Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Elf Owl Home Range and Habitat Study

2016 Annual Report

February 2019

Work conducted under LCR MSCP Work Task C24

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

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National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

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2016 Annual Report

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ACRONYMS AND ABBREVIATIONS

AC	activity center
ADS	arborescent desert scrub (vegetation type)
AZSLD	Arizona State Lands Department
BLM	Bureau of Land Management
DS	desert shrubland (vegetation type)
DW	desert woodland (vegetation type)
FWS	U.S. Fish and Wildlife Service
GBBO	Great Basin Bird Observatory
ha	hectare(s)
HAID	habitat assessment ID
km/hr	kilometer(s) per hour
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
m	meter(s)
MCP	minimum convex polygon
MEFF	mobile electronic field form
MR	mesic riparian (vegetation type)
NA	not applicable
NPS	National Park Service
Reclamation	Bureau of Reclamation
SE	standard error
UA	University of Arizona
USFS	U.S. Forest Service
UTM	Universal Transverse Mercator
VHF	very high frequency
XR	xeric riparian (vegetation type)

Symbols

≈	approximately
°	degrees
>	greater than
<	less than
n	number
%	percent
±	plus or minus

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ABSTRACT

The elf owl (*Micrathene whitneyi*) is a covered species under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). Within the LCR MSCP planning area, the elf owl's current breeding distribution is significantly reduced from its former extent. To assist the Bureau of Reclamation (Reclamation) in its goal of increasing elf owl habitat in the LCR MSCP planning area, the Great Basin Bird Observatory and University of Arizona initiated a 3-year research study in 2015 to investigate elf owl habitat use within the LCR MSCP planning area and across a broader Arizona study area. Topics of specific interest to Reclamation were the frequency of elf owl occupancy of riparian areas, the significance of riparian vegetation to elf owls, environmental factors that are good predictors of elf owl occurrence, and refinement of a standardized elf owl survey protocol with known detectability. The 2015 field season focused on identifying the pattern of elf owl occurrence over a large geographical region. In contrast, the 2016 field season focused on delineating elf owl breeding territories, assessing habitat attributes, and conducting responsiveness tests to characterize detection probability of elf owls to call-playback as a function of distance, survey conditions, and vegetation obstruction. Specific techniques used during the 2016 field season included discovery surveys, territory confirmations, territory delineations by means of passive listening surveys and radio telemetry, nest searches, and habitat assessments of territories. The 2017 field season will function as a continuation of 2016 field efforts to gather more data to enhance inferences. For that reason, data collected during the 2016 field season and presented in this annual report are not completed datasets, and analysis will be conducted following completion of 2017 field efforts. During the 2016 field season, the Great Basin Bird Observatory and University of Arizona accomplished the following tasks:

1) Identified 20 candidate focal sites

2) Conducted discovery surveys on 45 transects, obtaining 1,764 elf owl detections

3) Selected 14 focal sites for further study based on discovery survey data

4) Obtained 2,281 elf owl locations in focal sites using passive listening surveys and radio telemetry

5) Confirmed the locations of 55 occupied nest cavities

6) Confirmed 89 breeding territories

7) Captured 13 elf owls with mist nets and affixed radio tags to 11 of them to assist in obtaining owl locations

8) Performed 100 responsiveness tests at 25 different confirmed territories

9) Conducted territory assessments at all 89 confirmed territories based on fixed 75-meter-radius buffers surrounding either nest cavities or (if not known) activity centers of owl location points and on 95% minimum convex polygon home ranges calculated for 37 of those territories with sufficient data

These accomplishments significantly exceeded goals set for the 2016 field season in the project study plan (Boone and Flesch 2016). Analysis and interpretation of the 2016 results will be presented in the final comprehensive project report after being combined with comparable data from other years.

INTRODUCTION

To assist the Bureau of Reclamation (Reclamation) in its goal of implementing conservation under the auspices of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), the Great Basin Bird Observatory (GBBO), and the University of Arizona, School of Natural Resources and the Environment, are conducting elf owl (*Micrathene whitneyi*) research during the 2015–18 period. The occurrence of elf owls within the LCR MSCP planning area is too limited to generate robust inferences to support LCR MSCP goals, and thus, it was necessary to investigate elf owls across a broader area to generate data and inferences needed to plan, design, and implement LCR MSCP conservation measures. The Sonoran Desert region of western and southern Arizona was identified as a suitable study area for gathering the required information (as described in more detail in Boone and Flesch [2017]).

The overall goals of the 4-year project are to:

1) Determine the occurrence of elf owls during their breeding season in riparian areas and adjacent upland environments in the Sonoran Desert region of Arizona

2) Identify and delineate breeding territories occupied by elf owls and characterize those territories using rapid assessment methods

3) Experimentally investigate elf owl responsiveness to call-playback and use this data in combination with responsiveness data gathered by the GBBO in 2010–11 (GBBO 2012) to finalize a recommended protocol for elf owl surveys in the LCR MSCP planning area

Within the project's defined study area (Boone and Flesch 2017), a "gradient approach" was used to guide sampling design, site selection, and data analyses. Described more fully in Boone and Flesch (2017), gradient sampling involves identifying critical ecological, elevational, and climatological axes along which elf owl occurrence could plausibly vary in a systematic way, and using these gradients to guide the selection of study sites and inform data interpretation. Findings from the portions of those gradients most relevant to the LCR MSCP planning area can then be highlighted for LCR MSCP applications.

The 2015 field season focused strictly on assessing the occurrence of elf owls across a broad portion of southern and western Arizona during breeding season (goal 1 in the list above). During that period, elf owl presence/absence was determined for as many survey locations as possible using a standardized discovery survey protocol. In contrast, the focus of field work in 2016 was to identify, delineate, and characterize selected elf owl territories and conduct responsive tests (goals 2 and 3 in the list above). The 2017 field will function as a continuation of the 2016 field season to create larger datasets to support analyses.

This document describes the work performed during the 2016 field season. Because final analyses of data relevant to goals 2 and 3 cannot be completed until data from the 2017 field season are available and combined with 2016 data, this report is limited to describing field effort and summarizing data specific to the 2016 field season. Analyses relevant to goals 2 and 3 are not presented in this report, but will be included in a final comprehensive project report, which will incorporate data from the 2015–17 field seasons.

The following tasks were accomplished in the 2016 field season:

1) From the locations occupied by elf owls in 2015, a subset of focal study sites were selected for more intensive study of breeding territories and responsiveness to call-playback.

2) Discovery surveys were performed at focal sites to confirm the presence of breeding elf owls and to identify possible breeding territories suitable for further investigation.

3) A small number of new locations within previously surveyed sites were investigated using discovery surveys to supplement the 2015 elf owl occurrence dataset.

4) To confirm and delineate the spatial extent of breeding territories, multiple elf owl locations were obtained over an extended period by passive observation or by radio telemetry.

5) Nest searches were conducted to identify specific cavities used by nesting elf owls.

6) Standardized responsiveness tests were conducted on selected elf owl pairs.

7) For confirmed territories, habitat patches were delineated and vegetation characterized using a rapid assessment protocol.

METHODS

Overview

Only methods utilized during the 2016 field season are described in this section. Other methods used in 2015 as a prerequisite to the 2016 field season (including the gradient sampling design and 2015 site selections) are not described here but are covered in the project study plan (Boone and Flesch 2016) and 2015 annual report (Boone and Flesch 2017).

Focal Site Selection

From among all sites where discovery surveys were conducted in 2015 (see Boone and Flesch 2017), a subset was selected in collaboration with Reclamation as 2016 focal sites. The criteria considered to select these sites were:

1) Presence of elf owls in 2015 in riparian or riparian-adjacent vegetation

2) Estimated suitability of habitat for additional elf owls

3) Gradient sampling considerations (Boone and Flesch 2017)

4) Relevance of site to the LCR MSCP planning area and to Reclamation priorities

5) Logistical factors, including access and permitting

These candidate sites were then investigated using discovery surveys (see next section) at the beginning of the 2016 field season to confirm owl presence and generate a final list of focal sites for 2016 field work.

Discovery Surveys

Discovery surveys are call-playback surveys conducted at a series of point locations (i.e., "stations") arrayed along linear transects to determine whether elf owls are present and to gather information that may indicate territoriality. In 2016, discovery surveys were predominantly conducted at candidate focal sites (see above) during the early part of the field season to confirm elf owl presence prior to initiating more intensive territory delineation and responsive tests. These discovery surveys occurred at or very close to the locations of previous discovery surveys in 2015, and for this reason, they did not generate new, independent data to incorporate into the larger discovery survey dataset (see Boone and Flesch 2017). Instead, these "repeat" discovery surveys functioned only as prerequisites to assess needs for more focused field work to delineate territories and conduct responsive tests. If discovery surveys revealed that owls were not present at a candidate focal site (despite having been present in 2015), that site was discarded from further use in 2016.

In addition, a smaller number of discovery surveys were conducted at previously unsurveyed locations within previously surveyed sites. These discovery surveys did generate new data that were added to the overall elf owl occurrence dataset for eventual comprehensive analysis (Boone and Flesch 2017).

Regardless of the purpose of a given discovery survey, procedures and protocols were identical. Call-playback stations were arrayed along linear transects with spacing of 150 meters (m) between points as described in Boone and Flesch (2017). The number of stations per transect varied (8–19) depending on the extent of potential elf owl habitat, accessibility, and adherence to idealized distribution of points in relation to the overall sampling stratification design (Boone and Flesch 2017). For the new transects that were established in 2016, layout procedures and considerations remained as described for 2015 in Boone and Flesch (2017).

Discovery surveys commenced at dusk and continued for up to 4 hours. Discovery surveys were not conducted during periods of continuous precipitation or when the windspeed was sufficient to create consistently audible noise (typically > 12-mile-per-hour sustained windspeed for most observers). Call-playback levels were identical to those used by the GBBO in 2010–11 (GBBO 2012; ≈ 69 decibals at 1 m and ≈ 60 decibals at 30 m from the speaker). Call-playbacks were performed at every station within the transect and consisted of the following elements:

1) An initial 60 seconds of passive listening upon arriving at the station to detect and record elf owls that were calling before playback initiation.

2) Playback of three repetitions of a 1-minute recorded call cycle on a Fox Pro game caller, with each 1-minute cycle comprised of:

    a. ≈ 25 seconds of elf owl vocalizations consisting of six call iterations of territorial chatter calls

    b. ≈ 35 seconds of silence for passive listening

3) After the 3-minute playback period, an additional 60 seconds at the station for listening and to record required data.

4) A total of at least 5 minutes was allotted to each station, but more time was allowable if needed to record data.

5) While moving along the transect to the next station, surveyors were allotted up to 3 minutes to stop for passive listening (usually at 50-m intervals), especially when listening conditions were suboptimal due to environmental noise or dense vegetation. This passive listening sometimes helped surveyors to refine their position estimates for calling birds and to estimate the total number of individuals present.

In addition to basic information on location, date, time, and surveyor identification, data collected during discovery surveys at the station level included the items listed below. Several of these attributes (detection type,

vocalization type, position confidence level, community type, and new owl) could be recorded for multiple owls or multiple detections of an owl at a given station.

1) *Transect number*: Each discovery survey transect was given a unique number within a site. Coupled with the site name, this generated a unique identifier for each transect project-wide.

2) *Station number*: Each station within a given transect was consecutively numbered, starting with "1."

3) *Owl present*: A dichotomous attribute indicating whether any owls were detected from a given point.

4) *Owl count*: The total number of different owls detected at a given point.

5) *Bearing*: The compass bearing from the surveyor to the estimated owl position. Coupled with "distance," this allowed a trigonometric calculation of estimated owl position coordinates.

6) *Distance*: Estimated distance from the surveyor to the estimated owl position. See number 5 "bearing," above.

7) *Detection type*: Indicates whether the owl is detected by hearing calls, seeing the owl, or both.

8) *Vocalization type*: Distinguishes between several types of vocalization.

9) *Position confidence level:* A categorical estimate of the locational precision of the estimated owl position, as follows:

    a. *Plant*: This value indicates that the owl's position has been localized to a specific plant.

    b. *Clump*: This value indicates that owl's position has been localized to a distinct clump of vegetation but not to a specific plant.

    c. *Patch*: This value indicates that while the surveyor has high confidence that the owl is present within a particular vegetation-type patch, its location is not known down to the level of a specific plant or clump of plants.

    d. *Estimate*: This indicates that the position was estimated by triangulation after field data were recorded.

10) *Community type*: The vegetation community type present at the estimated owl location chosen from the vegetation types defined in Boone and Flesch (2016).

11) *Illumination, noise, and wind*: These three indicators of environmental conditions were recorded as shown in tables 1 and 2. The windspeed in kilometers per hour (km/h) was measured by Kestrel unit and the other attributes estimated.

12) *New owl*: This value indicates whether, in the judgement of the surveyor, a particular detection represented an individual owl that had already been recorded or is a new individual.

Table 1.—Explanation of wind and noise categories

Wind category	Explanation
0	Calm, smoke rises vertically (< 2 km/h)
1	Smoke drifts (2–5 km/h)
2	Light breeze felt on face, leaves rustle (6–12 km/h)
3	Leaves and twigs in constant motion (13–19 km/h)
4	Small branches move, raises loose paper, dust rises (20–29 km/h)
5	Fresh breeze, small trees sway (30–39 km/h)
6	Strong breeze, large branches moving, wind whistling (40–50 km/h)
Noise category	**Explanation**
0	Quiet; normal background noises; no interference
1	Low noise; might be missing some songs/calls of distant birds
2	Medium noise; detection radius is probably substantially reduced
3	High noise; probably detecting only the loudest/closest birds

Table 2.—Index of ambient illumination (with values from 0–5) used for owl survey responsiveness testing based on moon phase (rows) and position (columns)
(Phase and position are estimated by eye, and in the case of phase, assigned to the closest category).

Moon phase	Low (just above horizon – 30° above horizon)	Intermediate (30–60° above horizon)	High (60–90° above horizon)
New	0	0	0
Quarter	1	2	3
Half	2	3	4
Full	4	5	5

Territory Delineation

Overview

After confirming a final set of focal sites using discovery surveys, elf owl point locations were collected within each of these sites over an extended period in an attempt to:

1) Confirm the presence of an established breeding territory.

2) Find the nest cavity location.

3) Obtain a sufficient number of elf owl locations to analytically delineate the pair's home range (*Note*: In this report, the terms "territory" and "home range" are used interchangeably. We recognize the distinction between territory and home range, but this study was not designed to rigorously distinguish between the two).

Different methods were used to obtain elf owl locations within territories. The most commonly used method was passive listening, in which observers spent extended periods in a possible territory pinpointing locations of elf owl vocalizations. In addition, some elf owls were radio tagged with very high frequency (VHF) radio transmitters (Advanced Telemetry Systems, Isanti, Minnesota) so that location points could be obtained with telemetry. Collectively, passive listening locations and radio telemetry locations were labeled as "Detection – Territory" observations in project data, in contrast with discovery survey locations that were labeled "Detection – Discovery" observations.

In addition to passive listening surveys and radio telemetry surveys, the location of nest cavities was a high priority and the preferred way to confirm the presence of a breeding territory. Locating cavities required a combination of visual daytime searches, examination of candidate cavities with a pole-mounted video camera, and evening emergence observations. These techniques are described in more detail below.

Criteria for Territory Confirmation and Identification

Territories were considered confirmed if an occupied cavity was located, as indicated by either direct emergence observations or peeper cam observations. In the absence of finding an occupied cavity, detection of territorial calls (e.g., call types A or B; Ligon 1968) and behaviors over two or more visits to a potential territory was regarded as a territory confirmation.

Territories were designated using a combination of the site name plus a unique letter. For instance, the first territory designated at the Cienega Creek site was designated "Cienega Creek A," and any subsequent territories were designated "Cienega Creek B," "Cienega Creek C," etc.

Passive Listening

Passive listening surveys (which are identified as "Detection – Territory" observations in the project data structure) were considered preferable to call-playback surveys for territory confirmation and delineation because call-playback may artificially draw male owls to the territory edge and, therefore, generate spatial bias. Owl location estimates derived from passively heard calls are more likely to provide representative information on space use, and if collected over multiple periods of extended observation, can be sufficient to define the extent of the territory. There was no standardized protocol for passive listening surveys, but typically field crew would position themselves in one or a series of advantageous locations around the territory and listen for calls over a period of several hours. These sessions occurred at multiple dates over the course of the field season. On occasion when owls were not detected after significant time had passed, observers would broadcast single sets of territorial calls or imitate "pew" calls to rouse owls so as to determine occupancy and map locations.

When an elf owl detection occurred, the surveyor estimated the distance and bearing to the vocalizing owl. This sometimes required the surveyor to change positions to obtain a better listening vantage point. Other attributes recorded for each passive listening survey detection were similar to those recorded for the discovery surveys, with a few exceptions. One new attribute was recorded, "Pair ID," which assigned a unique code (comprised of the site name plus a letter) to each elf owl pair being observed. The attributes for discovery surveys that described "number of owls" or "new owls," and those that described environmental conditions, were not recorded for passive listening surveys.

Capture and Radio Telemetry

In 2016, passive listening detection was supplemented with radio telemetry on some territories to obtain elf owl locations. It was originally intended (see Boone and Flesch 2016) that radio telemetry would be used in territories where finding nest cavities or obtaining sufficient locations by passive listening was difficult (particularly in large patches of dense riparian vegetation), but in practice the determining factor in utilizing telemetry was whether or not owls could be captured by mist netting.

Several promising locations for radio telemetry were identified after initial passive listening sessions. The capture of owls was attempted in these locations by placing mist net arrays within the territory and using call-playback supplemented by a decoy owl to draw the resident elf owls (most typically, but not exclusively, the male) into the nets as described previously (see GBBO 2012). Each trapping crew contained at least one individual permitted by the U.S. Fish and Wildlife Service/U.S. Geological Survey Bird Banding Laboratory (Patuxent, Maryland) to capture and handle owls, apply leg bands, and affix transmitters. Captured owls were banded with U.S. Fish and Wildlife Service numbered

leg bands and fitted with a VHF radio transmitter affixed with cyanoacrylate adhesive to the interspacular region after trimming feathers in the area to a low (≈ 1/16 inch) "stubble." The transmitters weighed < 2.0 grams, which is < 5% of the typical elf owl adult body mass. Data collected for each owl during the course of handling, in addition to standard data describing location, date, time, etc., included the following (with items 3–7 being standard data required for Federal banding permit reports):

1) *Pair ID*

2) *Transmitter frequency*

3) *Leg band type*: New band versus recapture

4) *Leg band number*

5) *Wing chord length*

6) *Weight*

7) *Tail length*

8) *Brood patch*: U.S. Geological Survey categorical score indicating the degree of development of the brood patch

9) *Cloacal protuberance*: U.S. Geological Survey categorical score that indicates the degree of development of the cloacal protuberance

In addition, secondary feathers were plucked from each captured bird and submitted to the Animal Genetics Laboratory in Tallahassee, Florida (www.avianbiotech.com), for chromosomal sex determination. After processing a captured bird, it was released at point of capture. The capture team remained on site for at least 15 minutes following release to confirm (with telemetry equipment) that the bird was moving and presumably had recovered.

For each radio-tagged owl, the goal was to conduct sessions in which locations were obtained by telemetry at hourly or more frequent intervals for at least a 4- hour period. Hourly locations provide a sufficient level of independence between successive locations to estimate home range size and habitat use (Millspaugh and Marzluff 2001). Telemetry sessions were spaced at intervals of a week or less as long as transmitters remained attached and functional, and were conducted only during periods of fair weather when wind did not create continuously audible noise. Owls were tracked using two types of three-element, hand-held antennas and hand-held radio receivers (the TR-4 receiver made by Telonics, Inc., Mesa, Arizona; and the R-1000 receiver made by Communications Specialists, Inc., Orange California). Where possible, locations were obtained by

localizing signals to single trees or discrete vegetation clumps and by recording observation coordinates, bearing to an owl, and estimated distance to an owl. When field crew could not localize an owl in this manner, they obtained bi- or triangulated position estimates by obtaining bearings to a single owl location from two or three different locations. Data recorded during the course of obtaining telemetry locations for elf owls was similar to that collected for discovery and passive listening surveys and, in addition, included the following:

1) *Pair ID*

2) *Transmitter frequency*

3) *Type of observation:* This distinguished between "direct" observations (in which a single bearing and distance estimate were obtained as the basis for estimating owl position) and "indirect" observations in which multiple bearings were taken to estimate owl location by bi- or triangulation.

4) *Station number:* This value allowed multiple bearings meant to be used to generate a single location to be grouped appropriately and distinguished from other groups of bearings.

5) *Distance:* For direct observations only, this was the estimated distance to an owl. Coupled with a bearing, it allowed the trigonometric calculation of estimated owl position.

6) *Bearing:* For direct and indirect observations, this was the compass bearing(s) from the surveyor to the estimated owl position. It allowed for calculation of estimated owl position either trigonometrically (for direct observations) or by triangulation (for indirect observations).

7) *Movement type:* This value distinguished between locations where an owl appeared to be stationary versus those where it appeared to be moving. Obtaining an indirect observation by bi- or triangulation required at least two sequential bearings for which the owl appeared to be stationary.

Nest Locations

The techniques used to attempt to locate nest cavities was opportunistic and varied somewhat across focal territories. In general, field crews searched during daylight hours for possible nesting cavities on suitable substrates, often guided by locational information obtained during previous passive listening or telemetry surveys. They also observed possible cavity sites at dusk in an attempt to visually detect owls entering or leaving their nesting cavity. Confirmation of a nesting cavity could be obtained either by visually detecting owls in the cavity using a pole-mounted video camera or by observing owls entering or leaving a cavity.

Multiple attributes were recorded by field crews in the process of examining and confirming nest cavities and included the following for all cavities examined:

1) *Pair ID*: As above.

2) *Nest confirmation type*: The means by which the nest cavity was confirmed to be occupied. This could include use of a peeper cam to see owls in the cavity, observation of emergence from or entry into the cavity, or by obtaining a highly localized location on a radio-tagged owl.

3) *Nest confirmed*: Records whether observations of a particular cavity resulted in a nest confirmation of not.

4) *Distance:* The distance from the surveyor to the nest cavity. Coupled with a bearing, it allowed trigonometric calculation of the cavity coordinates.

5) *Bearing*

The following attributes were only recorded for confirmed nest cavities:

6) *Nest ID*: A unique number identifying each unique confirmed nest cavity.

7) *Nest tree type*: Identified whether the nest cavity substrate was a live plant or snag.

8) *Species*: Identified the nest plant species.

9) *Height*: The total height of the plant on which the nest cavity occurred.

10) *Cavity height*: The height of the entrance to the nest cavity above ground.

11) *Cavity aspect*: Compass direction of the nest cavity entrance.

12) *Community type*: As above.

13) *Cavity entrance length and width:* Estimated if > 10 m above ground or measured with a ruler mounted on a pole to the nearest 0.5 centimeter. Only measured in 2017.

Responsiveness Tests

Responsiveness tests are call-playback surveys performed from points that are a known distance from previously confirmed elf owl nest cavities. The purpose of a response test is to systematically determine the conditions under which elf owls respond to call-playbacks and the conditions under which surveyors can detect those responses. This information is used to quantify the detection probability of elf owls and to construct a standardized elf owl survey protocol with a known false absence rate that is suitable for use in areas of interest to Reclamation. Response tests were conducted during previous elf owl research by the GBBO in the LCR MSCP planning area in 2010–11 (see GBBO 2012), and additional tests were conducted in 2016 to supplement these data.

Responsiveness tests were performed across a series of fixed test distances (i.e., distance from the call-playback surveyor to the nest cavity), and ideally the full complement of distances were tested for each elf owl territory that was investigated. The goal for 2016 was to conduct a full set of responsiveness tests on approximately 12 confirmed elf owl pairs for which nest cavities were either known or had been localized to a small area of < 10 m radius. Response tests were conducted using the protocol developed in 2010–11 by the GBBO and approved by Reclamation (GBBO 2012), with some small modifications in the attributes recorded. Compared to 2010–11 responsiveness tests, those done in 2016 were performed at a different series of test distances and in locations where significant vegetation obstruction was present. Vegetation obstruction in this context was defined as the presence of continuous or nearly continuous vegetation with an average canopy height of at least 5 m along a linear pathway between the owl and the surveyor conducting the responsiveness test (GBBO 2012). Functionally, this meant that responsiveness tests in 2016 were done for territories that were entirely or partly located in riparian habitat where vegetation was sufficiently dense to meet the definition of "obstructed conditions." Responsiveness test distances used in 2016 were 50, 100, 150, 200, and 250 m from known or approximate nest cavity locations. To avoid confounding distance effects with other potential factors, the order in which the array of fixed distances was tested within each territory was randomized.

As elf owl territories were confirmed (see previous section), they were considered for responsiveness testing based on several criteria. These criteria included the opportunity to conduct tests in obstructed vegetation conditions (see above) across the full range of test distances, knowledge of nest cavity location, avoidance of areas where multiple neighboring territories were in close proximity (which could complicate interpretation of responses), and geographical distribution of responsiveness test sites.

