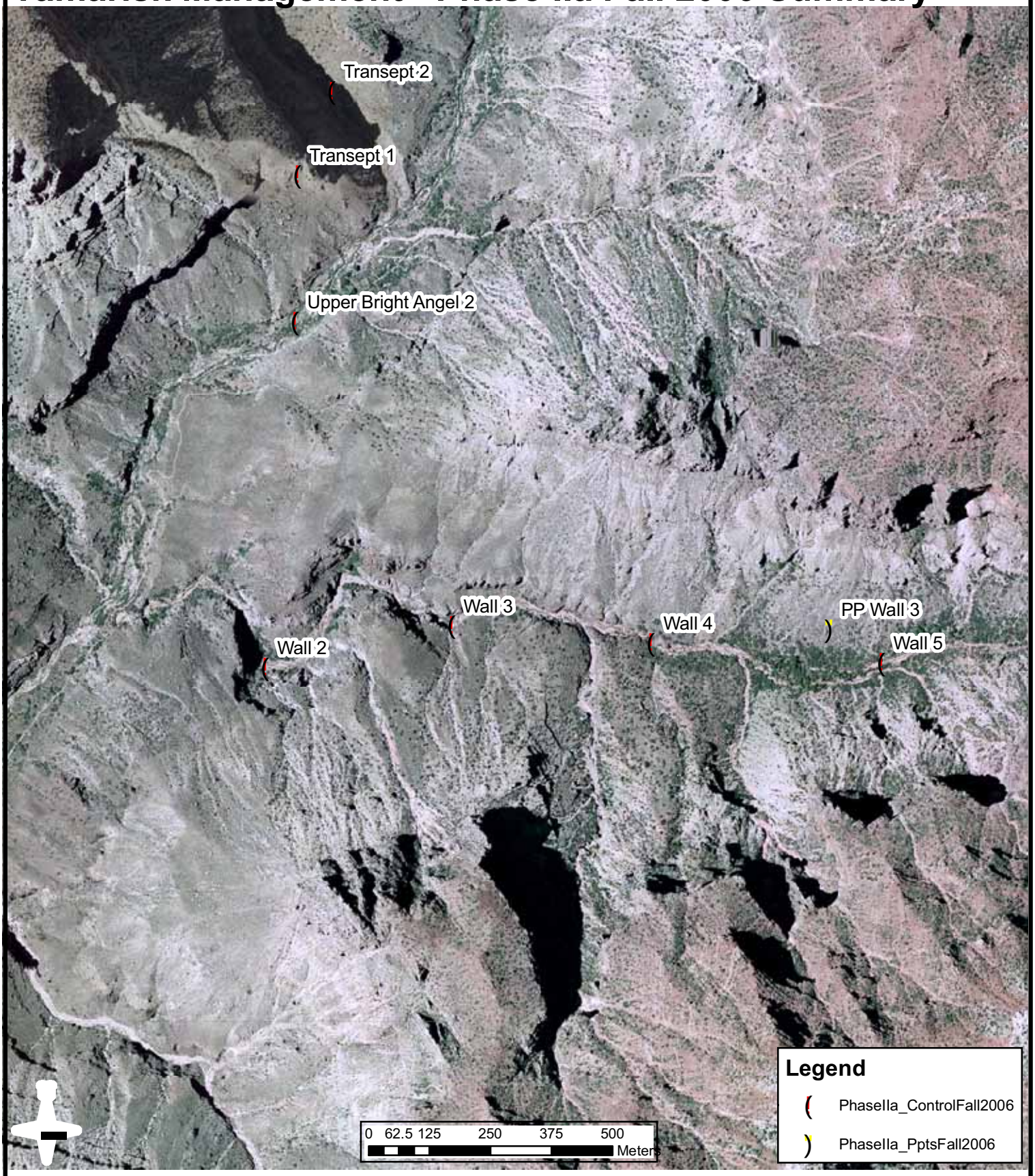

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