Response tests involved a paired survey team consisting of a "surveyor" that conducted the test using call-playback from the predetermined fixed distance and

an "observer" stationed near target owls to confirm owl presence and to document any owl responses not apparent to the surveyor. At a predetermined time, the surveyor conducted a standard call-playback survey (as described in the "Discovery Surveys" section, above) from the selected distance, but with an extended listening period of 5 minutes. The surveyor recorded any owl responses they detected during the 5-minute period. The observer collected information on owl positions and activities beginning approximately 10 minutes prior to initiation of call-playback and continued recording this information for the duration of the test. Responsiveness tests in which the observer did not confirm presence of a target owl at or near the nest site were generally considered invalid and discarded, though exceptions were made on a case-by-case basis if other data argued for inclusion.

To minimize habituation and disturbance, no territory was subjected to responsiveness testing more than once every 6 days, or more than five times per field season. Responsiveness tests were typically not conducted when wind conditions produced consistent audible noise (i.e., < 12 miles per hour windspeed, as measured by hand-held Kestrel® windspeed indicators). All tests were initiated before midnight, the period during which owls were determined to be most responsive during 2010–11 responsiveness testing (GBBO 2012).

Data recorded by the surveyor and observer during a responsiveness test were different. In addition to standard locational and time data, the surveyor recorded the following items:

1) *Windspeed*: See above.

2) *Noise*: See above.

3) *Illumination*: See above. Because moon phase can have both positive and negative effects on owl activity and vocalizations depending on the species (Clark and Anderson 1997; Ganey 1990; Morrell et al. 1991), it was recorded as an index linked to the quantity of light produced by the moon depending on moon phase and position. This index was treated as a continuous factor in models (see table 2).

4) *Station number*: This is unique number given to each responsiveness tests to allow surveyor and observer data to match up correctly.

5) *Pair ID*: As above.

6) *Distance category*: Indicates the fixed test distance at which the test was performed (50, 100, 150, 200, or 250 m).

7) *Obstruction index*: Categorical ranking of the degree of vegetation obstruction. This was estimated by eye, and was intended to reflect the average three-dimensional vegetation volume present along the pathway between the surveyor's position and cavity location. The pathway was defined as a "box" from 1 - 8 m above ground and 8 m wide, from the surveyor to the owl nest location. Five categories were defined as follows: 5–20% vegetation volume, 21–40 %, 41–60%, 61–80%, and > 80%. Pathways where average vegetation volume was less than 5% were considered "unobstructed" and were generally not included in the 2016 responsiveness tests.

8) *Response type*: Indicates whether the response(s) detected by the surveyor were calls, movements, or both. This value could be entered for multiple sequential detections during the course of a responsiveness test.

9) *Time response*: Indicates the time after initiation of call-playback when a specific response was detected.

10) *Vocalization type*: For aural responses, an indication of the call type (as above).

11) *Distance*: As above.

12) *Bearing*: As above.

13) *Target owl*: For each recorded response, an indication of whether the response appeared to come from the targeted owl pair or a different, neighboring owl pair, in the judgement of the surveyor.

The observer recorded many of these same attributes from their location (and with respect to their location), including station number, pair ID, distance, bearing, response type, vocalization type, time response, and target owl. In addition, they recorded:

1) *Telemetry*: This indicated whether the test involved a bird with a radio tag.

2) *Transmitter frequency*: If the test involved a telemetered bird, the frequency of the transmitter.

3) *Broadcast heard*: Indicates whether the observer heard the call-playback from his or her location.

4) *Owl present*: Indicates whether or not the observer confirms that the target owl or pair is present at or near its expected location at the nest cavity. Where this was not confirmed, the responsiveness test was invalidated.

Territory Assessment

When five or more owl locations were obtained during a territory delineation, rapid assessment of the vegetation and habitat within that territory was made, with the following exceptions:

1) If a nest cavity was confirmed, an assessment was done even if there were fewer than five location points.

2) In cases where there were less than five location points, but where these points were obtained at least 6 weeks apart (strongly suggesting the existence of a breeding territory), an assessment was made.

3) In some cases where there were five location points, assessments were not done because of the lack of landowner permission to access the site or because there was uncertainty about the existence of an actual breeding territory.

Territories were delineated in two ways: fixed-radius buffers and 95% minimum convex polygons (MCPs). Fixed-radius buffers were created for all territories by delineating a 75-m-radius circular polygon (≈ 1.77 hectares [ha]) around the nest site (if known) or alternatively an activity center (AC) for the territory. Where needed, the AC was calculated from existing location points using the ArcGIS "Mean Center" tool, and the 75-m circle centered around this point. The 75-m fixed-radius buffer size was chosen because it was thought to approximate the territory of a typical elf owl breeding pair (GBBO 2012; Gamel and Brush 2001). MCPs (95%) were calculated for only the subset of territories with sufficient locations using Biotas software (http://www.ecostats.com/web/Biotas). Area versus sample size plots were reviewed for each MCP for the presence of an asymptote.[1] MCPs where an asymptote was not reached were discarded.

Assessment procedures were the same for 75-m circles and 95% MCPs. Field crews used paper maps of each 75-m circle and MCPs were printed on top of

[1] An asymptote is where the curve plotting the MCP area (Y-axis) against the number of estimated owl locations used to generate the MCP estimate (X-axis) levels off and stays there. If there is a clear asymptote, the MCP won't change much with additional data; therefore, it is a good estimate of home range. Where there is not an asymptote, collecting additional data might increase the size of the MCP by a substantial but unknown amount, so this is not a good home range estimate.

aerial imagery. They walked within each polygon and sketched on the map boundaries of distinct vegetation communities types as defined in Boone and Flesch (2016). Each patch with a given territory was assigned a sequential "habitat identification ID" (HAID) number, starting at "1." For each territory, the following attributes were recorded while in the field:

1) *Pair ID*: As above.

2) *Assessment type*: This indicates whether the assessment is being done on a 75-m circle around the nest site or AC, or on a MCP. For territories where both were done, spatial overlap did occur, but these comprised separate assessments and separate data records.

3) *Activity center ID*: Where applicable, a unique identifier for each calculated AC (see above).

4) *Distance*: Shortest distance from any portion of the territory to the riparian/upland ecotone. Where the ecotone abutted or was within the territory, this distance was "0."

5) *Width*: The width of the riparian corridor along a line passing through the territory center and perpendicular to the main drainage channel.

6) *Saguaro count*: Then number of saguaro cacti (*Carnegiea gigantea*) > 4 m in height (i.e., large enough to have potential cavities) or that for any other reason appear to be suitable for elf owl use that are present within the delineated territory.

7) *Snag count*: The number of snags > 24 inches in diameter, or that for any other reason appear suitable for elf owl use, that are present in the territory.

For each HAID, the following attributes were recorded in the field:

1) *Community type*: As above. The community type that characterizes the HAID.

2) *Height*: The average height of vegetation within the HAID.

3) *Canopy cover*: Categorical value for average canopy cover within the HAID (< 5%, 5–10%, 10–20%, 20–40%, 40–60%, 60–80%, > 80%).

4) *LowMidVol*: Estimated vegetation volume in the vegetation layer between 1–3 m above ground, to the nearest 5%.

5) *MidVol*: Estimated vegetation volume within the vegetation layer 3–6 m above ground, to the nearest 5%.

Data Collection and Management

Except for HAID delineation in the field, all data were recorded on Trimble Juno devices using mobile electronic field forms (MEFFs) that were constructed by Reclamation.

Several steps were taken to ensure that data were recorded accurately and correctly. After survey sessions, surveyors (who worked in pairs) exchanged their Trimble units to review one another's MEFF-based data for consistency and completeness. Any questionable data entries were brought to the attention of the surveyor who originally recorded them for possible correction. After this step, Trimble data were uploaded to Pathfinder software for further review or entered into Pathfinder manually if required. This step was either performed or supervised in all cases by GBBO's David Vander Pluym or Alicia Arcidiacono, both of whom have worked multiple years on LCR MSCP projects and have high levels of competence and familiarity with MEFFs and Pathfinder. Once in Pathfinder, data were then differentially corrected, and any resulting coordinates that appeared problematic when plotted on base maps were further examined and corrected if appropriate. A final review of the data was conducted before delivery to the Reclamation point-of-contact for further review. Any issues identified during this review were brought to the attention of the GBBO and University of Arizona and corrected as appropriate. After all reviews, data were bundled and submitted to Reclamation via the SharePoint system, per Reclamation protocols.

Data Post-Processing

Many data attributes were not measured or estimated directly while in the field but derived from other attributes at a later time. The attributes that were derived in this manner are itemized below (including a description of the datasets to which they are relevant). Additional details and intermediate work products, including an accounting of whether the GBBO or Reclamation performed a given post-processing step, will be provided as part of the final comprehensive project report.

1) *Universal Transverse Mercator (UTM) coordinate conversion*: The study area for the project occurred in two different UTM zones, 11S and 12 S. All Reclamation data associated with the LCR MSCP is by default kept in a Zone 11 S framework even if the data were recorded in Zone 12 S. Because some data were recorded using the native (Zone 12 S) setting in the field, and because UTMs in the native Zone 12 S framework were

required for some data operations, it was necessary to create a zone "cross-walk" table that provided UTMs of each data point in both Zone 11 S and Zone 12 S frameworks regardless of the native zone of the data point. This post-processing step was relevant to all datasets.

2) *Direct owl position and nest cavity position*: For all datasets, estimated positions of owls or nest cavities were computed from distance and bearing estimates using these formulas:

$$N_{(x)} = N_{(o)} + (D(\cos B))$$

and

$$E_{(x)} = E_{(o)} + (D(\sin B))$$

where:

$N_{(x)}$ = estimated owl or nest cavity northing
$N_{(o)}$ = observer northing
D = estimated distance (surveyor to owl or nest cavity) in meters
B = true bearing (corrected for declination) from surveyor to owl or nest cavity in degrees
$E_{(x)}$ = estimated owl or nest cavity easting
$E_{(o)}$ = observer easting

3) *Indirect owl position*: This post-processing step was relevant only to telemetry data using bi-or triangulated position estimation from two or more bearings. Bearing data were input into LOAS software (http://www.ecostats.com/web/LOAS) to estimate owl positions using triangulation. The software output does not generate position estimates for some bearing groupings where there is no intersection, and these positions were discarded. For positions derived from three or more bearings, angle errors and estimated distances were examined to evaluate position estimate quality. Angle bearing errors are given greater precedence, and where this value was high (> 10° on average), the position estimate was deleted. In marginal cases, estimated receiver distance was also considered. If this value was large relative to the overall dataset average, the position was deleted. For a position derived from two bearings only, no angle error could be computed, and the only method available to assess position estimate quality was to determine whether the estimated position fell within or outside of other use points obtained for the same pair. Positions that fell outside the cluster of other points were discarded as likely outliers.

4) *Final Pair ID*: The "PairID" assigned during field observations was based on the knowledge available to the surveyor at the time the position estimate was made. This knowledge was often incomplete at the time of data recording, especially early in the field season. As the field season progressed, additional knowledge about neighboring territories was gathered, and the accumulation of position estimates associated with a given territory gave more resolution to that territory's spatial extent. In some cases, this increased knowledge provided a basis for concluding that an owl position point originally assigned to one territory was most likely associated with a different territory. The re-examination of the territories to which initial position estimates were assigned was a critical post-processing step that was most relevant to territory delineation and assessment datasets, and indirectly relevant to nest cavity data. It was not relevant to responsiveness test data, as responsiveness tests were done only on territories where no ambiguity about pair identity existed. The procedure for assigning the final pair ID involved plotting all recorded nest sites and owl position estimates, labelling these points by their initially assigned "PairID" values, and looking for spatial patterns of the point clusters that were generated. Where a point that was initially assigned to one territory was most logically associated with a neighboring territory, the pair ID value was changed. The spatial basis for this procedure is that, during the breeding season, elf owls are highly territorial (Ligon 1968), making it unlikely that neighboring territories overlap to any appreciable extent.

5) *Activity centers*: ACs were calculated for some territories as described above in the "Territory Assessment" section. This post-processing step was relevant to the territory assessment dataset.

6) *75-m radius "territory" circles*: 75-m radius buffers approximating the anticipated home range were calculated for most territories as described above in the "Territory Assessment" section. This post-processing step was relevant to the territory assessment dataset.

7) *MCP home range polygons*: Calculation of 95% MCP home range polygons for some territories was a post-processing step that is described above in the "Territory Assessment" section. This post-processing step was relevant to the territory assessment dataset.

8) *HAID delineation*: As described above in the "Territory Assessment" section, distinct vegetation patches (HAIDs) that were sketched by hand onto imagery maps in the field were later digitized in ArcGIS. This post-processing step was relevant to the territory assessment datasets.

9) *HAID percentages*: After digitizing all HAIDs (previous item), the area of each HAID and the percentage it comprised of the total home range polygon (either a 75-m-radius circle or a 95% MCP) were calculated in ArcGIS.

10) *Time after response*: This post-processing step was relevant only to the responsiveness test dataset. The "time after response" for any responses obtained was calculated by subtracting the time at which the call-playback began from the time when a given response was detected.

Data Analysis

For the purpose this report, only 2016 data were summarized. Data from 2016 will be combined with that for other years for analysis and presented in the final comprehensive project report.

Training, Timeline, and Personnel

Training of field crews occurred during the second week of March 2016. Four crew members in 2016 were returnees from 2015, and they served to familiarize new crew members with project protocols and practices. The training period included an introduction of project goals and protocols, field training in all techniques to be employed, and thorough treatment of data recording standards and data management requirements and duties. Crew members were familiarized with elf owl vocalization using recordings obtained from multiple sources, covering all the vocalization types described by Henry and Gehlbach (1999) and Ligon (1968). Additionally, all crew members were tested to ensure that they have adequate hearing ability to detect elf owl call-playbacks and vocalizations from at least 400 m under optimal conditions (no audible wind and no physical impediments to sound transmission). All field techniques were trialed under realistic but controlled field conditions to ensure comparability data collected, particularly with regard to estimation of distances, bearings, and rapid assessment of community type and habitat/vegetation parameters.

The main field season for data collection, which included all project elements except for territory assessments, began on March 14, 2016, and continued until June 29, 2016. Discovery surveys occurred from March 14 to May 12; territory delineation (passive listening surveys and telemetry surveys) occurred from March 21 to June 29; nest searches and confirmations occurred from April 25 to June 29; and responsive tests occurred from April 11 to June 29. A separate fall field season took place between September 20 to October 25 during which selected territories were assessed.

Personnel involved in data collection were David Vander Pluym, Alicia Arcidiacono, Keith Brennan, Carlos Sanchez Gonzalez, Aaron Flesch, Vincent Murphy, Robert Villa, Geoff Bland, Kelly Urban, and Diane Wong-Kone.

RESULTS

Focal Site Selection and Discovery Surveys

Twenty candidate focal sites were initially identified in 11 different drainages using the criteria discussed previously. In all but one of these sites (see below), discovery surveys were repeated at 37 transects previously surveyed in 2015 to determine if owls were still present at locations where they had been detected the previous spring. In addition, eight new discovery transects were surveyed within five of these candidate focal sites and in one new site (Kohen Ranch in the Bill Williams River watershed) (table 3). Data from the new transects was added to the overall elf owl occurrence dataset (see Boone and Flesch 2017), but data from the other 37 repeated transects were not.

Of the 45 discovery survey transects operated between March 14 and May 12 in 2016, there were 1,764 elf owl detections recorded (table 3). Based on these data, 13 sites were retained for intensive territory delineation study (next section), and 1 additional site on which discovery surveys were not done (BW Marsh) was also added based on incidental owl detections, for a total of 14 final focal sites. The remaining seven sites had either insufficient evidence of elf owl territoriality to retain as focal sites, or were deferred until 2017 for other reasons, and were omitted from further investigation in 2016.

Territory Delineation and Nest Sites

Using a combination of passive listening surveys and radio telemetry, 2,281 elf owl locations were obtained (1,895 by passive listening, 386 by radio telemetry) to assist in territory delineation and confirmation. These data were gathered from March 21 to June 29 at what were eventually determined to be 118 candidate territories. Nest cavities were identified and characterized for 55 of these territories during the period from April 25 to June 27.

Table 4 summarizes all of the candidate territories that were investigated in 2016. Of the 118 candidate territories, 89 were confirmed based on 1 or more of the criteria previously described, and these were the subjects of later responsiveness tests and territory assessments (below). Confirmed territories and associated location points are shown in attachment 1.

Table 3.—Candidate focal sites for 2016 field work, with jurisdictions, number of discovery transects surveyed in total and (in parentheses) number of discovery transects that had not been previously surveyed in 2015, and number of elf owls detected by discovery surveys (Sites with single asterisks were selected for further study based on the presence of a sufficient number of elf owls and evidence of territoriality in the initial discovery surveys. One site denoted by double asterisks was also added for further study based on incidental observations. All locations are in Arizona.)

Watershed	Site	Jurisdiction[1]	Number of discovery transects (new)	Number of elf owl detections
Arivaca Creek	Arivaca Creek*	FWS	3 (1)	186
Big Sandy River	Big Sandy North	BLM	5	6
Alamo Lake	Borrow Pit*	BLM	1	12
Bill Williams River	Browns Crossing*	BLM	3	12
Bill Williams River	BW Marsh**	FWS	0	NA
Bill Williams River	BW Delta	FWS	2	6
Cienega Creek	Cienega Creek*	Pima County	5 (2)	210
Bill Williams River	Cross River	FWS	1	60
Date Creek	Date Creek*	AZSLD, private	2	162
Bill Williams River	Fox Wash*	FWS	2 (1)	60
Bill Williams River	Kohen Ranch*	FWS	1 (1)	36
Bill Williams River	Middle Delta	FWS	1	36
Bill Williams River	Mosquito Flats*	FWS	3	126
Bill Williams River	North Burn	FWS	1	0
Posta Quemada	Posta Quemada*	Pima County	1	156
Rincon Creek	Rincon Creek*	NPS private	1	126
Bill Williams River	Saguaro Slot*	FWS	2 (1)	72
San Pedro River	San Pedro River	BLM, USFS	3 (2)	168
Bill Williams River	Sandy Wash	FWS	1	6
Santa Cruz River	Santa Cruz River*	University of Arizona, Pima County	1	66
Santa Maria River	Santa Maria River*	BLM	6	258
		Total	**45 (8)**	**1,764**

[1] AZSLD = Arizona State Land Department; BLM = Bureau of Land Management; FWS = U.S. Fish and Wildlife Service; NPS = National Park Service; and USFS = U.S. Forest Service.

Table 4.—Summary of territory delineation work on 118 candidate focal territories (distinguished by unique "pair" values) in 2016

("Nest" indicates whether a nest cavity was confirmed for the territory. "Passive points" is the total number of elf owl locations obtained for the territory by passive listening surveys. "Telemetry points" is the number of locations obtained by telemetry. "Total points" is the total of all location points. "Confirmed" indicates whether or not the candidate territory was confirmed as a breeding territory based on one or more of the criteria previously described.)

Pair	Nest	Passive points	Telemetry points	Total points	Confirmed
Arivaca Creek A	Yes	7	19	26	Yes
Arivaca Creek B	Yes	23	0	23	Yes
Arivaca Creek C	Yes	10	0	10	Yes
Arivaca Creek D	No	14	0	14	Yes
Arivaca Creek E	Yes	15	0	15	Yes
Arivaca Creek F	No	9	0	9	Yes
Arivaca Creek G	Yes	12	0	12	Yes
Arivaca Creek I	No	3	0	3	No
Arivaca Creek J	No	5	0	5	Yes
Arivaca Creek K	No	4	0	4	No
Arivaca Creek L	No	10	0	10	Yes
Arivaca Creek LL	No	1	0	1	No
Arivaca Creek M	Yes	19	0	19	Yes
Arivaca Creek N	No	4	0	4	Yes
Arivaca Creek O	No	6	0	6	Yes
Arivaca Creek P	No	2	11	13	No
Arivaca Creek U	Yes	14	1	15	Yes
Arivaca Creek V	Yes	18	0	18	Yes
Arivaca Creek W	Yes	13	0	13	Yes
Arivaca Creek X	No	3	12	15	Yes
Arivaca Creek Y	Yes	8	0	8	Yes
Arivaca Creek Z	No	5	0	5	No
Borrow Pit A	Yes	36	0	36	Yes
Borrow Pit C	Yes	42	0	42	Yes
Browns Crossing A	No	5	0	5	Yes

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("Nest" indicates whether a nest cavity was confirmed for the territory. "Passive points" is the total number of elf owl locations obtained for the territory by passive listening surveys. "Telemetry points" is the number of locations obtained by telemetry. "Total points" is the total of all location points. "Confirmed" indicates whether or not the candidate territory was confirmed as a breeding territory based on one or more of the criteria previously described.)

Pair	Nest	Passive points	Telemetry points	Total points	Confirmed
BW Marsh A	No	61	0	61	Yes
BW Marsh B	No	6	0	6	No
BW Marsh C	No	26	0	26	Yes
BW Marsh D	No	1	0	1	No
Cienega Creek A	Yes	5	0	5	Yes
Cienega Creek B	Yes	10	0	10	Yes
Cienega Creek C	Yes	4	0	4	Yes
Cienega Creek D	Yes	15	0	15	Yes
Cienega Creek E	Yes	3	0	3	Yes
Cienega Creek F	Yes	2	0	2	Yes
Cienega Creek G	No	1	0	1	No
Cienega Creek H	No	6	0	6	Yes
Cienega Creek I	Yes	6	0	6	Yes
Cienega Creek K	No	1	0	1	No
Cienega Creek L	Yes	0	0	0	Yes
Cienega Creek M	Yes	0	0	0	Yes
Cienega Creek N	No	3	0	3	No
Cienega Creek O	Yes	1	0	1	Yes
Cienega Creek P	No	1	0	1	No
Cienega Creek U	Yes	0	0	0	Yes
Date Creek A	No	17	0	17	No
Date Creek B	No	29	0	29	Yes
Date Creek C	Yes	12	0	12	Yes
Date Creek D	Yes	49	0	49	Yes
Date Creek E	No	13	0	13	Yes

Table 4.—Summary of territory delineation work on 118 candidate focal territories (distinguished by unique "pair" values) in 2016

("Nest" indicates whether a nest cavity was confirmed for the territory. "Passive points" is the total number of elf owl locations obtained for the territory by passive listening surveys. "Telemetry points" is the number of locations obtained by telemetry. "Total points" is the total of all location points. "Confirmed" indicates whether or not the candidate territory was confirmed as a breeding territory based on one or more of the criteria previously described.)

Pair	Nest	Passive points	Telemetry points	Total points	Confirmed
Date Creek F	No	74	106	180	Yes
Date Creek G	Yes	86	0	86	Yes
Date Creek H	No	4	0	4	No
Date Creek J	No	67	0	67	Yes
Date Creek K	Yes	42	0	42	Yes
Date Creek L	No	46	0	46	Yes
Date Creek M	No	18	0	18	Yes
Date Creek N	Yes	19	0	19	Yes
Date Creek O	Yes	13	0	13	Yes
Date Creek P	No	1	0	1	No
Date Creek Q	No	2	0	2	No
Date Creek R	No	1	0	1	No
Fox Wash A	Yes	59	0	59	Yes
Fox Wash B	No	6	0	6	No
Kohen Ranch A	No	39	91	130	Yes
Kohen Ranch B	No	6	0	6	Yes
Kohen Ranch C	No	1	0	1	No
Kohen Ranch D	No	1	0	1	No
Mosquito Flats A	Yes	56	0	56	Yes
Mosquito Flats B	Yes	60	0	60	Yes
Mosquito Flats C	Yes	31	137	168	Yes
Mosquito Flats D	No	49	0	49	Yes
Posta Quemada A	No	3	0	3	No
Posta Quemada B	No	3	0	3	Yes
Posta Quemada C	Yes	1	0	1	Yes

Table 4.—Summary of territory delineation work on 118 candidate focal territories (distinguished by unique "pair" values) in 2016

("Nest" indicates whether a nest cavity was confirmed for the territory. "Passive points" is the total number of elf owl locations obtained for the territory by passive listening surveys. "Telemetry points" is the number of locations obtained by telemetry. "Total points" is the total of all location points. "Confirmed" indicates whether or not the candidate territory was confirmed as a breeding territory based on one or more of the criteria previously described.)

Pair	Nest	Passive points	Telemetry points	Total points	Confirmed
Posta Quemada D	Yes	2	0	2	Yes
Posta Quemada E	Yes	5	0	5	Yes
Posta Quemada F	Yes	10	0	10	Yes
Posta Quemada G	No	13	0	13	Yes
Posta Quemada H	Yes	8	0	8	Yes
Posta Quemada I	No	13	0	13	Yes
Posta Quemada J	Yes	6	0	6	Yes
Posta Quemada L	Yes	6	0	6	Yes
Rincon Creek A	Yes	12	0	12	Yes
Rincon Creek B	No	8	0	8	Yes
Rincon Creek C	Yes	13	0	13	Yes
Rincon Creek D	No	13	0	13	Yes
Rincon Creek E	Yes	6	0	6	Yes
Rincon Creek F	Yes	14	0	14	Yes
Rincon Creek G	Yes	11	0	11	Yes
Rincon Creek H	Yes	8	0	8	Yes
Rincon Creek I	No	16	0	16	Yes
Rincon Creek Z	No	2	0	2	No
Saguaro Slot A	Yes	89	0	89	Yes
Saguaro Slot B	Yes	92	0	92	Yes
Saguaro Slot E	No	1	0	1	No
Saguaro Slot F	No	1	0	1	No
Saguaro Slot G	No	1	0	1	No
Santa Cruz River A	Yes	1	0	1	Yes
Santa Cruz River B	Yes	0	0	0	Yes

Table 4.—Summary of territory delineation work on 118 candidate focal territories (distinguished by unique "pair" values) in 2016

("Nest" indicates whether a nest cavity was confirmed for the territory. "Passive points" is the total number of elf owl locations obtained for the territory by passive listening surveys. "Telemetry points" is the number of locations obtained by telemetry. "Total points" is the total of all location points. "Confirmed" indicates whether or not the candidate territory was confirmed as a breeding territory based on one or more of the criteria previously described.)

Pair	Nest	Passive points	Telemetry points	Total points	Confirmed
Santa Cruz River C	Yes	0	0	0	Yes
Santa Cruz River D	Yes	0	0	0	Yes
Santa Cruz River E	Yes	0	0	0	Yes
Santa Maria River A	No	1	0	1	No
Santa Maria River B	No	1	0	1	No
Santa Maria River C	No	18	0	18	Yes
Santa Maria River D	No	52	9	61	Yes
Santa Maria River E	No	2	0	2	No
Santa Maria River F	Yes	37	0	37	Yes
Santa Maria River H	Yes	35	0	35	Yes
Santa Maria River I	No	30	0	30	Yes
Santa Maria River J	No	9	0	9	Yes
Santa Maria River K	No	73	0	73	Yes
Santa Maria River L	No	5	0	5	Yes
Santa Maria River M	No	8	0	8	Yes
Santa Maria River N	No	22	0	22	Yes
Santa Maria River O	No	2	0	2	No
Santa Maria River P	No	1	0	1	No
	Total	**1,895**	**386**	**2,281**	

As summarized in table 5, most confirmed nest cavities were in saguaro cacti, though 11 were in live cottonwoods (*Populus fremontii*) or cottonwood snags. Nearly half of all nest cavities were present in xeric riparian habitat (see Boone and Flesch 2016 for definition), but as illustrated in attachment 1, many nest cavities located in a cactus had territories that extended into mesic riparian vegetation.

Table 5.—Summary of selected characteristics of confirmed nest cavities in 2016, organized by site, region, and substrate type

(Vegetation community codes are DS = desert shrubland, ADS = arborescent desert scrub, DW = desert woodland, MR = mesic riparian, and XR = xeric riparian. These vegetation community types and the extents of the east and west regions are fully defined in Boone and Flesh 2016, 2017). Mean [± standard error] cavity heights and substrate plant heights are also shown.)

	Number of nest cavities	Substrate			Vegetation community					Cavity height (m) mean ± standard error	Substrate height (m) mean ± standard error
		Saguaro	*Populus*, live	*Populus*, snag	DS	ADS	DW	MR	XR		
Site											
Arivaca Creek	10	0	4	6	0	0	0	10	0	14.4±1.6	18.9±1.6
Bill Williams River West[1]	8	8	0	0	3	1	0	0	4	5.7+/-0.4	7.0+/-0.3
Cienega Creek	11	11	0	0	1	0	0	0	10	6.3+/-0.3	8.4+/-0.4
Date Creek	6	5	1	0	0	3	1	1	1	6.4+/-0.7	9.7+/-1.2
Posta Quemada	7	7	0	0	0	2	0	0	5	6.1+/-0.4	8.3+/-0.4
Rincon Creek	6	6	0	0	0	2	1	0	3	5.2+/-0.6	7.8+/-0.7
Santa Cruz River	5	5	0	0	0	2	0	0	3	6.1+/-0.7	7.8+/-0.2
Santa Maria River[2]	2	2	0	0	1	0	1	0	0	6.6 [2]	8.6+/-0.5
Region											
East	39	29	4	6	1	6	1	10	21	8.1+/-0.7	10.9+/-0.9
West	16	15	1	0	4	4	2	1	5	6.0+/-0.4	8.2+/-0.6
Species											
Saguaro	44	44	-	-	5	10	3	0	26	5.9+/-0.2	8.0+/-0.2
Cottonwood (*Populus* spp.)	11	-	5	6	0	0	0	11	0	13.9+/-1.5	18.5+/-1.5
All	**55**	**44**	**5**	**6**	**5**	**10**	**3**	**11**	**26**	**7.6+/-0.6**	**10.1+/-0.7**

[1] This includes the specific sites of Borrow Pit, Fox Wash, Mosquito Flats, and Saguaro Slot.
[2] Cavity height was not recorded for one nest.

Capture and Radio Telemetry

Capture attempts via mist net were made in over 13 different sessions at 6 different sites in April and May, as summarized in table 6. Over the course of these attempts, 13 owls were captured and leg banded, and 11 of these were also radio tagged (the remaining 2 were released after banding due to signs of stress). Gender was obtained for all radio-tagged owls and for one of the two additional banded owls by karyotype (table 6), and they were predominantly male.

Table 6.—Summary of elf owl capture attempts and results by mist net in 2016
(In the "Results" column, outcome codes are: #C = number of owls captured (where # is replaced by a number); #B = the number of captured owls that were leg banded; and # R = the number of captured owls that were radio tagged. In the "Gender" column, NA = not applicable.)

Site	Date	Number of Nets	Results	Gender
Santa Maria River	4/21	2	0C	NA
Kohen Ranch	4/25	4	1C (1B 1R)	1 male
Mosquito Flats	4/26	2	1C (1B 1R)	1 male
Santa Maria River	4/27	2	1C (1B 1R)	1 male
Cienega Creek	4/28	4	NC	NA
Date Creek	4/28	2	1C (1B 0R)	1 female
Cienega Creek	4/29	3	NC	NA
Arivaca Creek	5/1	8	2C (2B 2R)	1 male, 1 female
Arivaca Creek	5/2	7	2C* (2B 2R)	2 males
Date Creek	5/2	2	1C (1B 1R)	1 male
Arivaca Creek	5/3	7	4C* (4B 3R)	2 males, 1 female, 1 unknown (individual not radio tagged)
Santa Maria River	5/3	4	NC	NA
Santa Maria River	5/4	5	NC	NA
Total			13C**(13B 11R)	

* One of these owls was recaptured from earlier capture attempts.
** Two of these owls were recaptured from earlier capture attempts.

All radio-tagged owls were periodically surveyed by telemetry to obtain locations. The number of valid locations obtained via radio telemetry observations (either direct or indirect; see the "Methods" section) is summarized in table 7. For unknown reasons, radio telemetry was generally more successful for owls radio tagged in the western sites (Kohen Ranch, Mosquito Flats, Date Creek, and Santa Maria River) than in the east (Arivaca Creek). Three of the western birds retained their radio tags for a month or longer. In contrast, three of the radio-tagged owls at Arivaca Creek lost their tags before any locations could be generated, another lost its tag after the first day, and the remaining three retained their tags for 1–2 weeks.

Table 7.—Summary of telemetry survey results
(The number of valid telemetry locations may be lower than the number of telemetry observations recorded in the field for either of two reasons. First, some indirect positions taken in the field were discarded as being of poor quality, as described in the Methods section. Second, some initially assumed pair IDs attached to telemetry observations were later reassigned as also described in the "Methods" section.)

Pair	Number of valid telemetry locations	Tagging date	Telemetry date range	Tag frequency
Kohen Ranch A	91	4/25	4/29 – 5/24	150.251
Mosquito Flats C	137	4/26	5/2 – 6/6	150.561
Santa Maria River D	9	4/27	4/28 – 5/5	150.271
Arivaca Creek A	19	5/1	5/2 – 5/19	150.351
Arivaca Creek U	1	5/1	5/2	150.601
Date Creek F	106	5/2	5/5 – 6/2	150.372
Arivaca Creek P	11	5/2	5/3 -5/19	150.481
Arivaca Creek X	12	5/3	5/4 – 5/9	150.311

Responsiveness Tests

From April 11 to April 29 – June 2016, 100 responsiveness tests were performed at 25 different confirmed elf owl territories. Results for a full set of test distances were obtained for 15 of these territories, and another 3 territories were tested at 4 of the 5 distances (table 8). Where a full array of test distances was not obtained for a given territory, reasons could include the impossibility of setting up sufficiently obstructed tests from certain distances, loss of scheduled test nights due to high wind, insufficient time between confirming the presence of target owls and fledging of young in the nest, or disappearance of a pair part way through the breeding season.

Table 8.—Summary of the number of responsiveness tests conducted in 2016, by territory (i.e., pair) and test distance

Pair	Number of tests per categorical distance					Total
	50 m	100 m	150 m	200 m	250 m	
Arivaca Creek A	1	1	1	1	1	5
Arivaca Creek V	1	1	2	1	1	6
Arivaca Creek W	0	2	1	0	1	4
Arivaca Creek Y	1	1	1	1	1	5
Borrow Pit C	1	1	1	1	1	5
Cienega Creek A	1	0	0	0	0	1
Cienega Creek B	1	1	0	2	1	5
Cienega Creek C	1	1	1	1	1	5
Cienega Creek D	0	0	0	0	1	1
Cienega Creek F	1	1	1	2	0	5
Cienega Creek G	0	0	1	0	0	1
Cienega Creek H	0	1	0	0	0	1
Cienega Creek I	1	1	1	1	1	5
Date Creek K	0	0	1	0	0	1
Fox Wash A	1	1	1	1	1	5
Kohen Ranch A	1	1	1	1	1	5
Mosquito Flats B	1	1	1	1	1	5
Mosquito Flats C	1	1	1	1	1	5
Rincon Creek A	1	1	1	1	0	4
Rincon Creek C	1	1	1	1	1	5
Rincon Creek F	1	1	1	1	1	5
Saguaro Slot B	1	1	1	1	1	5
Santa Maria River F	1	1	1	1	1	5
Santa Maria River H	0	0	0	1	0	1
Santa Maria River K	1	1	1	1	1	5
Total	**19**	**21**	**21**	**21**	**18**	**100**

The distribution of completed responsiveness tests across variation in design variables and covariates is illustrated on figure 1. Tests were evenly distributed across test distances but (by intent) concentrated in periods of low wind and low ambient noise. All tests occurred (again, by design) between the hours of 8 pm – midnight. Most tests were done between mid-May and mid-June, but there was also representation of earlier and later parts of the breeding season. The whole spectrum of vegetation obstruction was sampled, but most tests occurred in intermediate obstruction levels (≈ 20–50% vegetation volume) because these were the most common conditions encountered. Similarly, the entire spectrum of illumination was sampled, with tests split evenly between conditions with no illumination versus some degree of illumination. The target owl was confirmed by the observer to be present for a majority (≈ 77%) of responsiveness tests, but the validity of responsiveness tests based on this and other criteria (as described previously) will not be determined until the 2016 dataset has been collected and combined with 2017 data. Therefore, not all of the responsiveness tests completed in 2016 will contribute to final data analysis. The final count of valid responsiveness tests and associated analyses will be presented in the final comprehensive project report along with additional details of responsiveness testing attributes.

Territory Assessment

Eighty-nine confirmed elf owl territories were assessed, as summarized in table 9. Of these, nest cavities were confirmed for 55 territories, and ACs were calculated for the remaining 34 territories. Buffers of 75-m radius were centered around nest sites or ACs (where nest sites were not known) for all 89 territories. MCPs were calculated for 48 confirmed territories that had a sufficient number of data points (see above), and of these, examination of MCP diagnostics indicated that 37 were sufficiently reliable to be assessed. Calculated MCPs that were retained for assessment ranged in size from 0.16–6.51 ha (mean = 1.42 ha, standard error = 0.20 ha).

Combining the 75-m buffers and the assessed MCPs, 126 territory polygons were assessed in the field in 2016 using the protocol described above. Across all polygons, 654 HAIDs were delineated (some of these were identical where they fell completely within overlapping 75-m circles and corresponding MCPs), with surface areas ranging from 24.6–29,514.6 square meters.

Attachment 1 illustrates all polygons that were assessed and the elf owl location points that were used to create polygons. From a qualitative visual perspective, the maps in attachment 1 suggest that a majority of assessed territories contained a substantial proportion of riparian habitat. Additional summaries, details, and

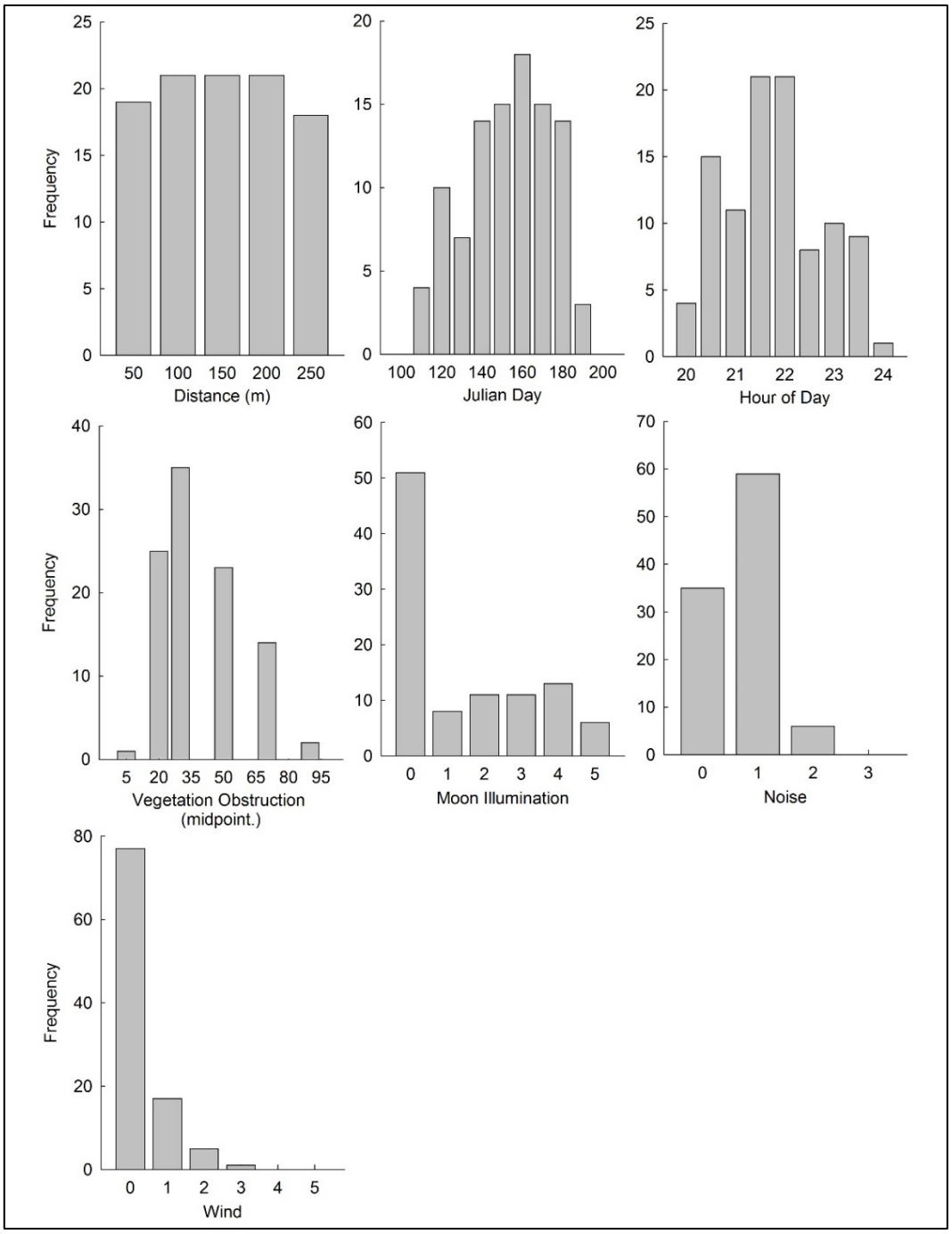

Figure 1.—Distribution of responsiveness tests in 2016 across multiple gradients of test conditions and design variables.
The "Hour of Day" axis is shown in a 24-hour format. The "Vegetation Obstruction" axis represents the percent vegetation volume, as described in the "Methods" section. The "Moon Illumination," "Noise," and "Wind" axes have units that represent indices that were previously defined in the "Methods" section.

Table 9.—Summary of confirmed elf owl territories for which territory assessments were conducted (using 75-m radius circles for all assessed territories plus MCPs for a subset of territories)

"Nest" indicates whether the nest cavity for the territory was known. The "Assessment75" column indicates whether the 75-m-radius buffer was centered around a nest cavity ("Yes – Nest") or AC ("Yes – AC). The "MCP calculated" column shows whether an MCP was calculated. The "MCP assessed" column shows whether a calculated MCP met the criteria for assessment, as described previously.

Pair	Nest	Assessment 75	MCP calculated	MCP assessed
Arivaca Creek A	Yes	Yes – Nest	Yes	Yes
Arivaca Creek B	Yes	Yes – Nest	Yes	Yes
Arivaca Creek C	Yes	Yes – Nest	Yes	Yes
Arivaca Creek D	No	Yes – AC	Yes	Yes
Arivaca Creek E	Yes	Yes – Nest	Yes	Yes
Arivaca Creek F	No	Yes – AC	Yes	Yes
Arivaca Creek G	Yes	Yes – Nest	Yes	Yes
Arivaca Creek J	No	Yes – AC	No	NA
Arivaca Creek L	No	Yes – AC	Yes	No
Arivaca Creek M	Yes	Yes – Nest	Yes	Yes
Arivaca Creek N	No	Yes – AC	No	NA
Arivaca Creek O	No	Yes – AC	No	NA
Arivaca Creek U	Yes	Yes – Nest	Yes	Yes
Arivaca Creek V	Yes	Yes – Nest	Yes	Yes
Arivaca Creek W	Yes	Yes – Nest	Yes	Yes
Arivaca Creek X	No	Yes – AC	Yes	Yes
Arivaca Creek Y	Yes	Yes – Nest	No	NA
Borrow Pit A	Yes	Yes – Nest	Yes	No
Borrow Pit C	Yes	Yes – Nest	Yes	Yes
Browns Crossing A	No	Yes – AC	No	NA
BW Marsh A	No	Yes – AC	Yes	Yes
BW Marsh C	No	Yes – AC	Yes	No
Cienega Creek A	Yes	Yes – Nest	Yes	Yes
Cienega Creek B	Yes	Yes – Nest	Yes	No
Cienega Creek C	Yes	Yes – Nest	No	NA
Cienega Creek D	Yes	Yes – Nest	Yes	No
Cienega Creek E	Yes	Yes – Nest	No	NA
Cienega Creek F	Yes	Yes – Nest	No	NA
Cienega Creek H	No	Yes – AC	No	NA
Cienega Creek I	Yes	Yes – Nest	No	NA

Table 9.—Summary of confirmed elf owl territories for which territory assessments were conducted (using 75-m radius circles for all assessed territories plus MCPs for a subset of territories)

"Nest" indicates whether the nest cavity for the territory was known. The "Assessment75" column indicates whether the 75-m-radius buffer was centered around a nest cavity ("Yes – Nest") or AC ("Yes – AC). The "MCP calculated" column shows whether an MCP was calculated. The "MCP assessed" column shows whether a calculated MCP met the criteria for assessment, as described previously.

Pair	Nest	Assessment 75	MCP calculated	MCP assessed
Cienega Creek L	Yes	Yes – Nest	No	NA
Cienega Creek M	Yes	Yes – Nest	No	NA
Cienega Creek O	Yes	Yes – Nest	No	NA
Cienega Creek U	Yes	Yes – Nest	No	NA
Date Creek B	No	Yes – AC	Yes	Yes
Date Creek C	Yes	Yes – Nest	No	NA
Date Creek D	Yes	Yes – Nest	Yes	Yes
Date Creek E	No	Yes – AC	No	NA
Date Creek F	No	Yes – AC	Yes	Yes
Date Creek G	Yes	Yes – Nest	Yes	Yes
Date Creek J	No	Yes – AC	Yes	No
Date Creek K	Yes	Yes – Nest	Yes	Yes
Date Creek L	No	Yes – AC	Yes	Yes
Date Creek M	No	Yes – AC	No	NA
Date Creek N	Yes	Yes – Nest	No	NA
Date Creek O	Yes	Yes – Nest	No	NA
Fox Wash A	Yes	Yes – Nest	Yes	Yes
Kohen Ranch A	No	Yes – AC	Yes	Yes
Kohen Ranch B	No	Yes – AC	No	NA
Mosquito Flats A	Yes	Yes – Nest	Yes	Yes
Mosquito Flats B	Yes	Yes – Nest	Yes	No
Mosquito Flats C	Yes	Yes – Nest	Yes	Yes
Mosquito Flats D	No	Yes – AC	Yes	No
Posta Quemada B	No	Yes – AC	No	NA
Posta Quemada C	Yes	Yes – Nest	No	NA
Posta Quemada D	Yes	Yes – Nest	No	NA
Posta Quemada E	Yes	Yes – Nest	No	NA
Posta Quemada F	Yes	Yes – Nest	Yes	Yes
Posta Quemada G	No	Yes – AC	No	NA
Posta Quemada H	Yes	Yes – Nest	No	NA

Table 9.—Summary of confirmed elf owl territories for which territory assessments were conducted (using 75-m radius circles for all assessed territories plus MCPs for a subset of territories)

"Nest" indicates whether the nest cavity for the territory was known. The "Assessment75" column indicates whether the 75-m-radius buffer was centered around a nest cavity ("Yes – Nest") or AC ("Yes – AC). The "MCP calculated" column shows whether an MCP was calculated. The "MCP assessed" column shows whether a calculated MCP met the criteria for assessment, as described previously.

Pair	Nest	Assessment 75	MCP calculated	MCP assessed
Posta Quemada I	No	Yes – AC	No	NA
Posta Quemada J	Yes	Yes – Nest	No	NA
Posta Quemada L	Yes	Yes – Nest	No	NA
Rincon Creek A	Yes	Yes – Nest	Yes	Yes
Rincon Creek B	No	Yes – AC	No	NA
Rincon Creek C	Yes	Yes – Nest	Yes	Yes
Rincon Creek D	No	Yes – AC	Yes	Yes
Rincon Creek E	Yes	Yes – Nest	No	NA
Rincon Creek F	Yes	Yes – Nest	Yes	No
Rincon Creek G	Yes	Yes – Nest	Yes	Yes
Rincon Creek H	Yes	Yes – Nest	No	NA
Rincon Creek I	No	Yes – AC	Yes	Yes
Saguaro Slot A	Yes	Yes – Nest	Yes	Yes
Saguaro Slot B	Yes	Yes – Nest	Yes	Yes
Santa Cruz River A	Yes	Yes – Nest	No	NA
Santa Cruz River B	Yes	Yes – Nest	No	NA
Santa Cruz River C	Yes	Yes – Nest	No	NA
Santa Cruz River D	Yes	Yes – Nest	No	NA
Santa Cruz River E	Yes	Yes – Nest	No	NA
Santa Maria River C	No	Yes – AC	No	NA
Santa Maria River D	No	Yes – AC	Yes	Yes
Santa Maria River F	Yes	Yes – Nest	Yes	No
Santa Maria River H	Yes	Yes – Nest	Yes	No
Santa Maria River I	No	Yes – AC	Yes	Yes
Santa Maria River J	No	Yes – AC	No	NA
Santa Maria River K	No	Yes – AC	Yes	Yes
Santa Maria River L	No	Yes – AC	No	NA
Santa Maria River M	No	Yes – AC	No	NA
Santa Maria River N	No	Yes – AC	Yes	Yes

analyses of territory assessment data, including the habitat characteristics of whole territories and component habitat patches, will be presented in the final comprehensive project report.

DISCUSSION

The project study plan (Boone and Flesch 2016) established quantitative goals for the second and third years of the project (2016–17) as follows, with about half of each overall goal targeted for year 2 (2016):

1) Identify eight general sites where elf owls breed in riparian vegetation

2) Confirm 45 breeding territories, with 30 or more occurring wholly or largely in riparian vegetation

3) Identify about 16 focal territories in which to conduct responsiveness tests and territory assessments

These 2-year goals were all exceeded in 2016 alone, as reported above. However, additional data will be collected in 2017 using the same approaches to bolster these datasets and to ensure that sites are considered across a broad range of contexts to maximize the value of inferences. For this reason, 2016 datasets for territory delineation, territory assessment, and responsiveness testing are considered incomplete at the end of 2016, and no analysis or interpretation of these data are presented in this report, but is deferred until the final comprehensive project report. Similarly, the discovery transect analysis presented for year 1 in Boone and Flesch (2017) will be bolstered by new discovery transect data from both years 2 and 3; therefore, a final analysis is deferred until the final comprehensive project report.