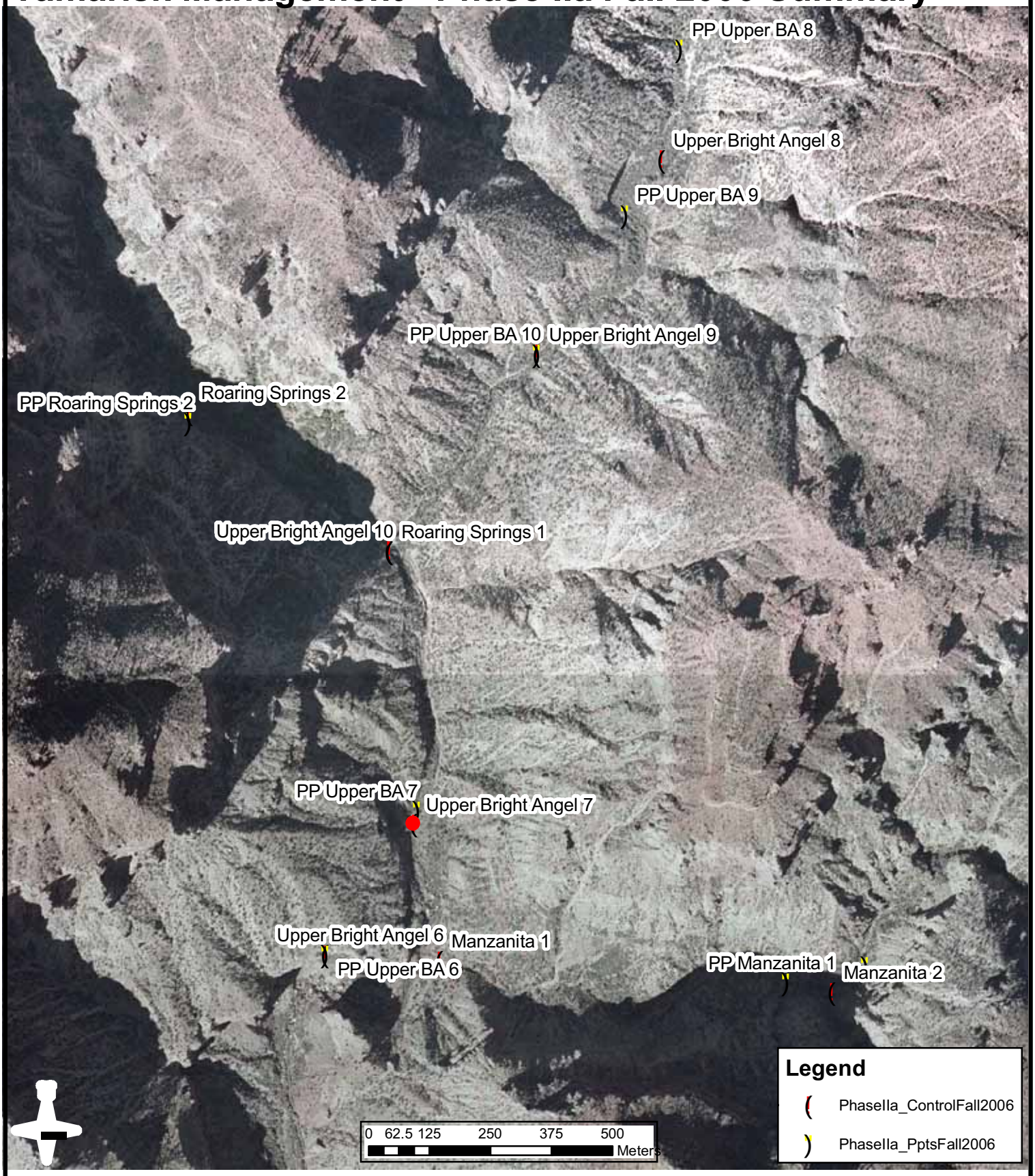

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