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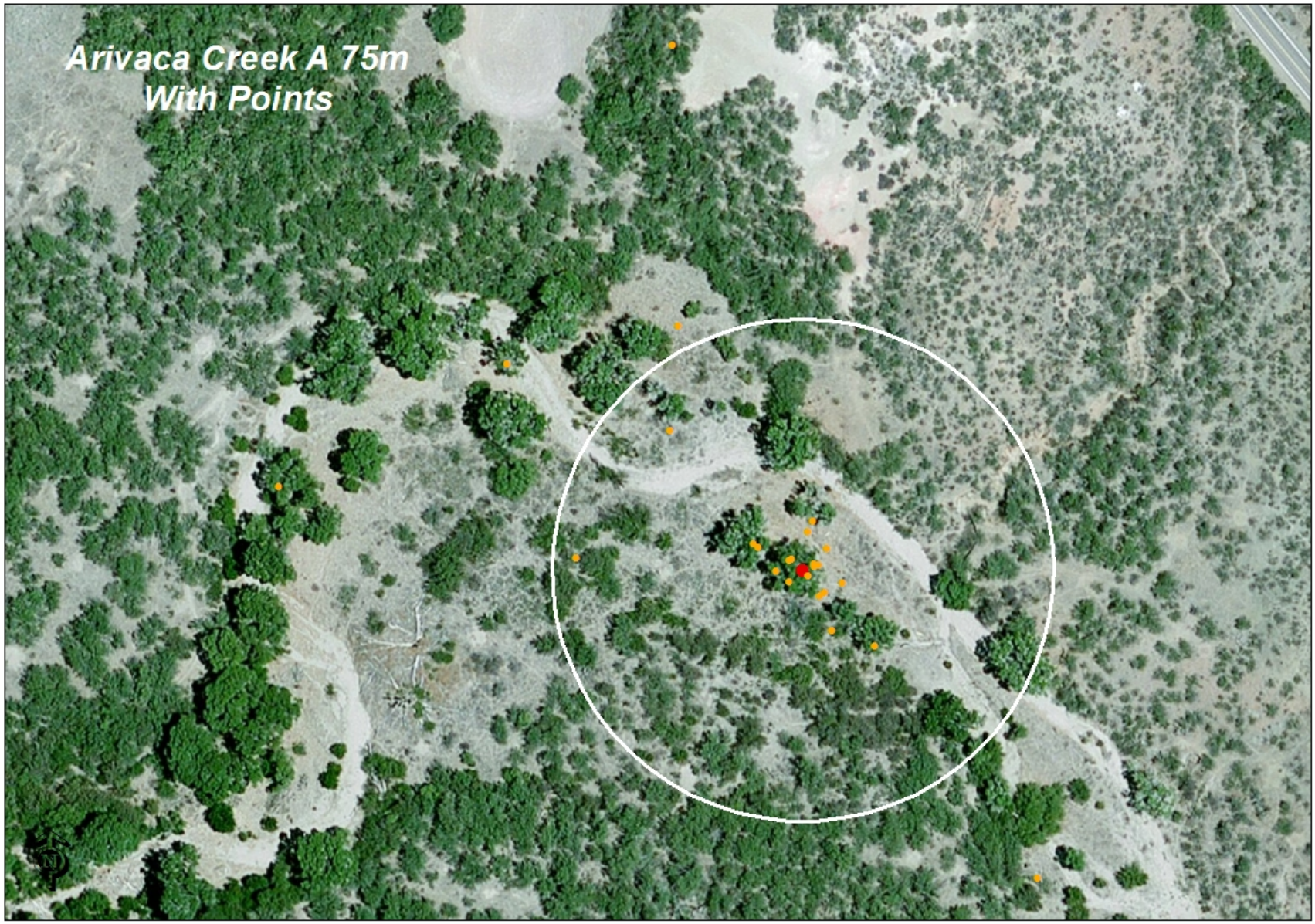
ATTACHMENT 1

Maps

Maps showing the extent of 75-meter (m)-radius circles and 95% minimum convex polygons (MCPs) that were assessed in 2016 along with elf owl (*Micrathene whitneyi*) location points obtained by passive listening surveys, telemetry surveys, and nest cavity confirmations. Note that while every assessed territory had a 75-m circle as a basis for assessment, only some also had a MCP (see table 9). On the 75-m circle maps, nest cavities (where known) or activity centers are shown as red points and other elf owl locations as yellow points. Note that some territories (especially at Cienega Creek and the Santa Cruz River) were assessed using 75-m circles based solely on the discovery of a confirmed nest cavity, with no other elf owl use point available.


Arivaca Creek A 75m
With Points

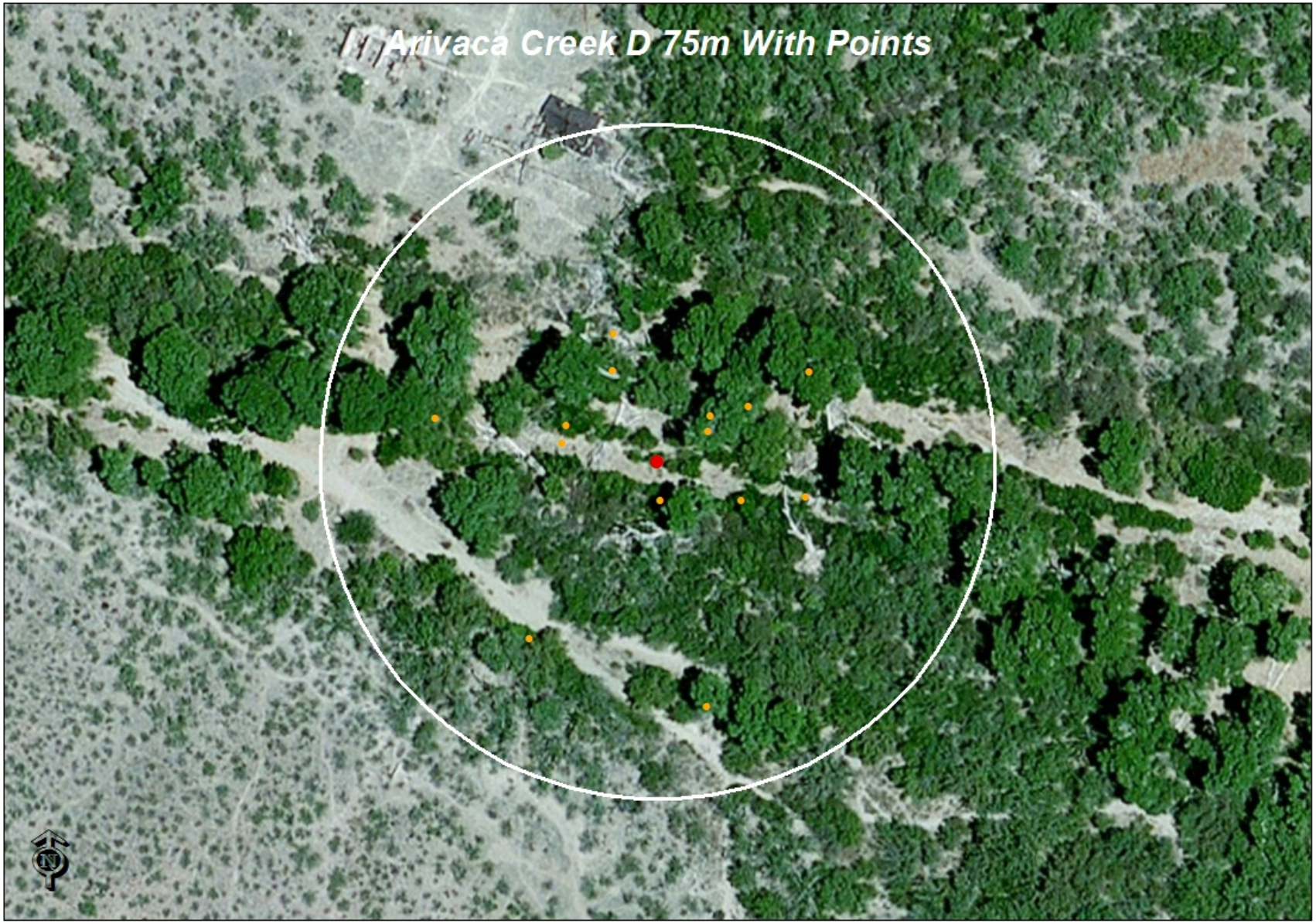
Arivaca Creek A 95% MCP
With Points

Arivaca Creek B 75m With Points
N

Arivaca Creek B 95% MCP
With Points
N

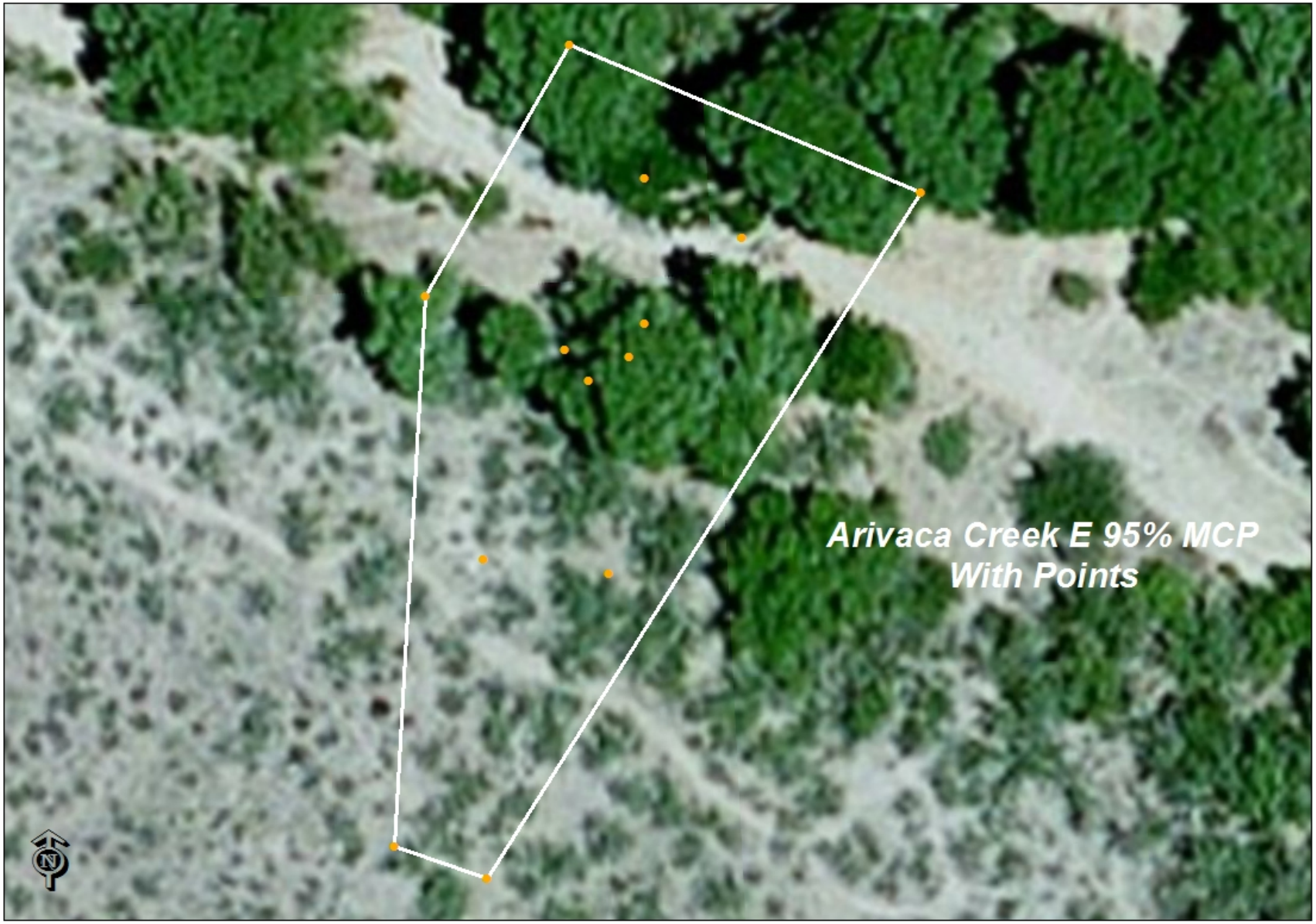
Arivaca Creek C 75m With Points
N

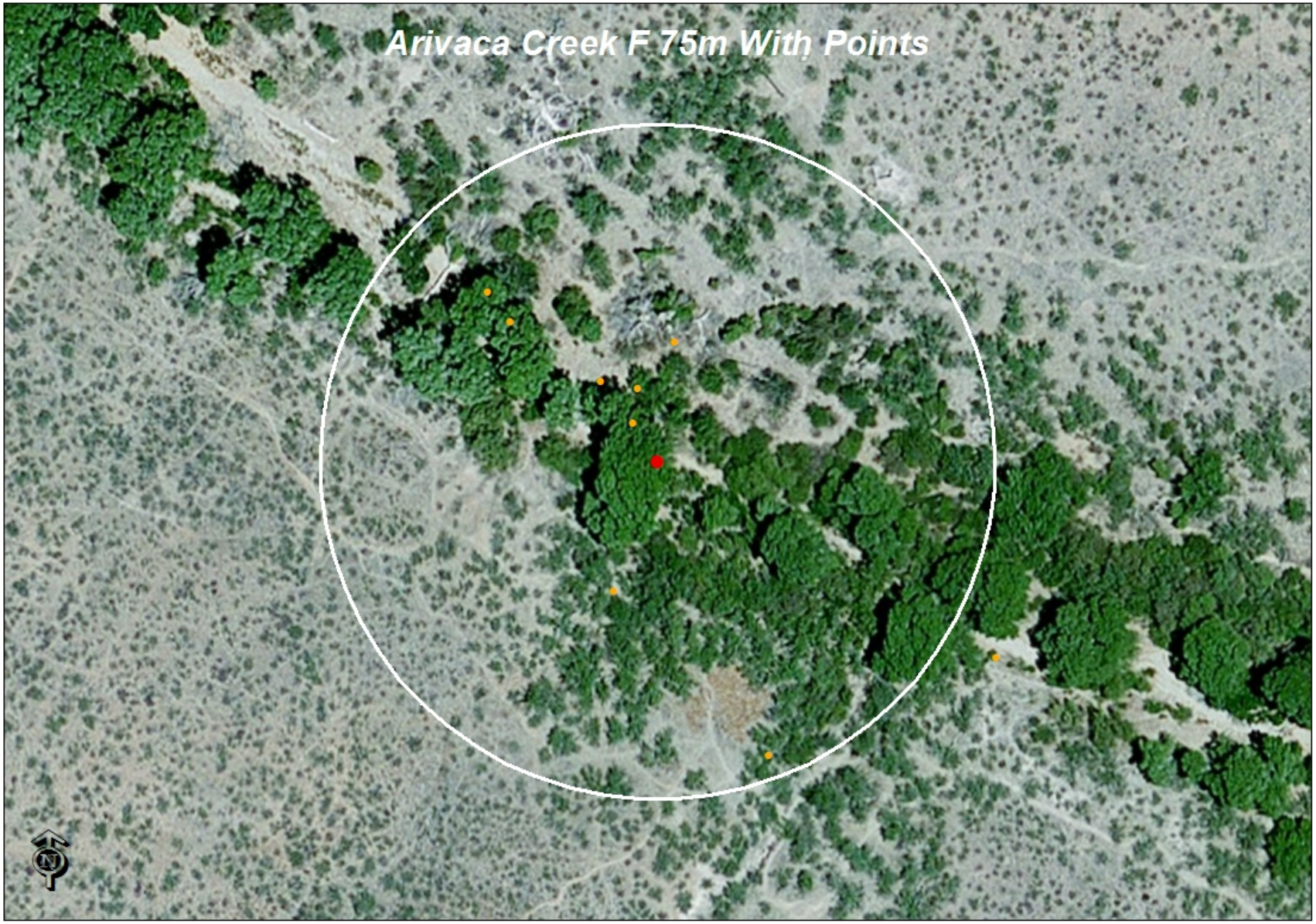
Arivaca Creek C 95% MCP
With Points


Arivaca Creek D 75m With Points
N

Arivaca Creek D 95% MCP With Points
N

Arivaca Creek E 75m With Points
N


Arivaca Creek E 95% MCP
With Points


Arivaca Creek F 75m With Points
N

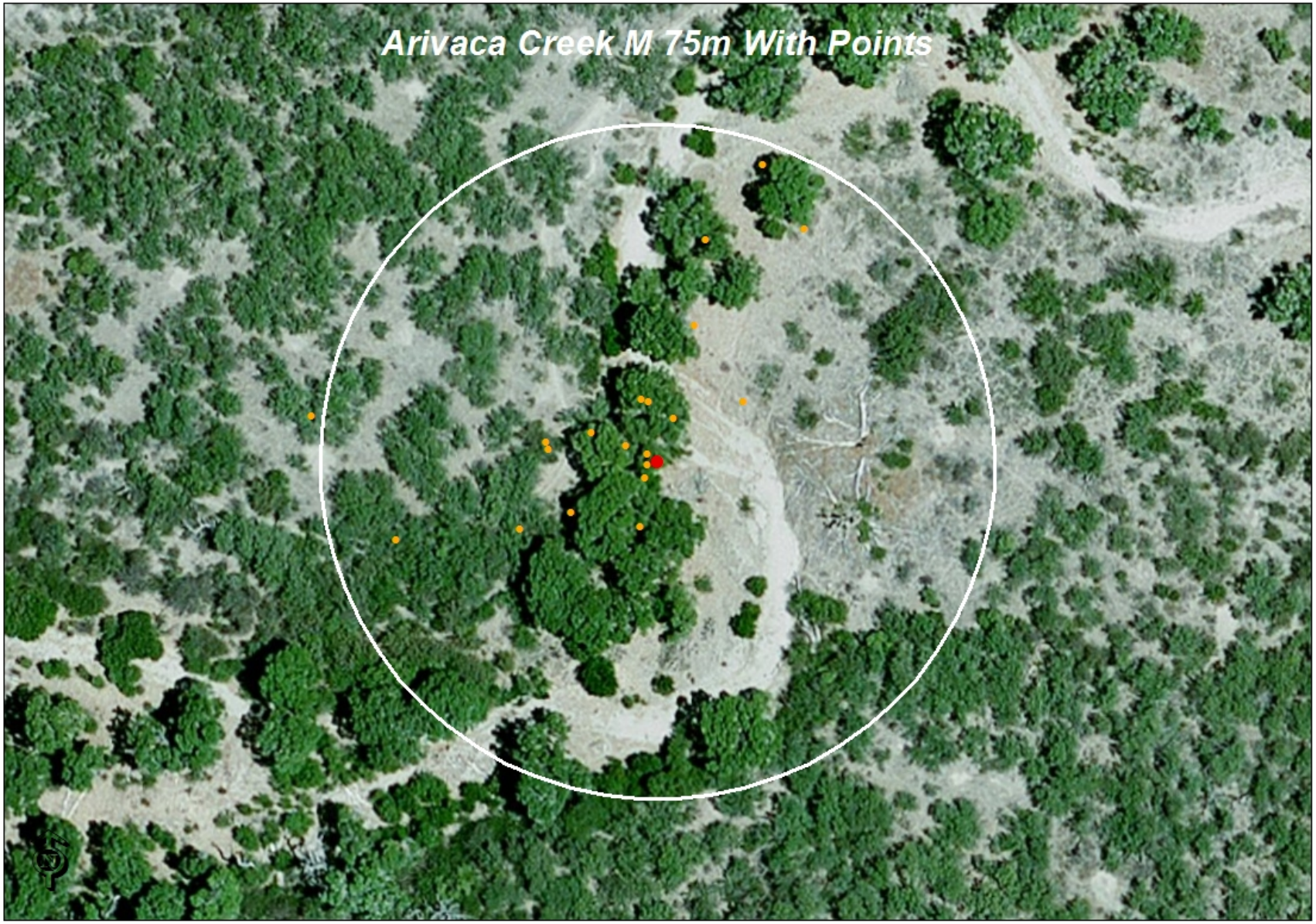
Arivaca Creek F 95% MCP
With Points
N

Arivaca Creek G 75m With Points
N

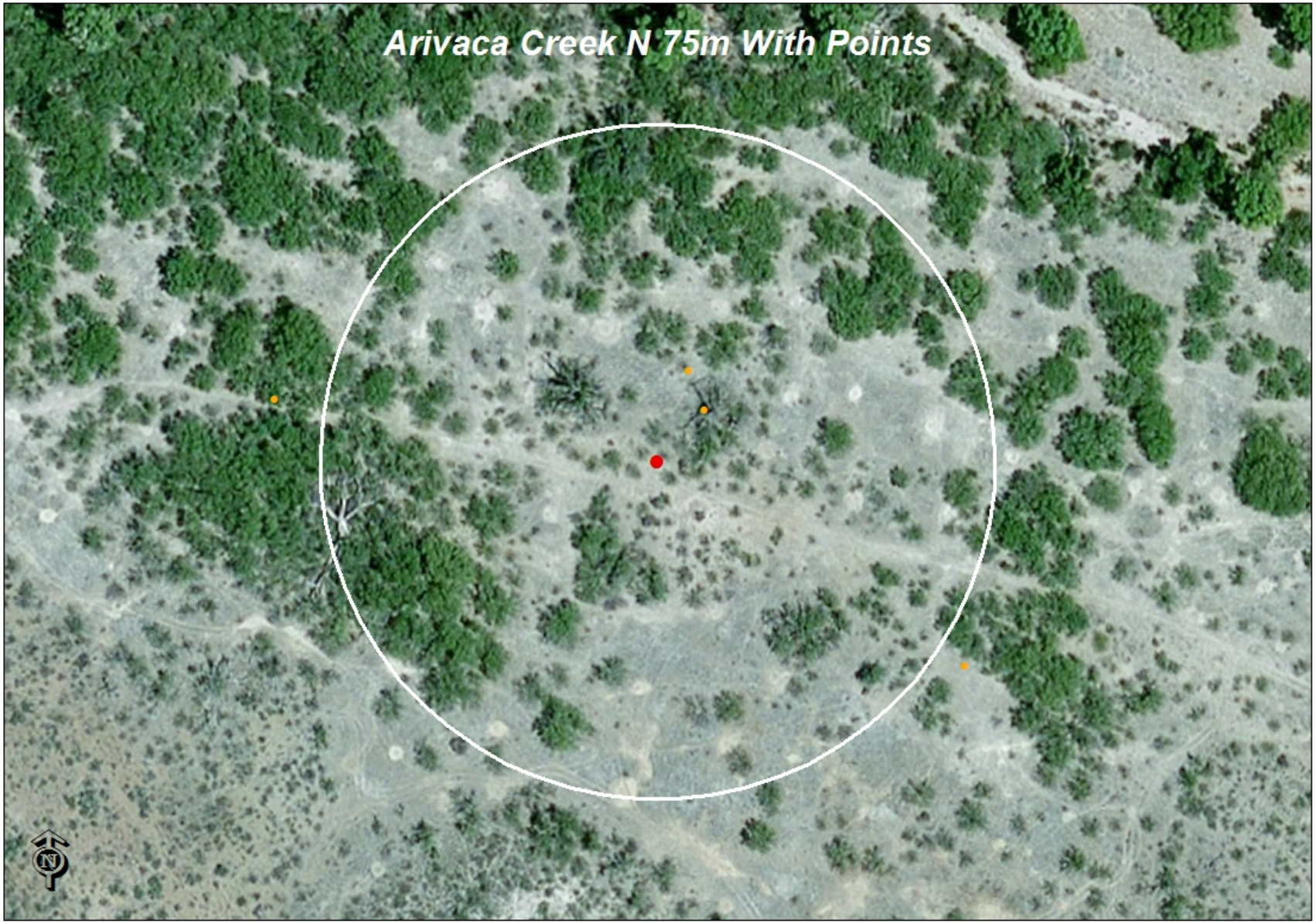
Arivaca Creek G 95% MCP With Points
N

Arivaca Creek J 75m Wiith Points
N

Arivaca Creek L 75m With Points
N


Arivaca Creek M 75m With Points

Arivaca Creek M 95% MCP
With Points
N


Arivaca Creek N 75m With Points
N