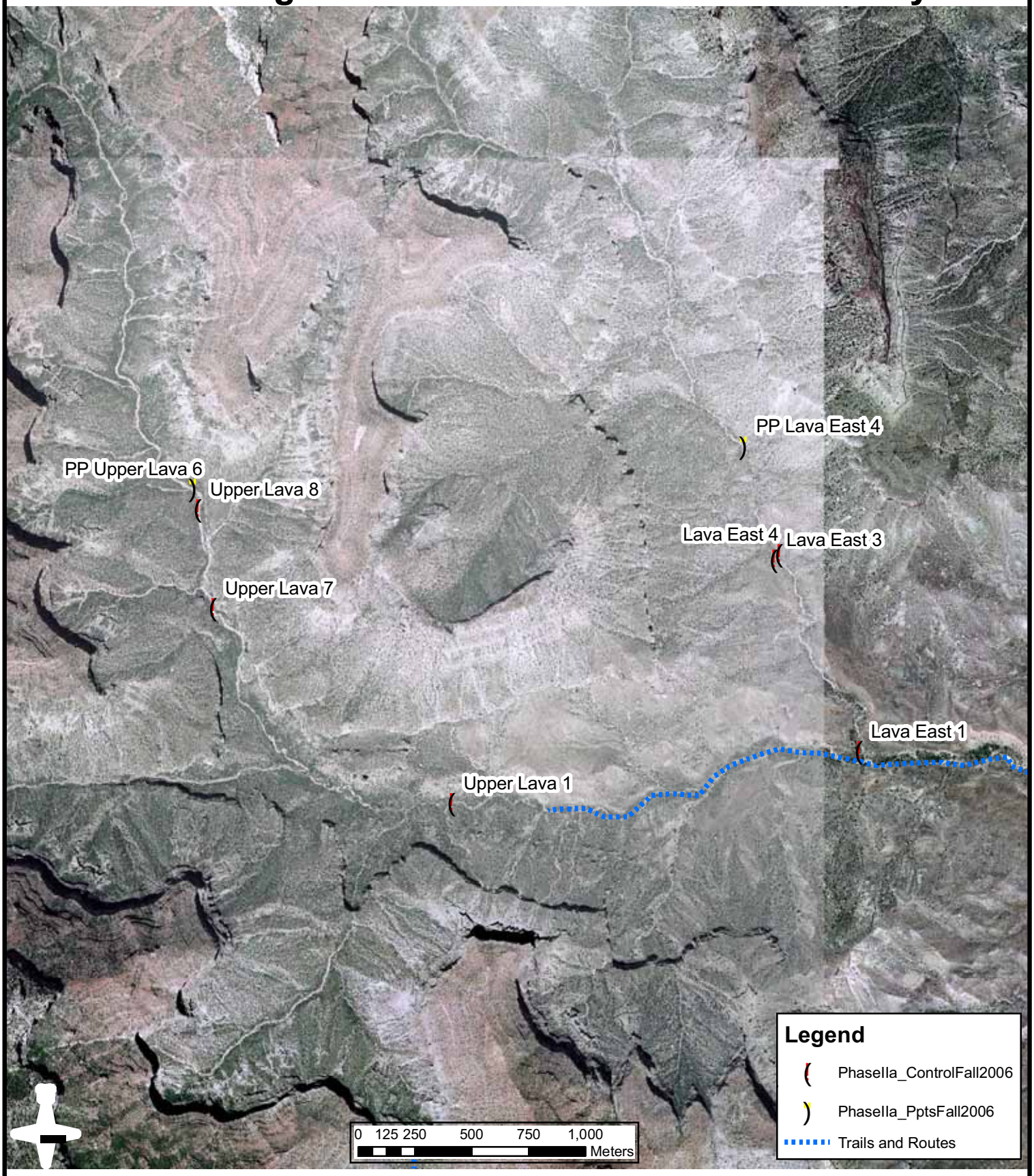

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