Arivaca Creek O 75m With Points
N

Arivaca Creek U 75m With Points

Arivaca Creek U 95% MCP With Points
N

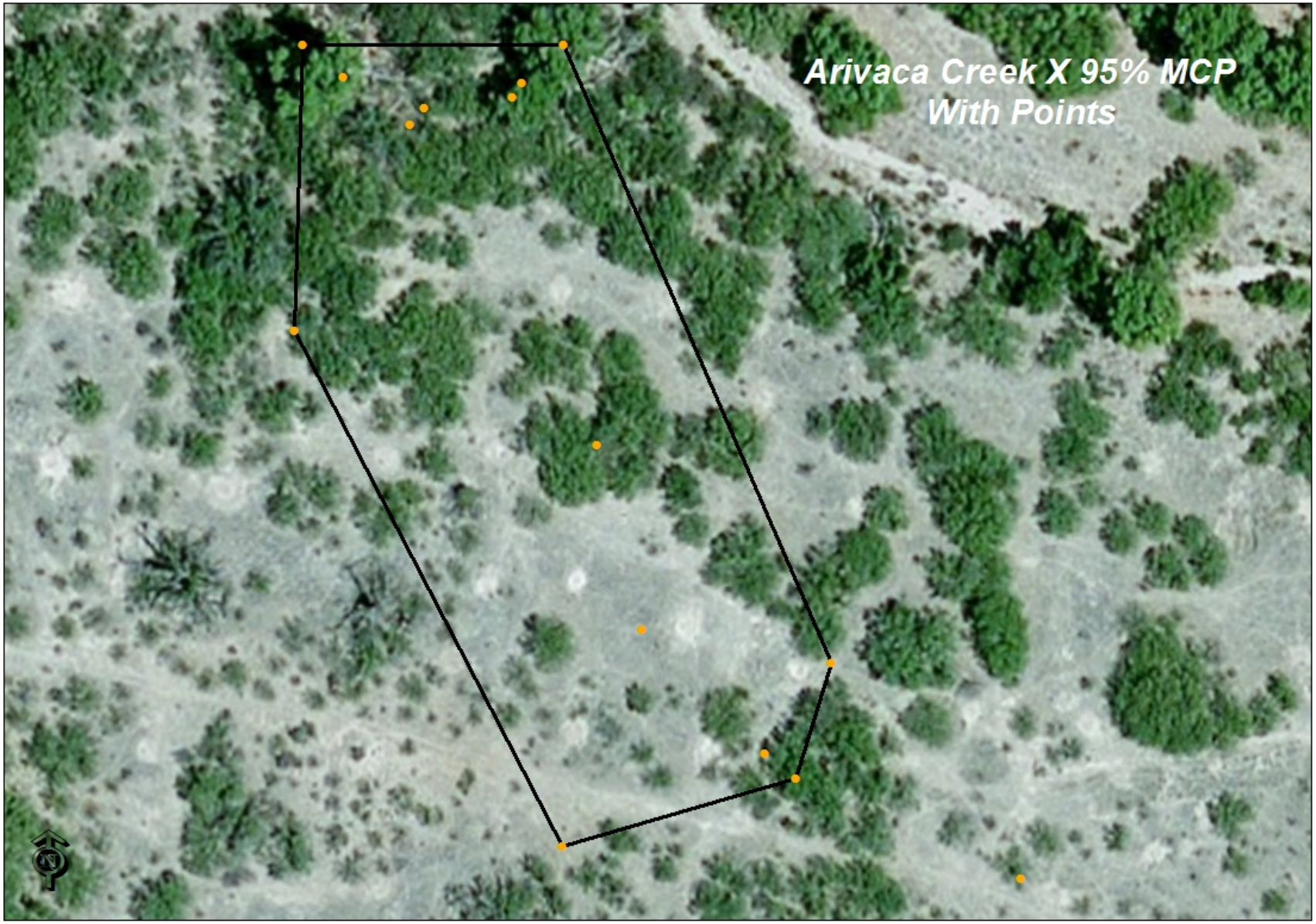
Arivaca Creek V 75m With Points
N

Arivaca Creek V 95% MCP With Points
N

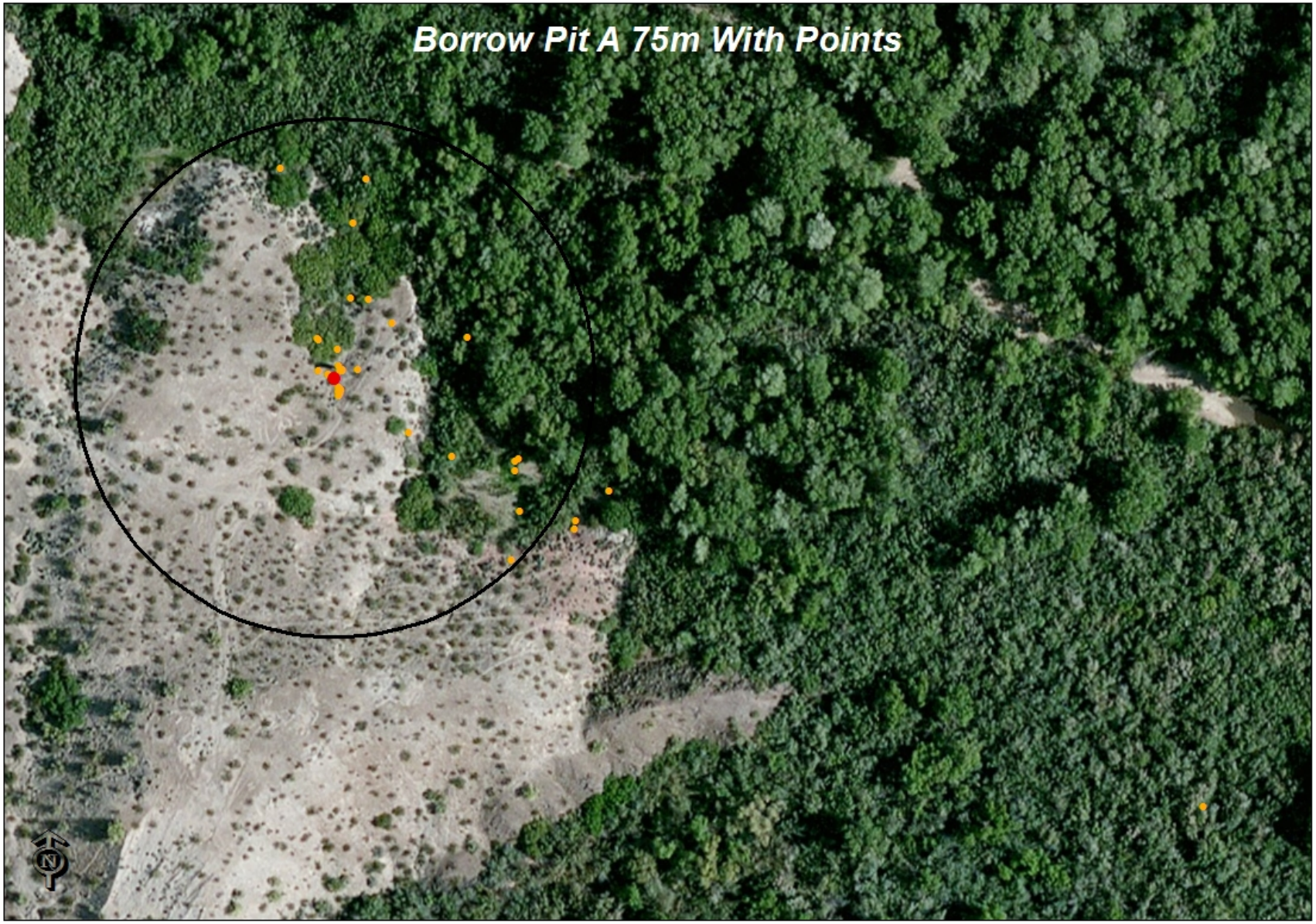
Arivaca Creek W 75m With Points
N

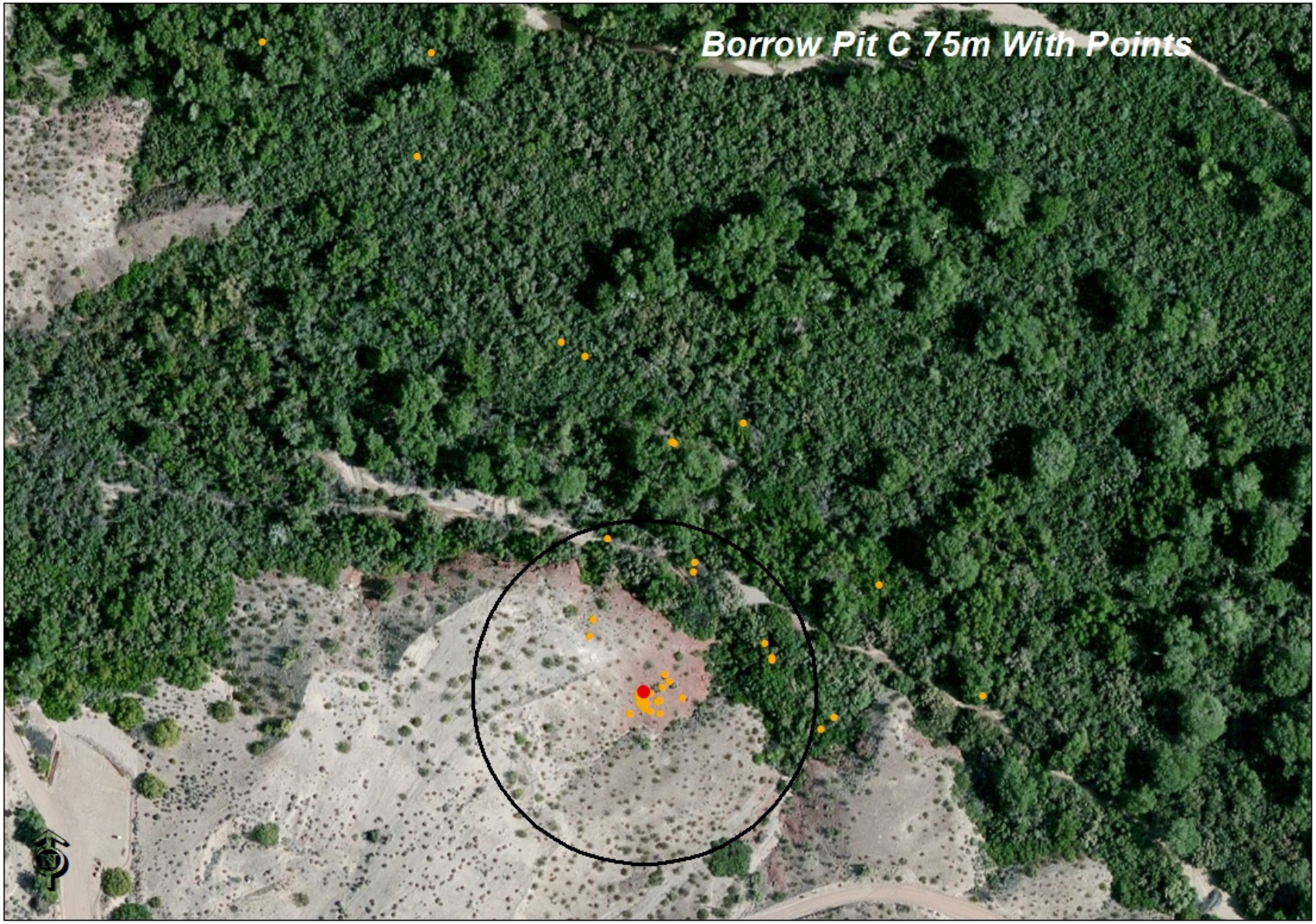
Arivaca Creek W 95% MCP With Points
N

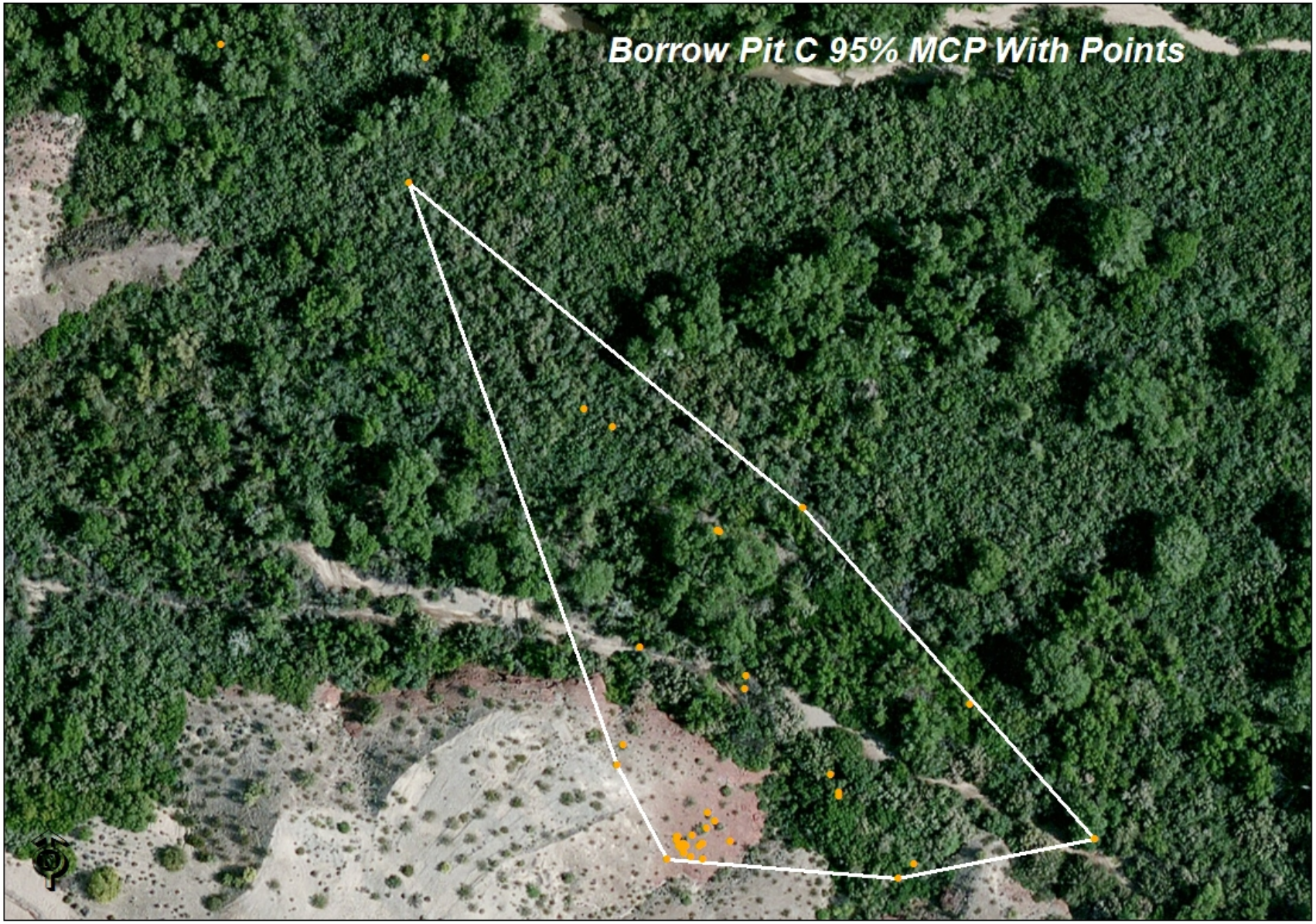
Arivaca Creek X 75m With Points
N


Arivaca Creek X 95% MCP
With Points

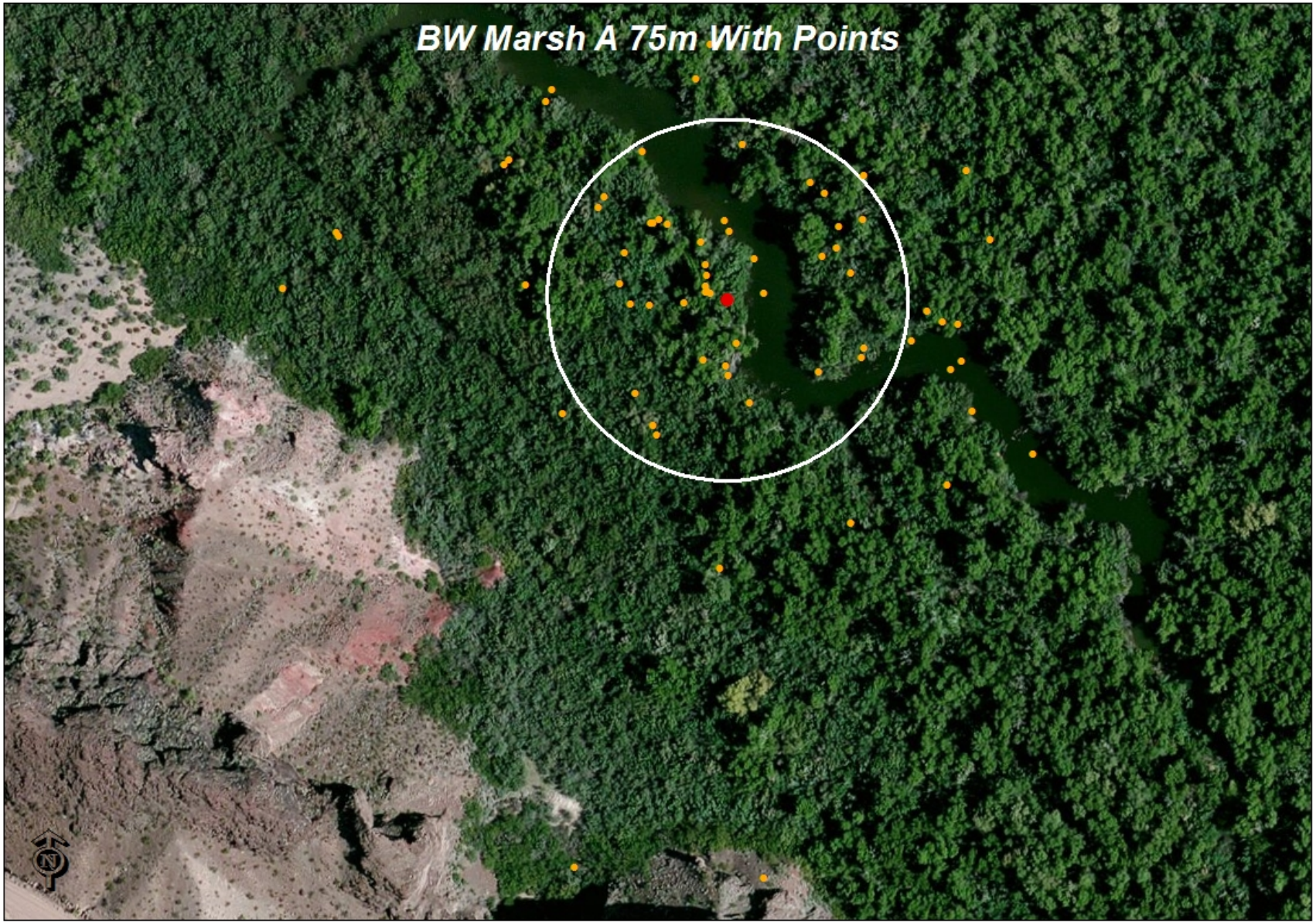
Arivaca Creek Y 75m With Points
N

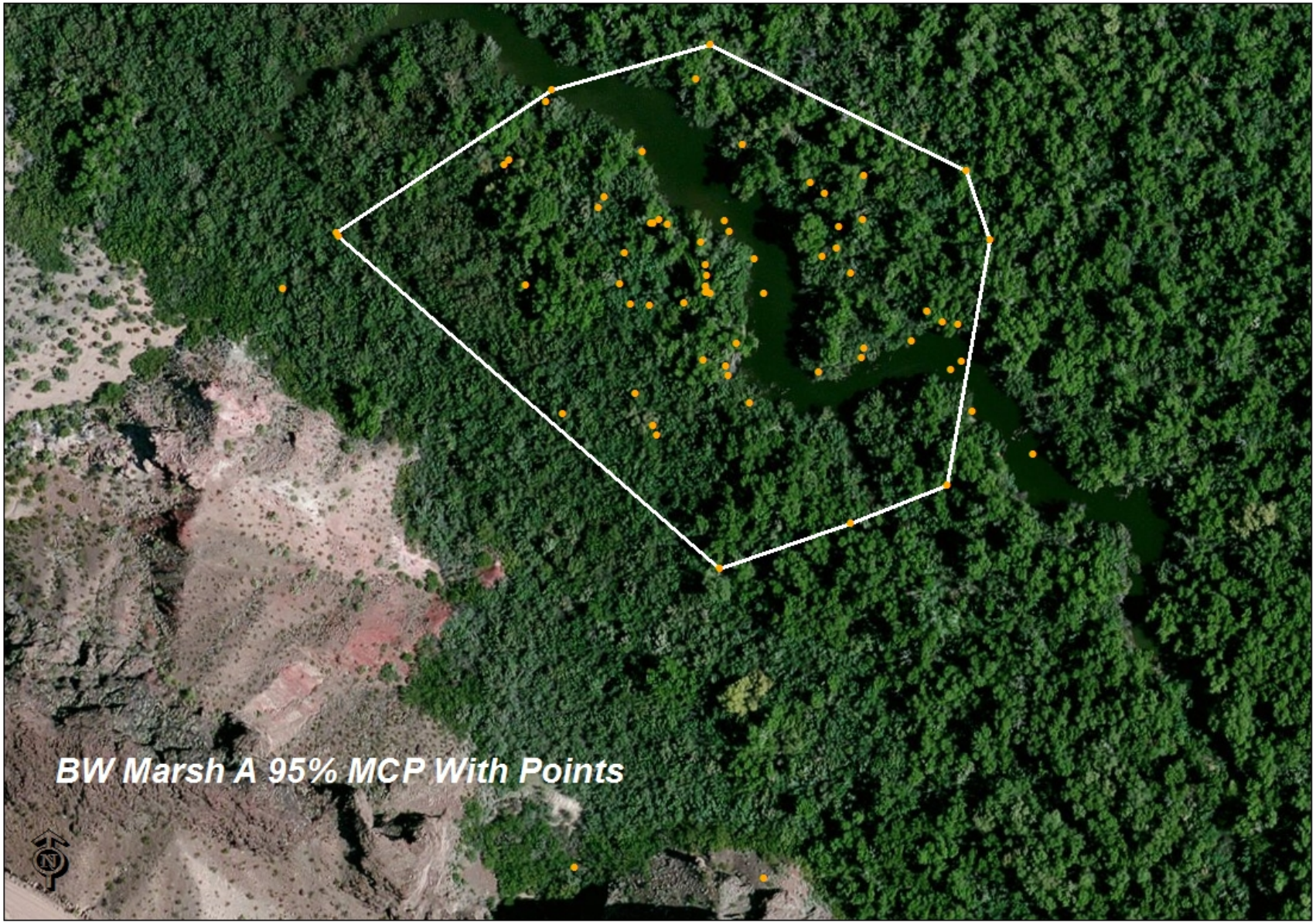

Borrow Pit A 75m With Points
N

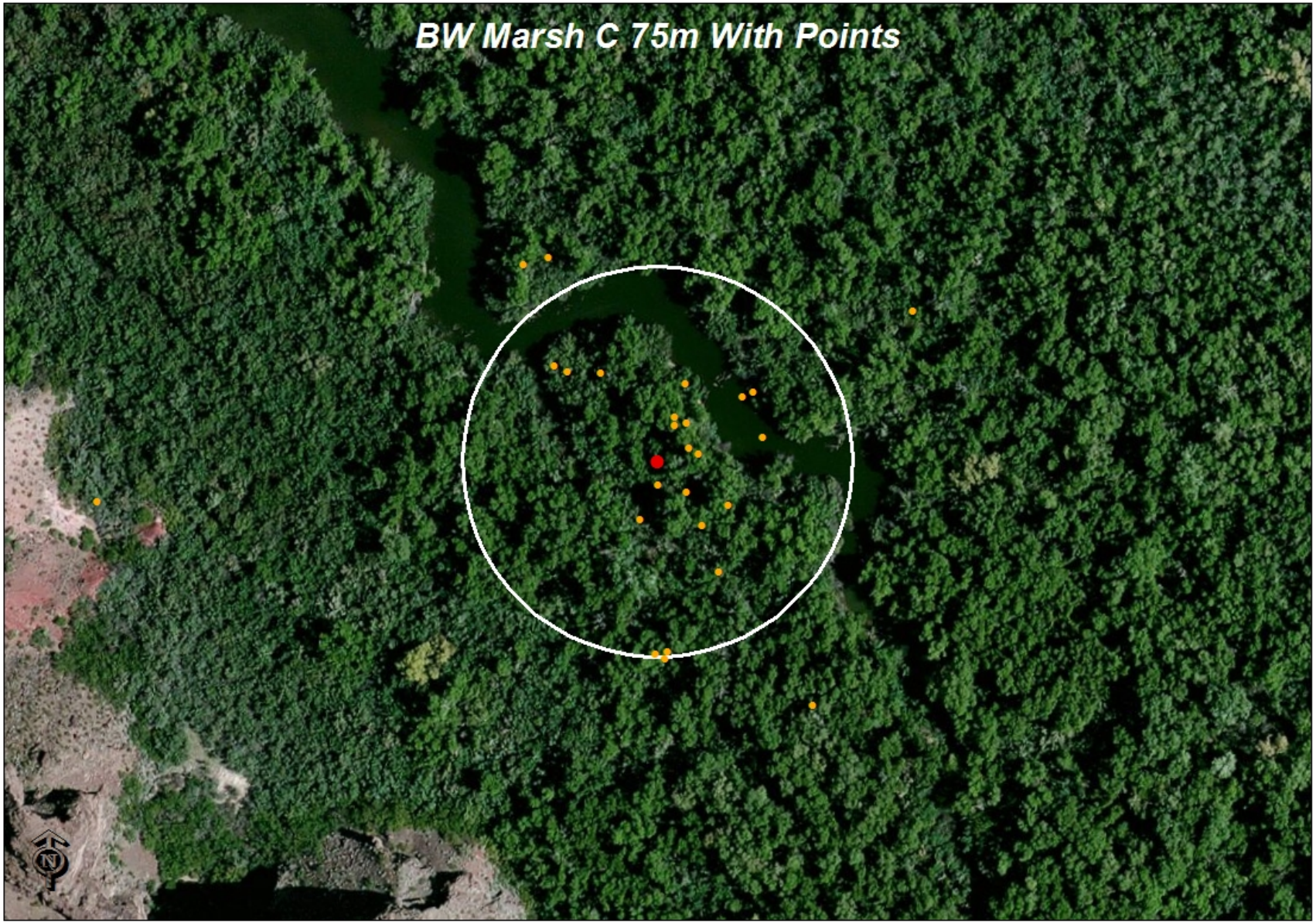

Borrow Pit C 75m With Points
N


Borrow Pit C 95% MCP With Points

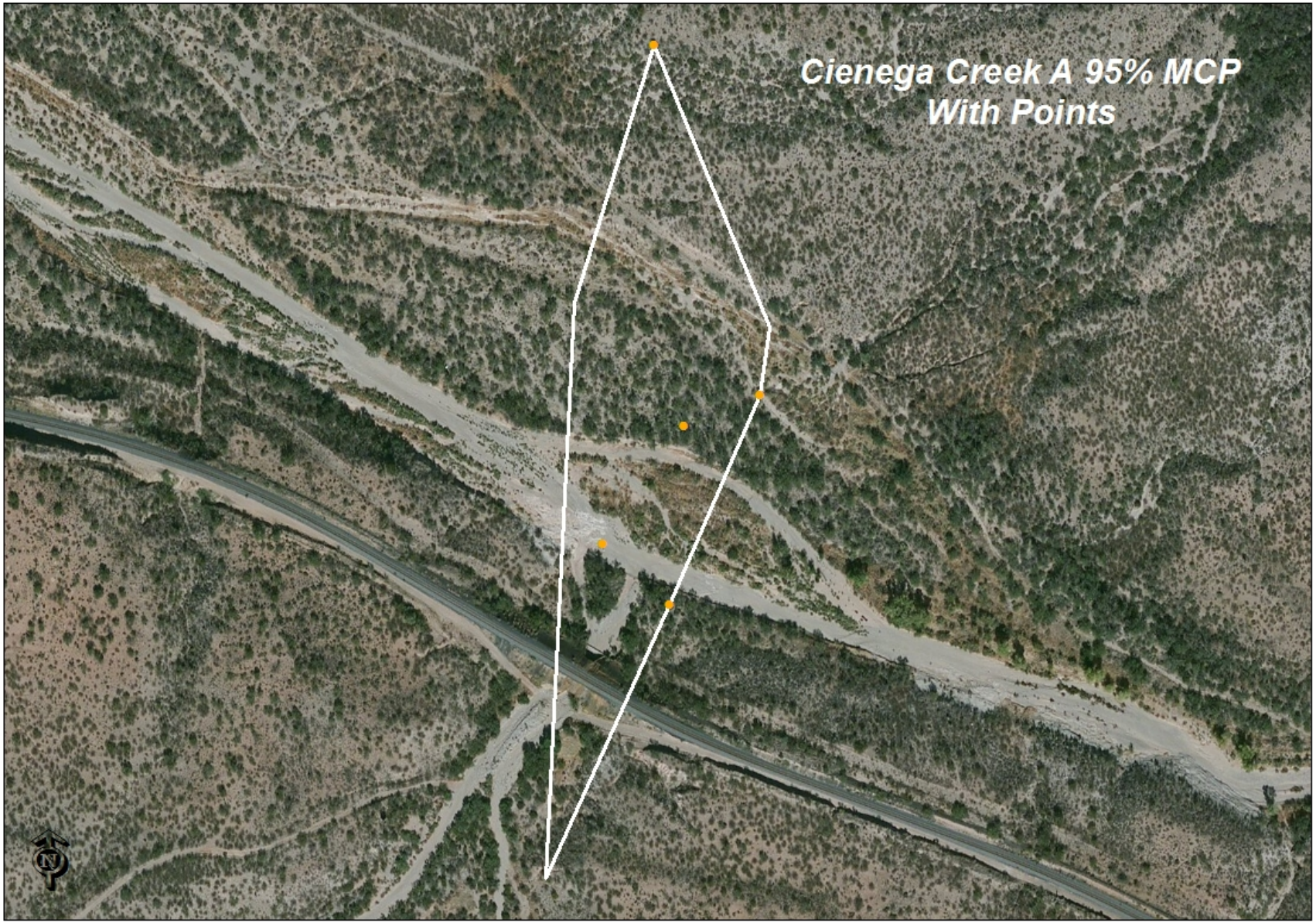
Browns Crossing A 75m With Points
N


BW Marsh A 75m With Points
N


BW Marsh A 95% MCP With Points
N

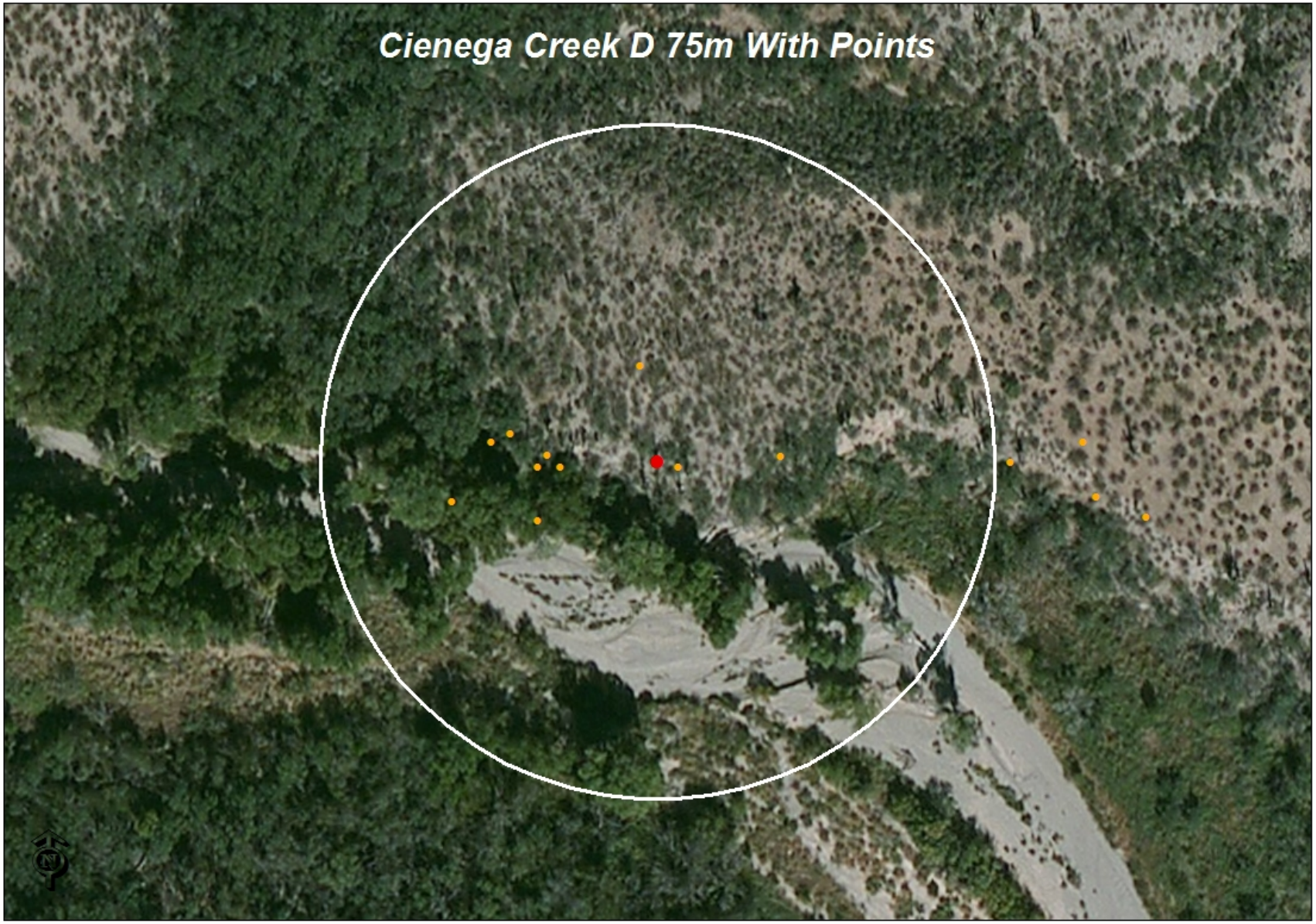

BW Marsh C 75m With Points
N

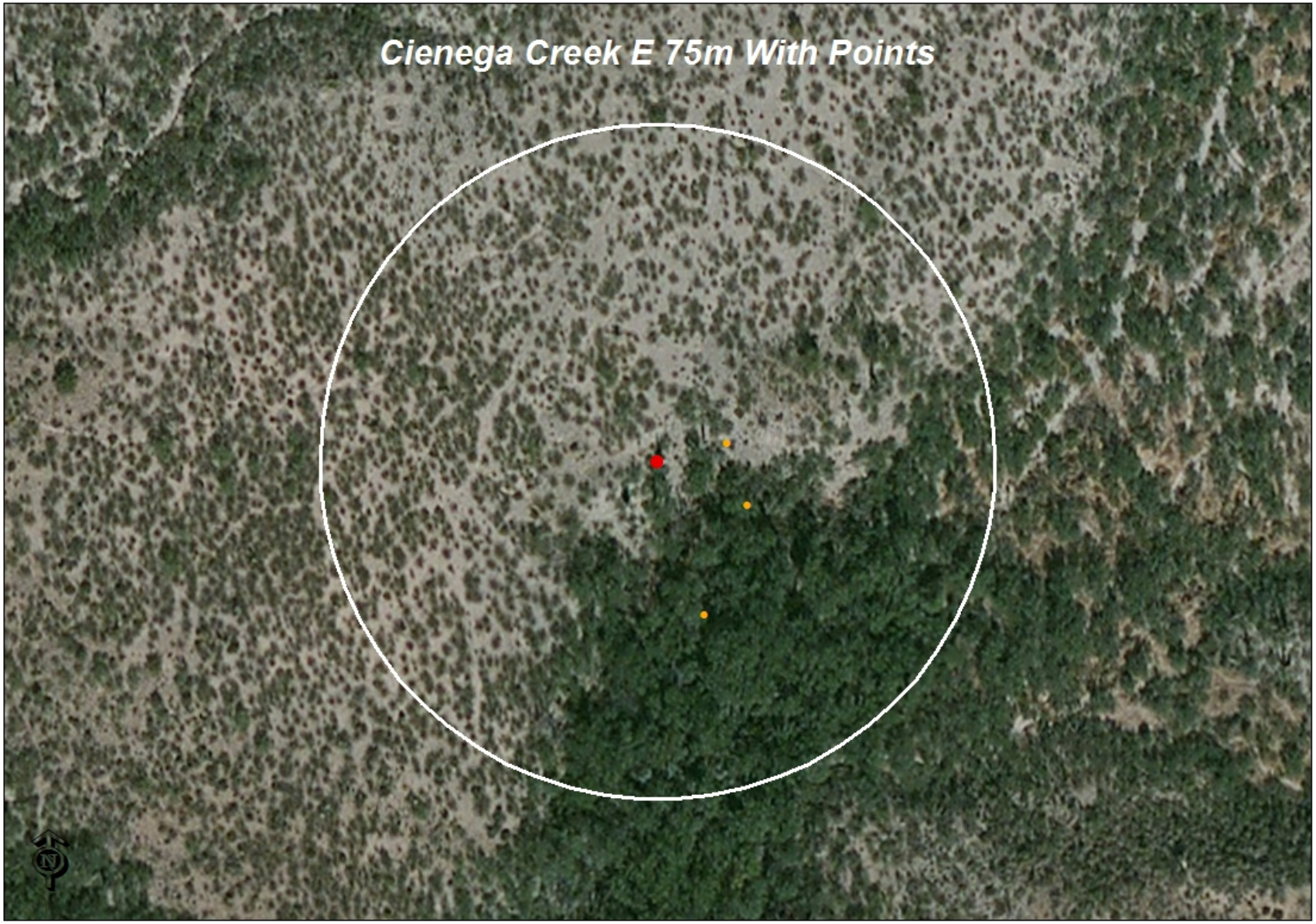
Cienega Creek A 75m
With Points

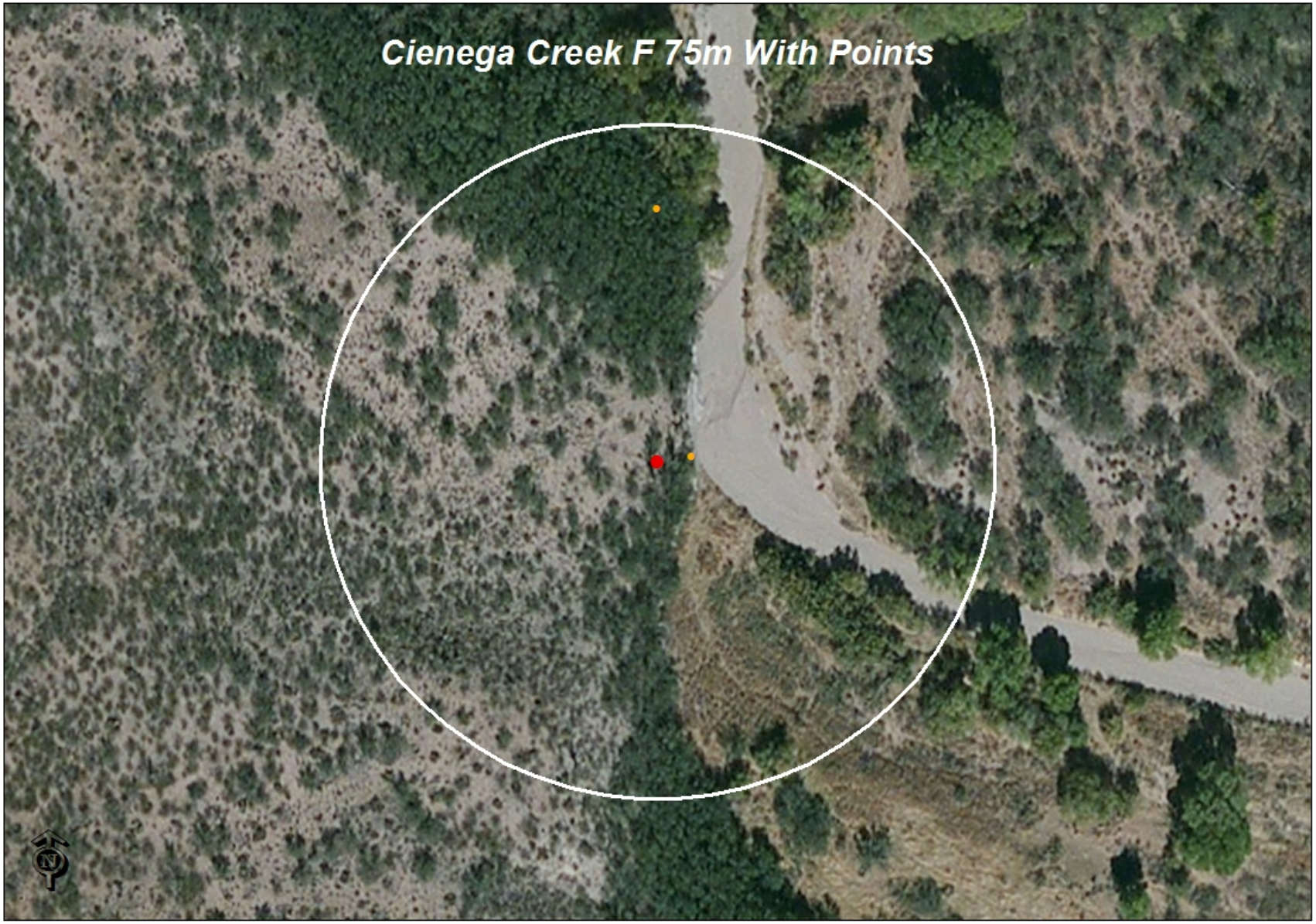

Cienega Creek A 95% MCP
With Points

Cienega Creek B 75m With Points

Cienega Creek C 75m With Points
N

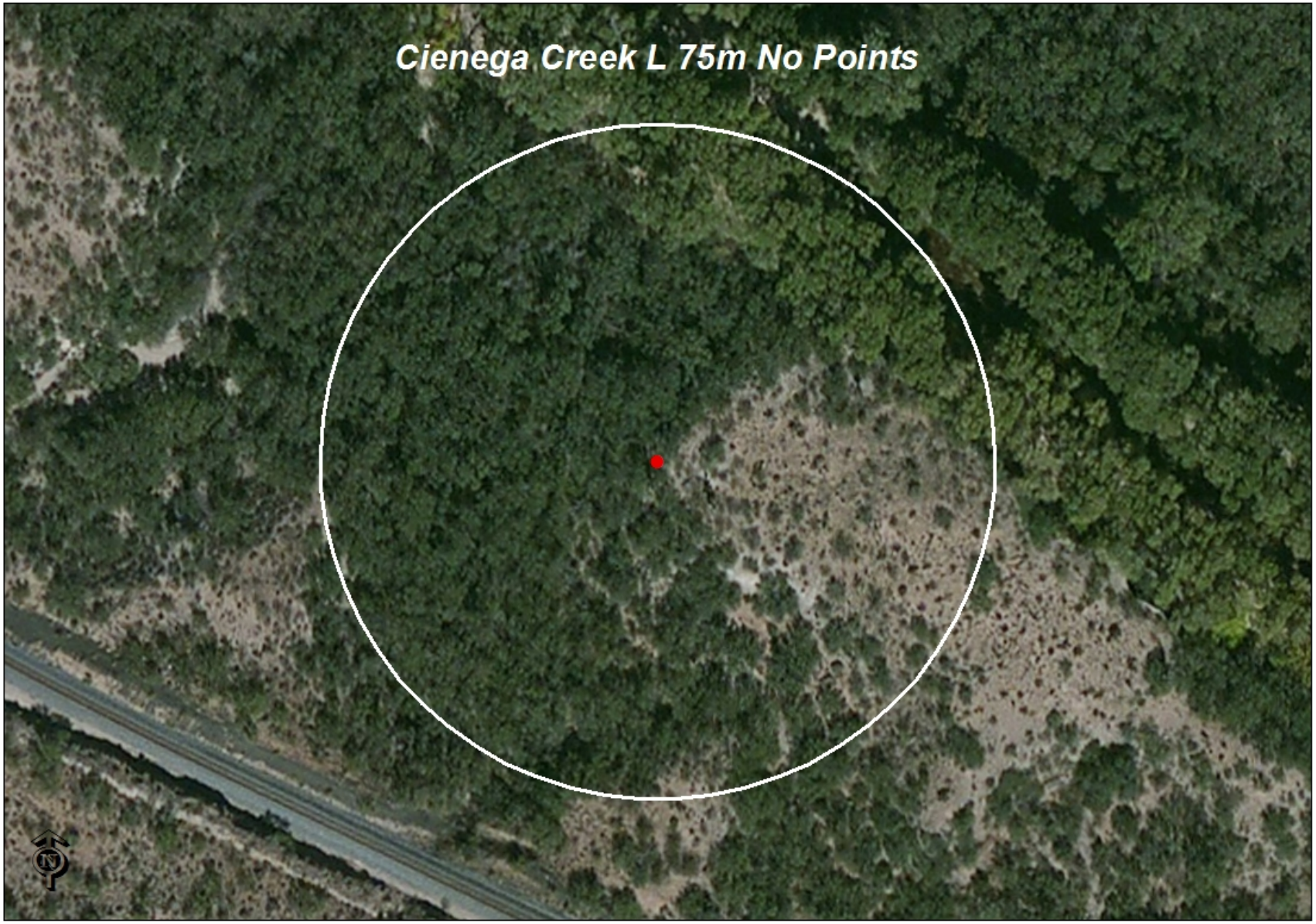

Cienega Creek D 75m With Points

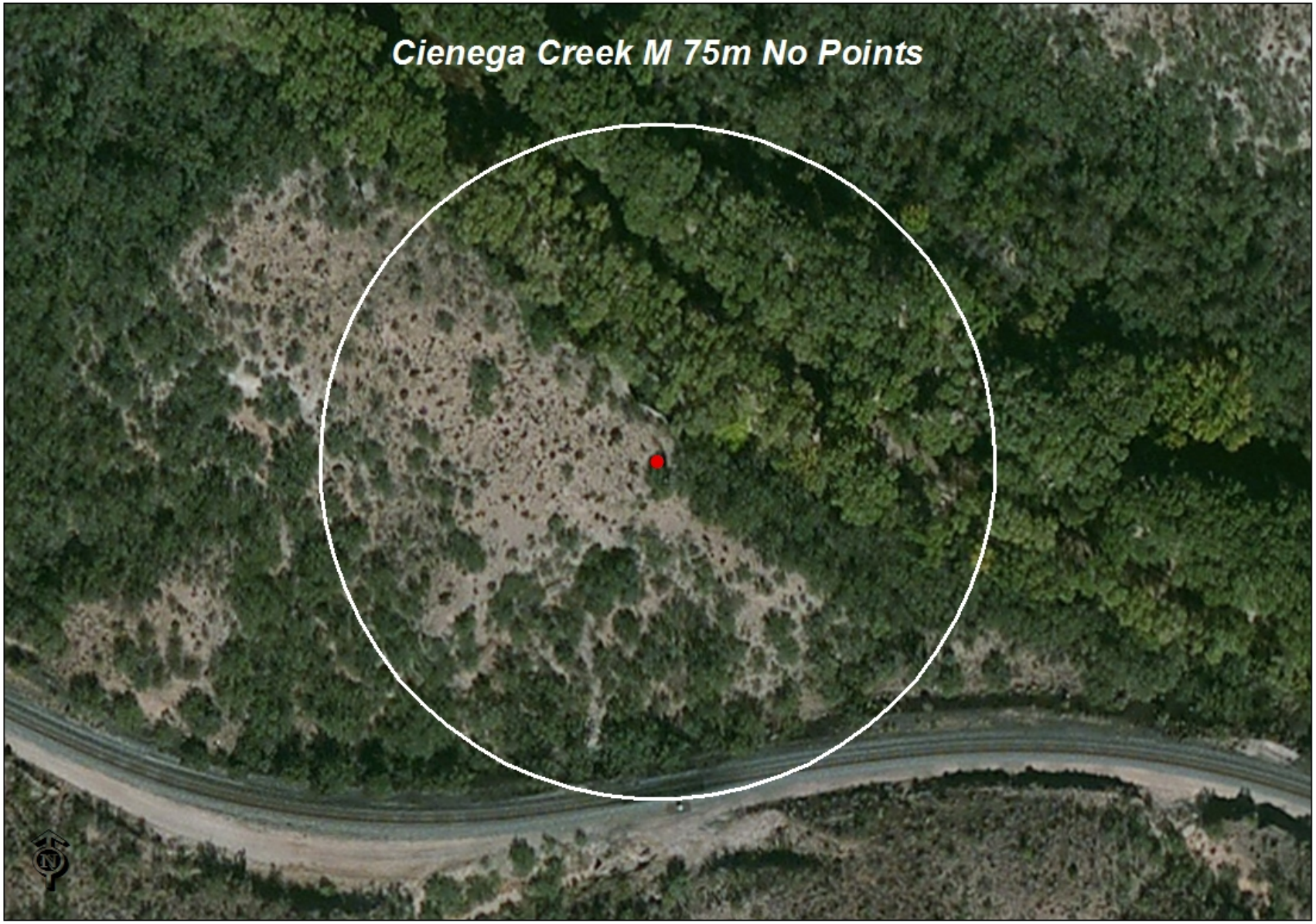

Cienega Creek E 75m With Points
N

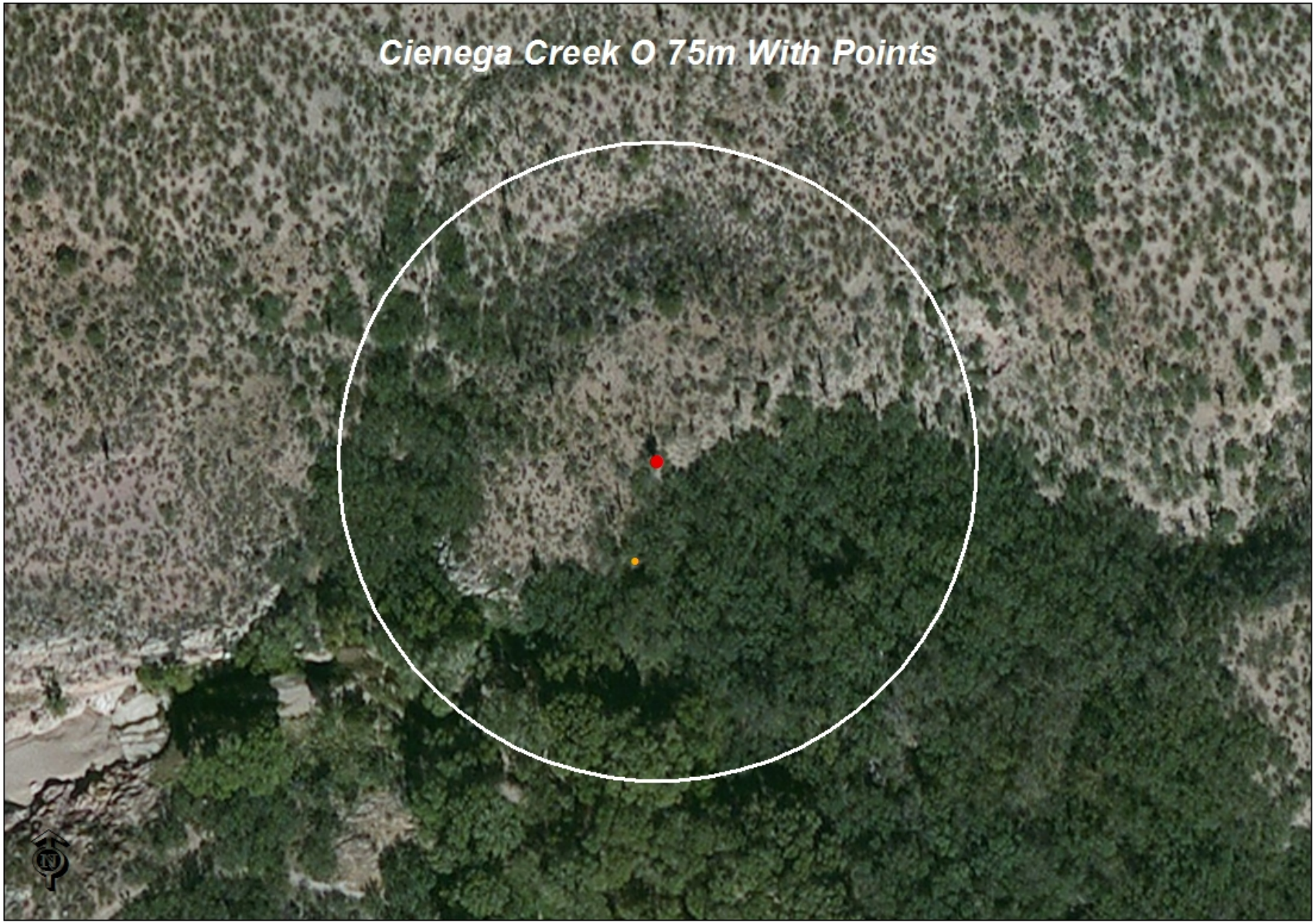

Cienega Creek F 75m With Points

Cienega Creek H 75m With Points

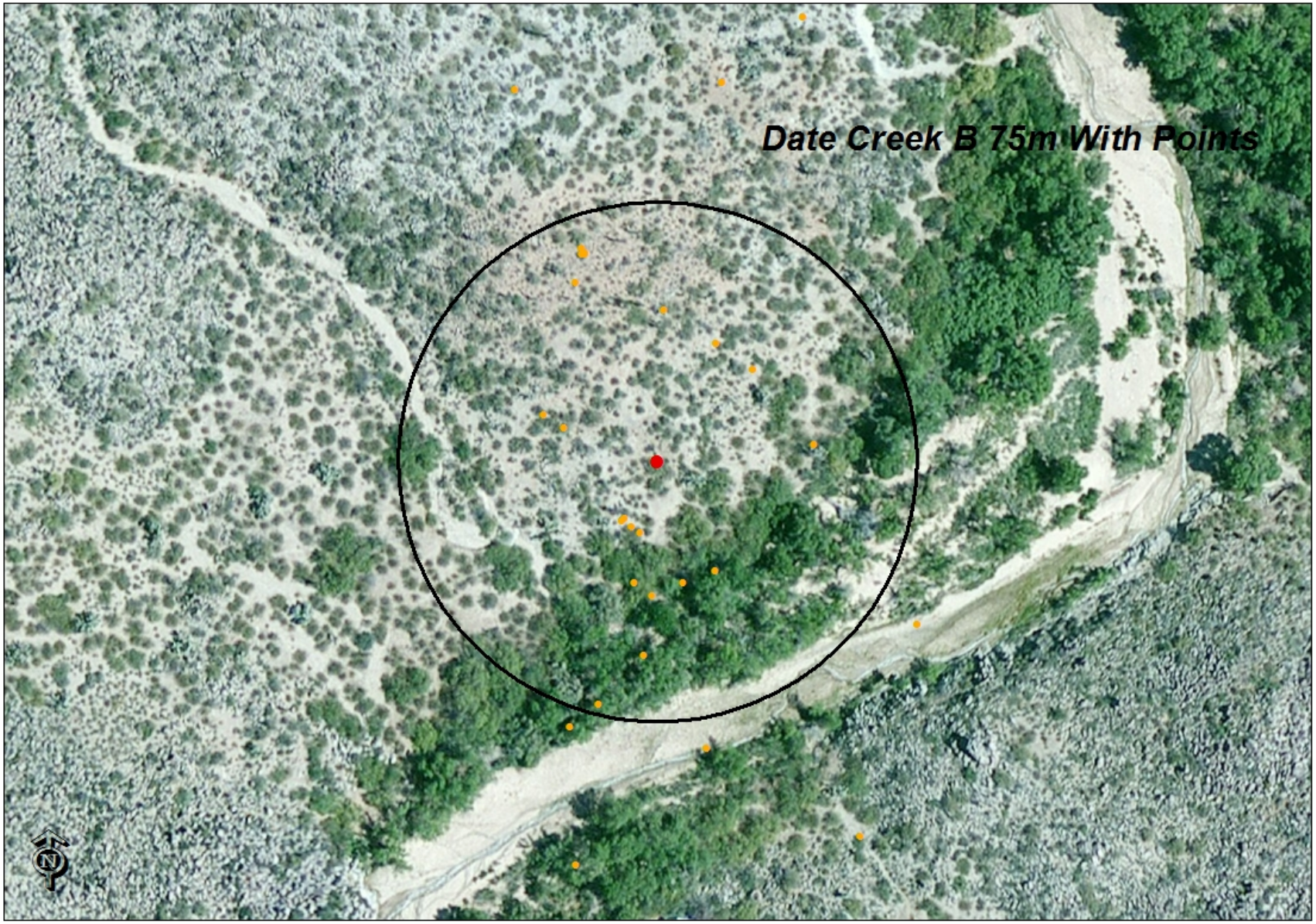
Cienega Creek I 75m With Points


Cienega Creek L 75m No Points


Cienega Creek M 75m No Points

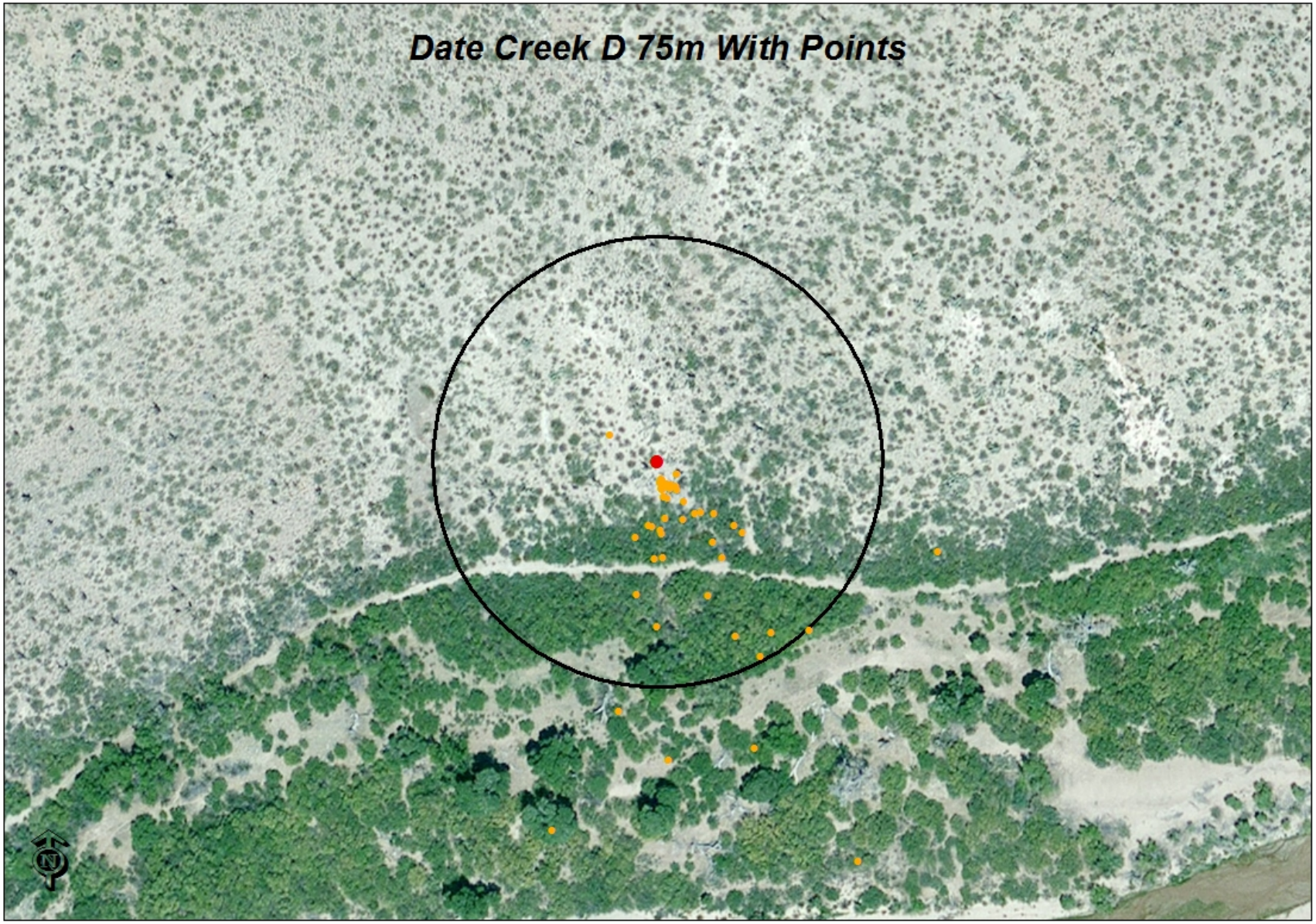

Cienega Creek O 75m With Points

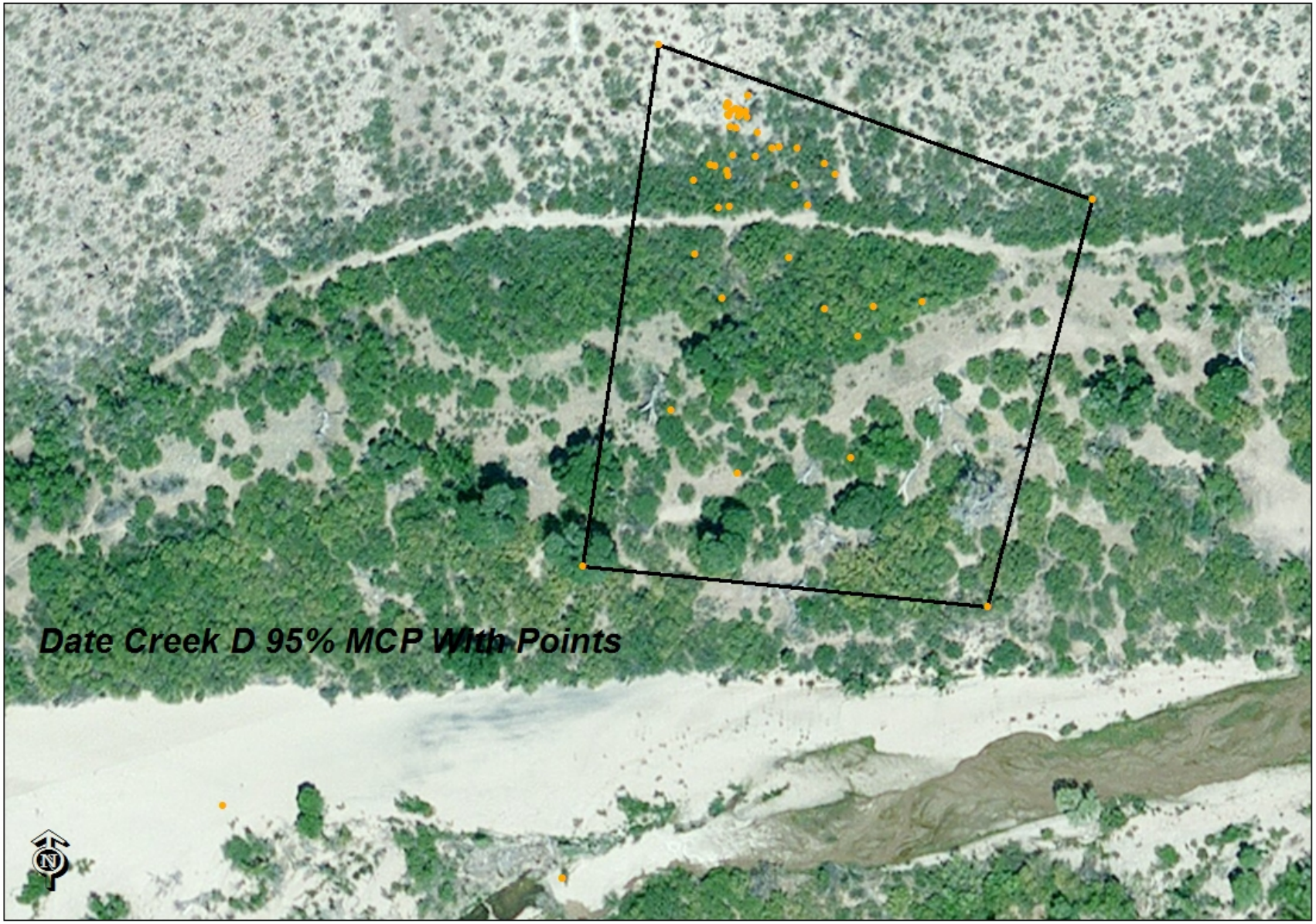
Cienega Creek U 75m No Points

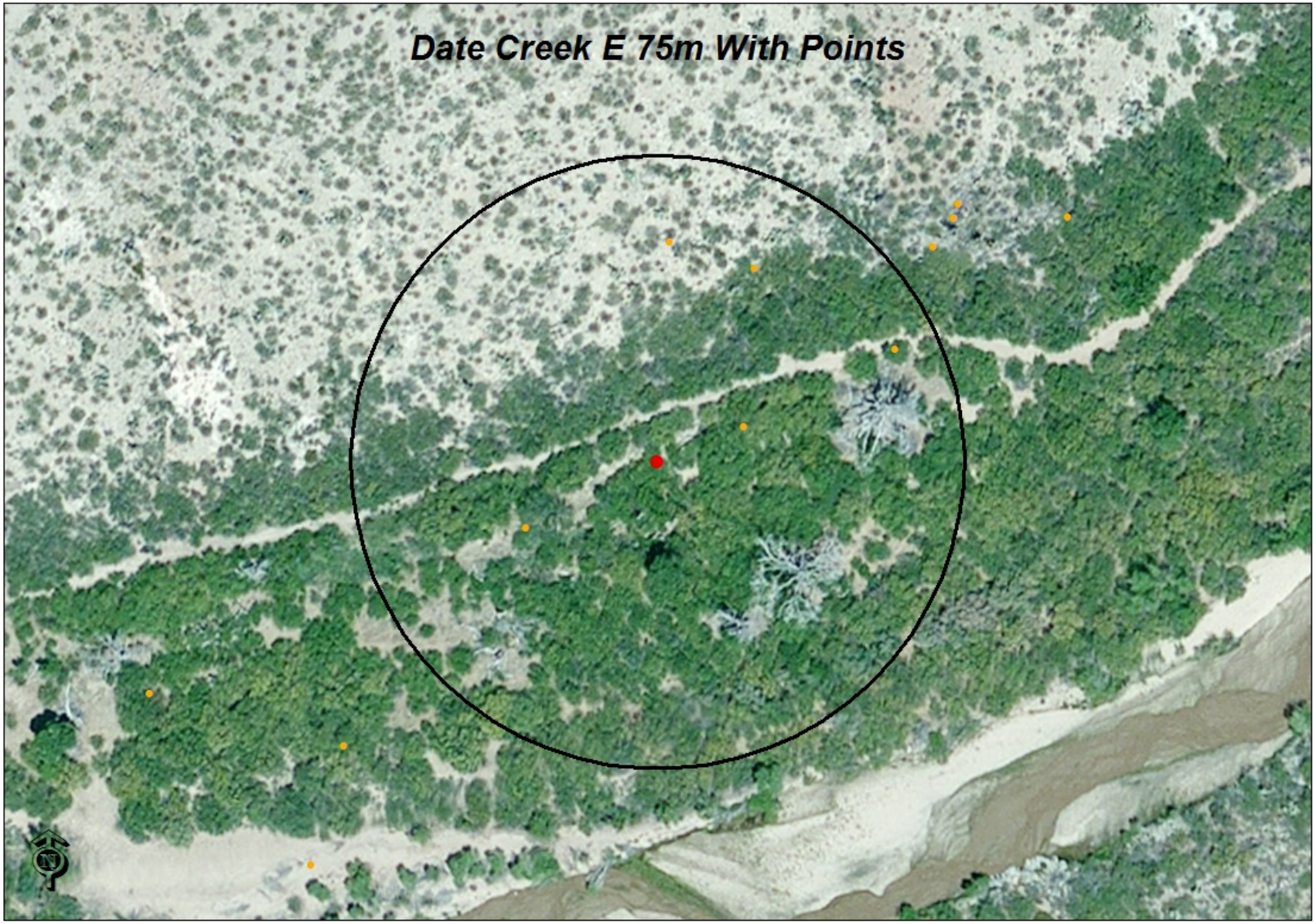

Date Creek B 75m With Points
N

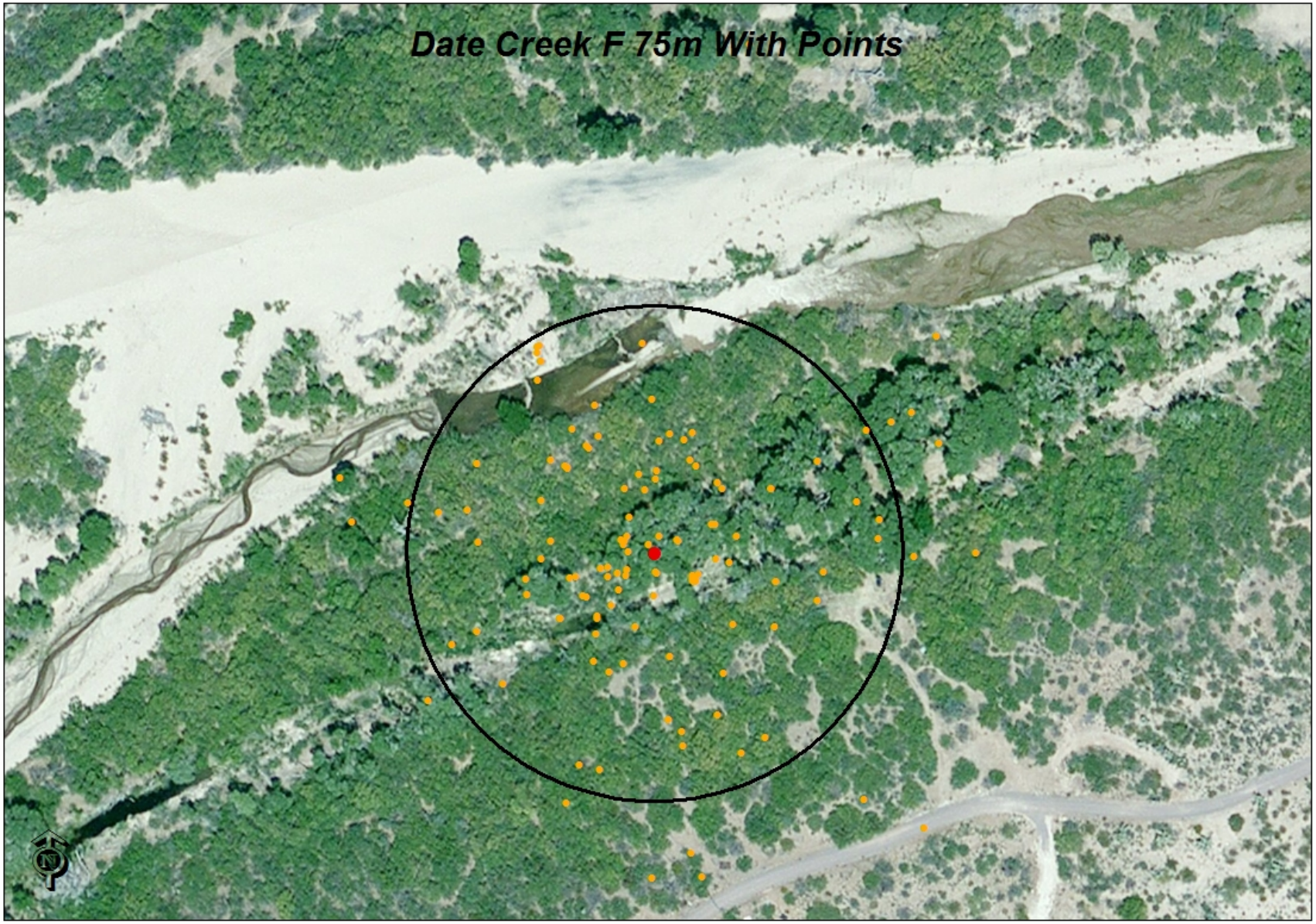
Date Creek B 95% MCP
With Points
N

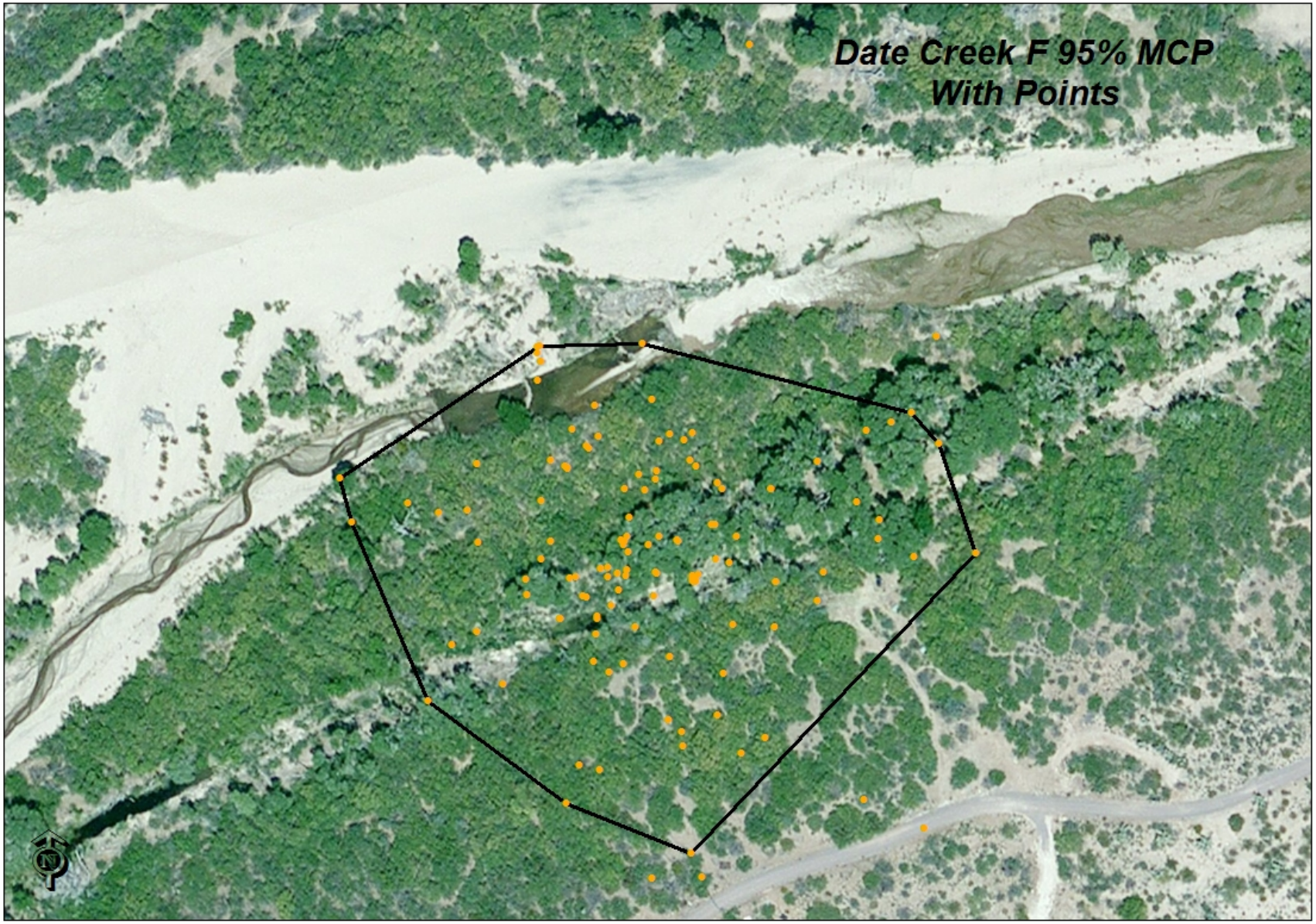
Date Creek C 75m With Points
N


Date Creek D 75m With Points
N

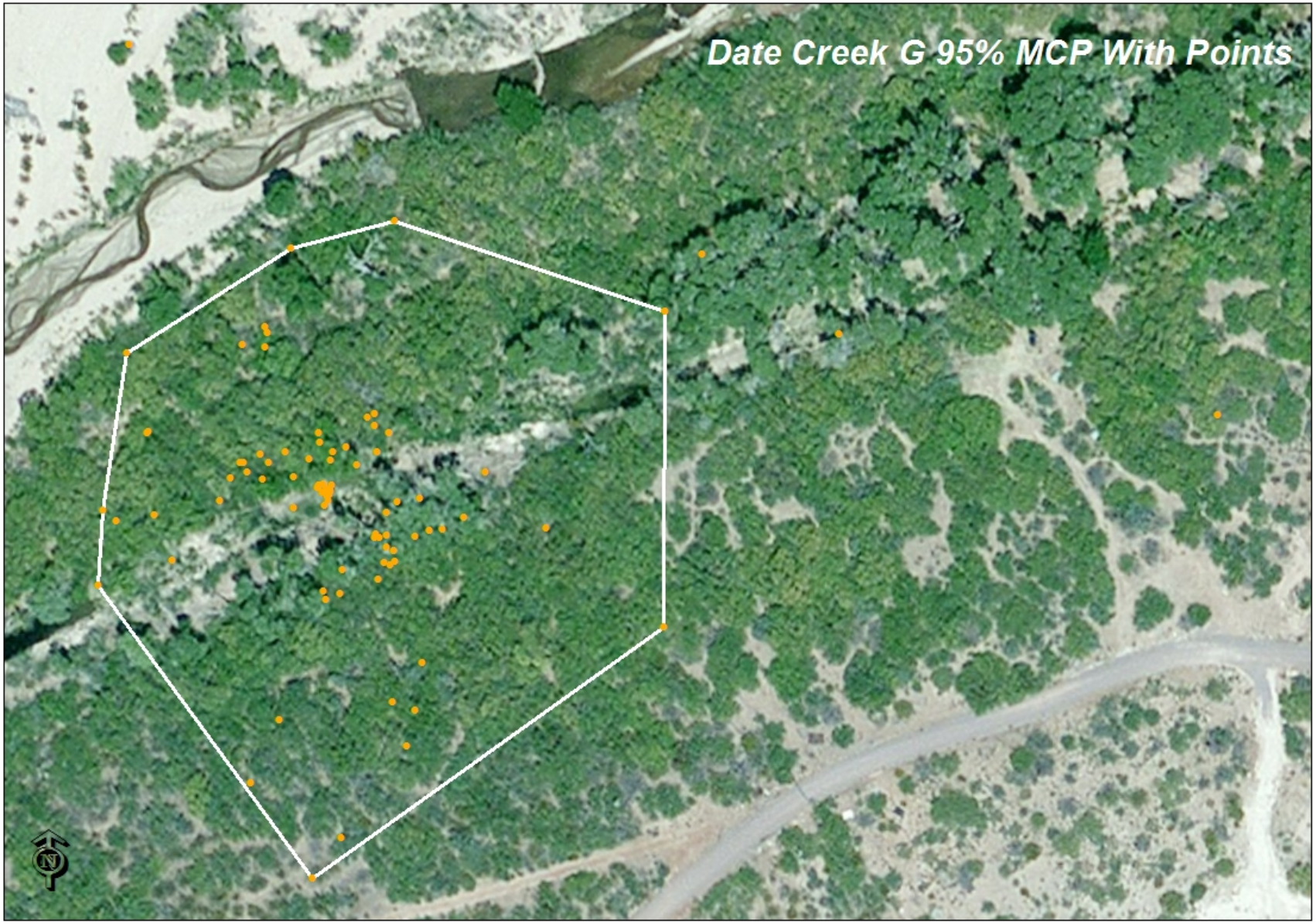

Date Creek D 95% MCP With Points
N


Date Creek E 75m With Points
N


Date Creek F 75m With Points
N


Date Creek F 95% MCP
With Points
N

Date Creek G 75m With Points
N

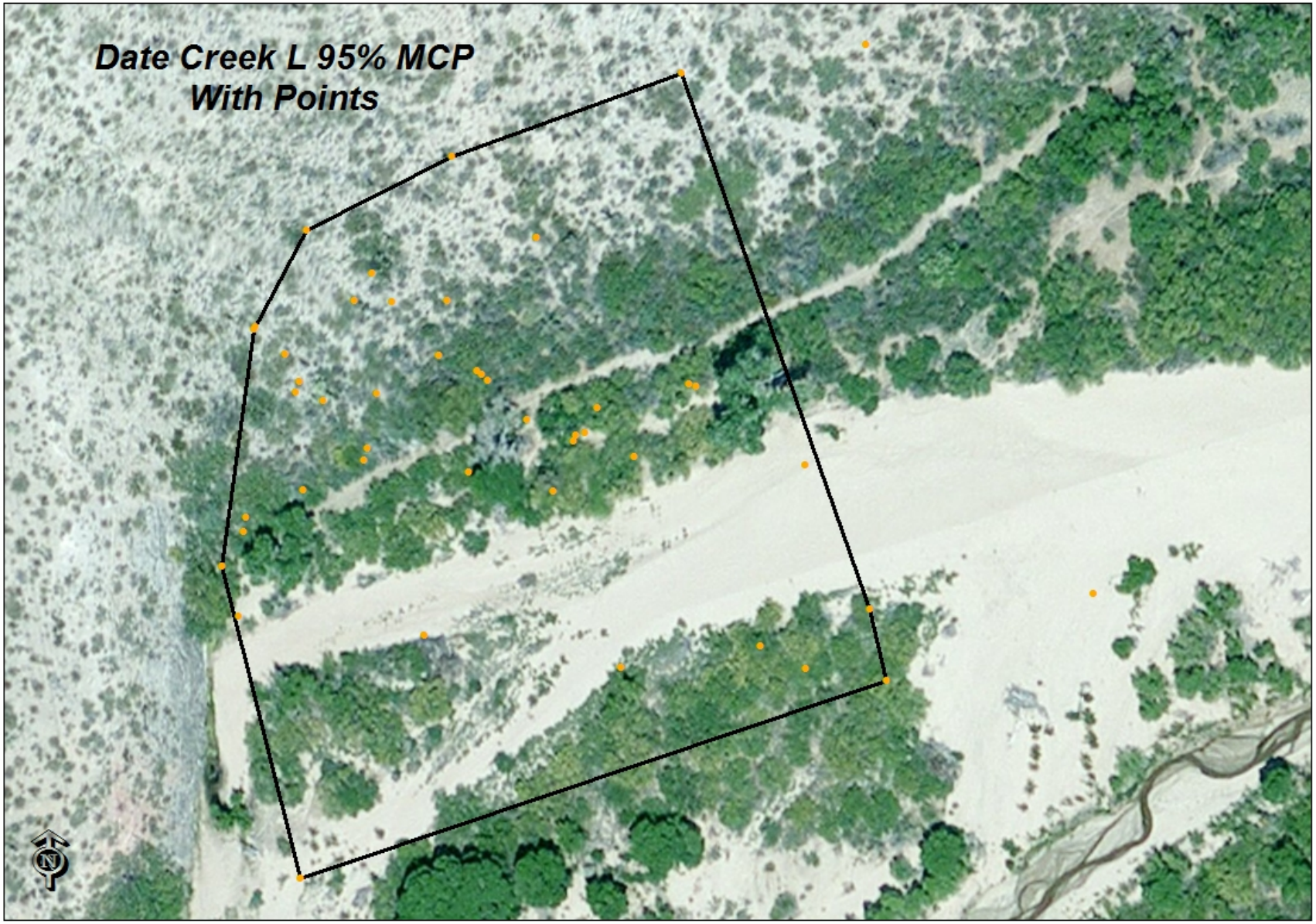

Date Creek G 95% MCP With Points
N

Date Creek J 75m With Points
N

Date Creek K 75m With Points
N

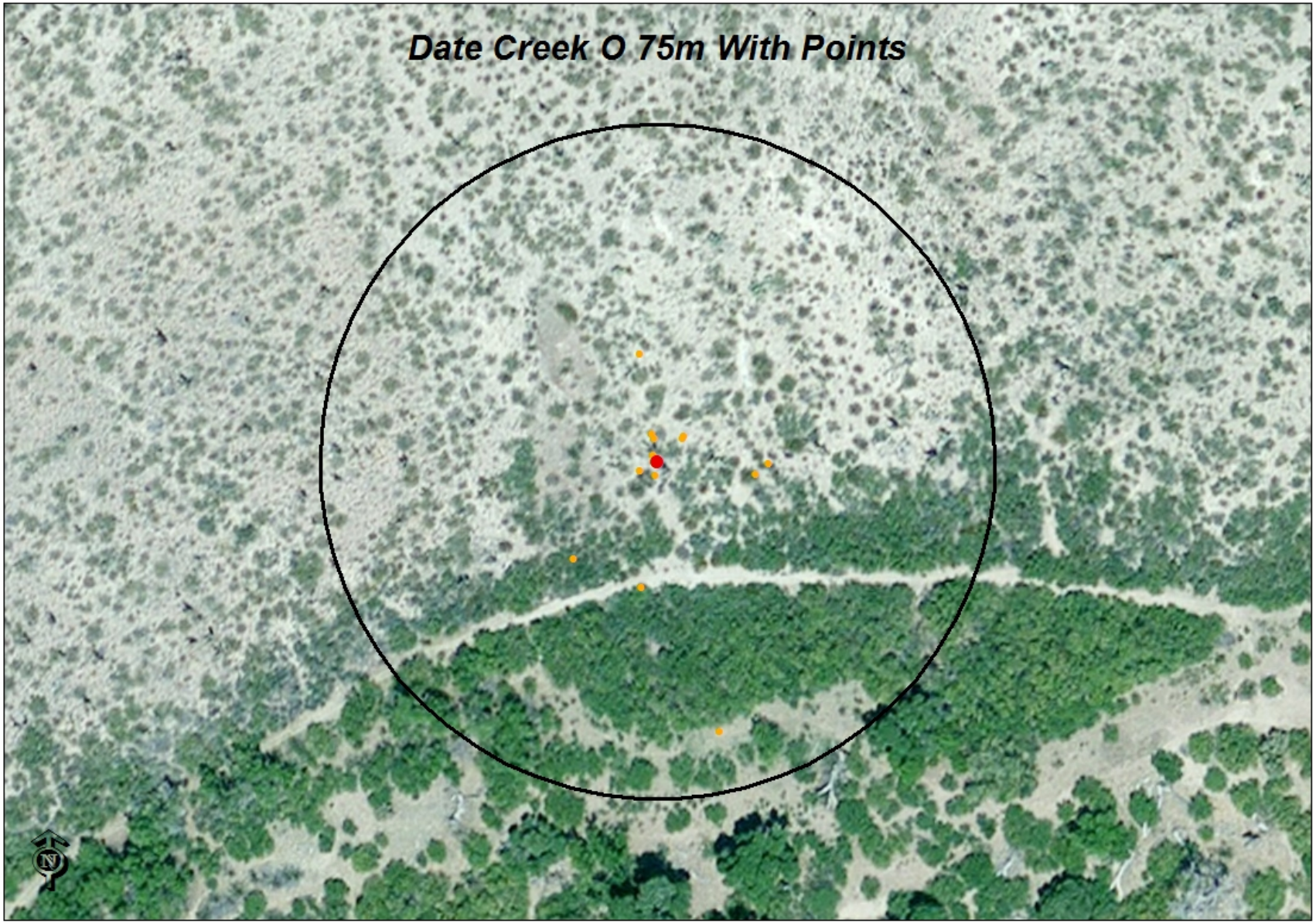
Date Creek K 95% MCP
With Points
N

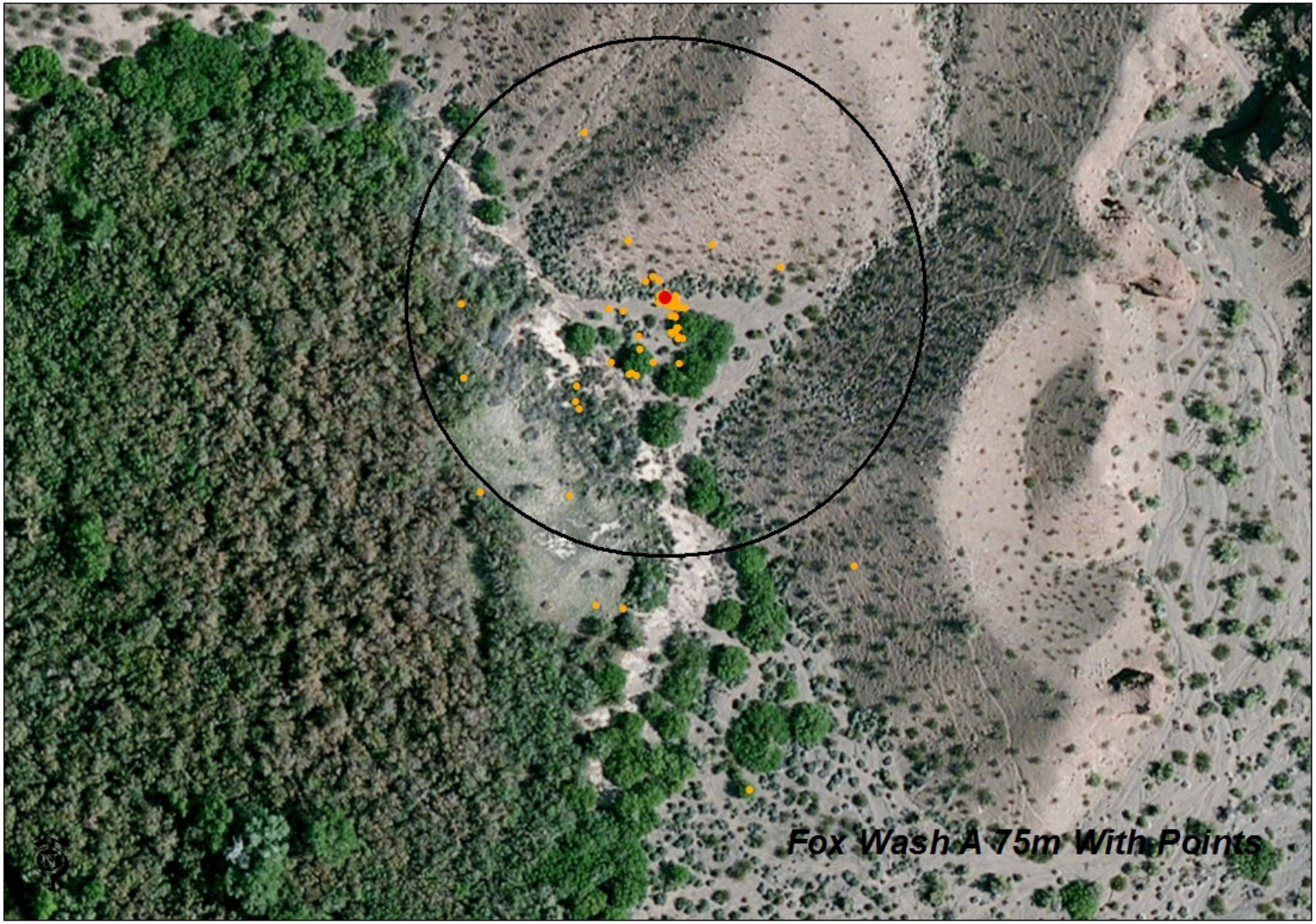
Date Creek L 75m With Points
N


Date Creek L 95% MCP
With Points
N

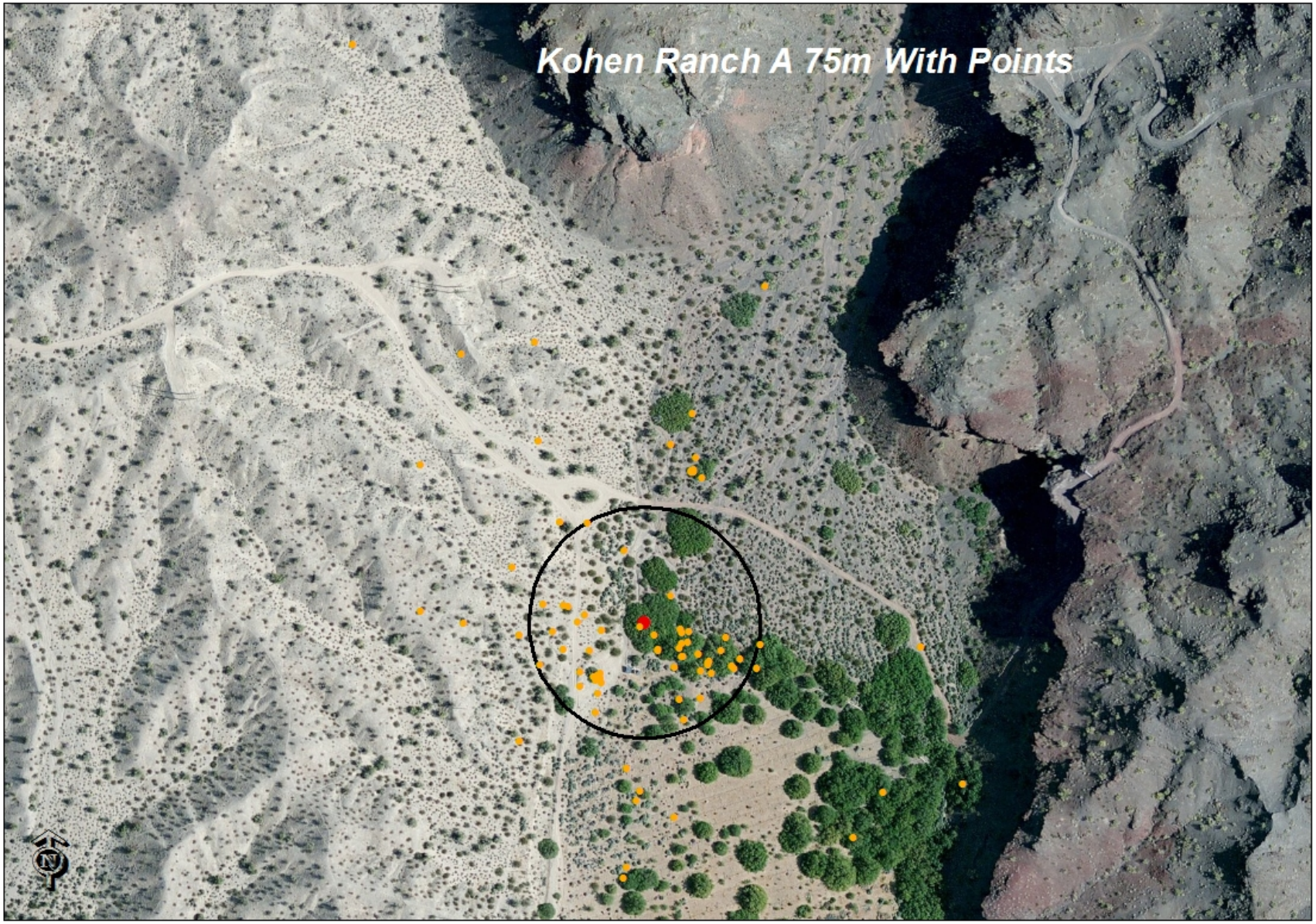
Date Creek M 75m With Points
N

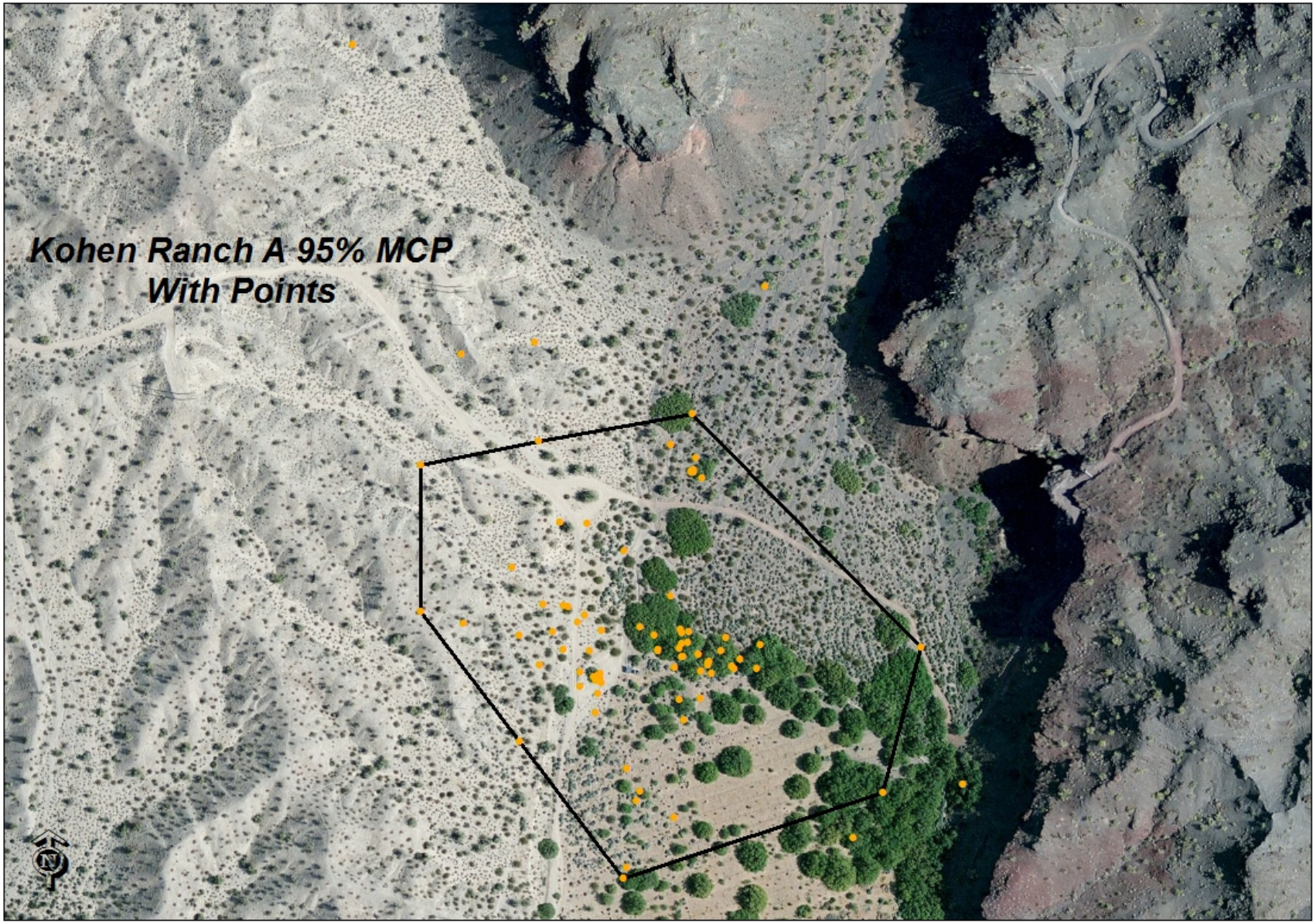
Date Creek N 75m With Points
N

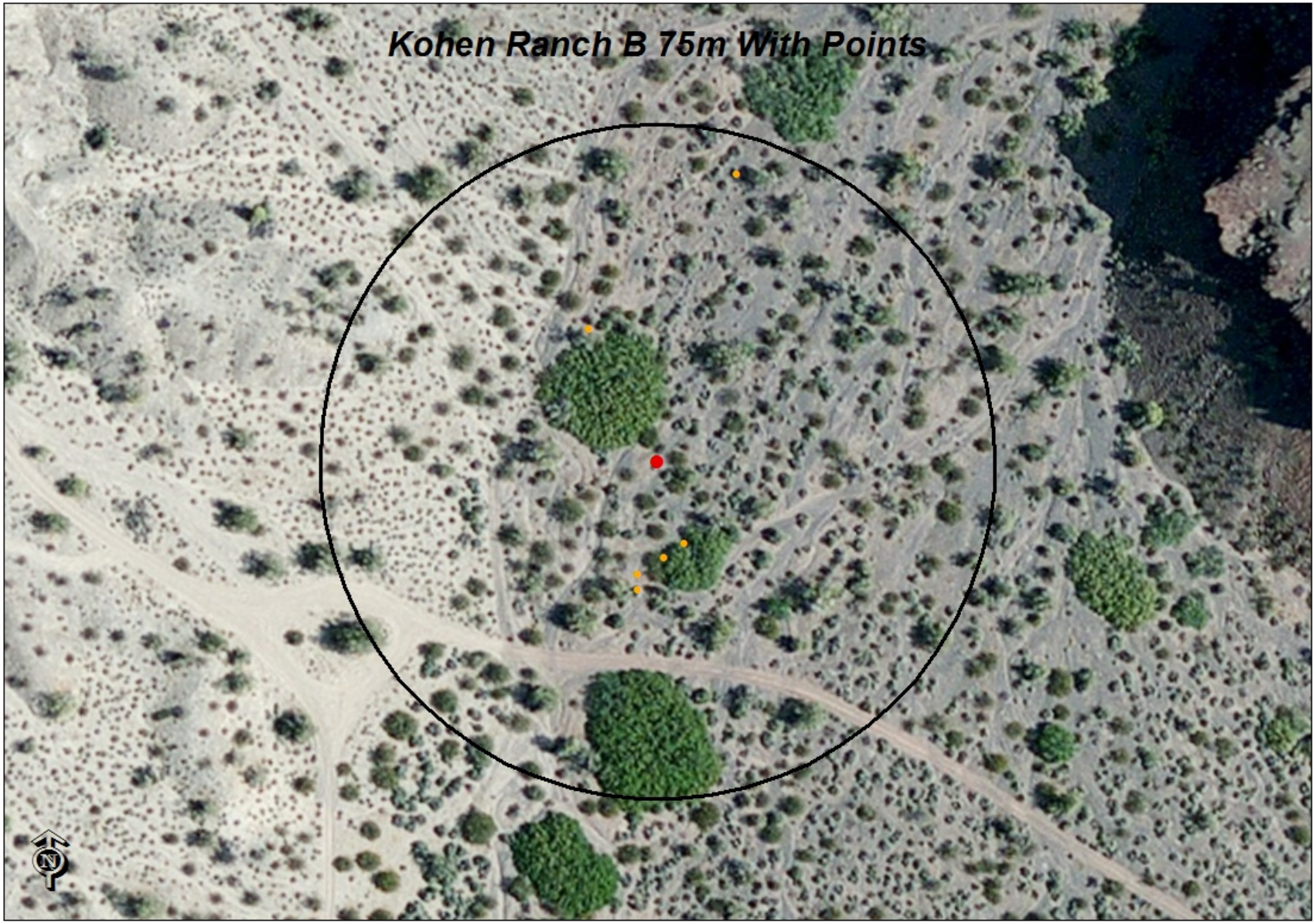

Date Creek O 75m With Points
N

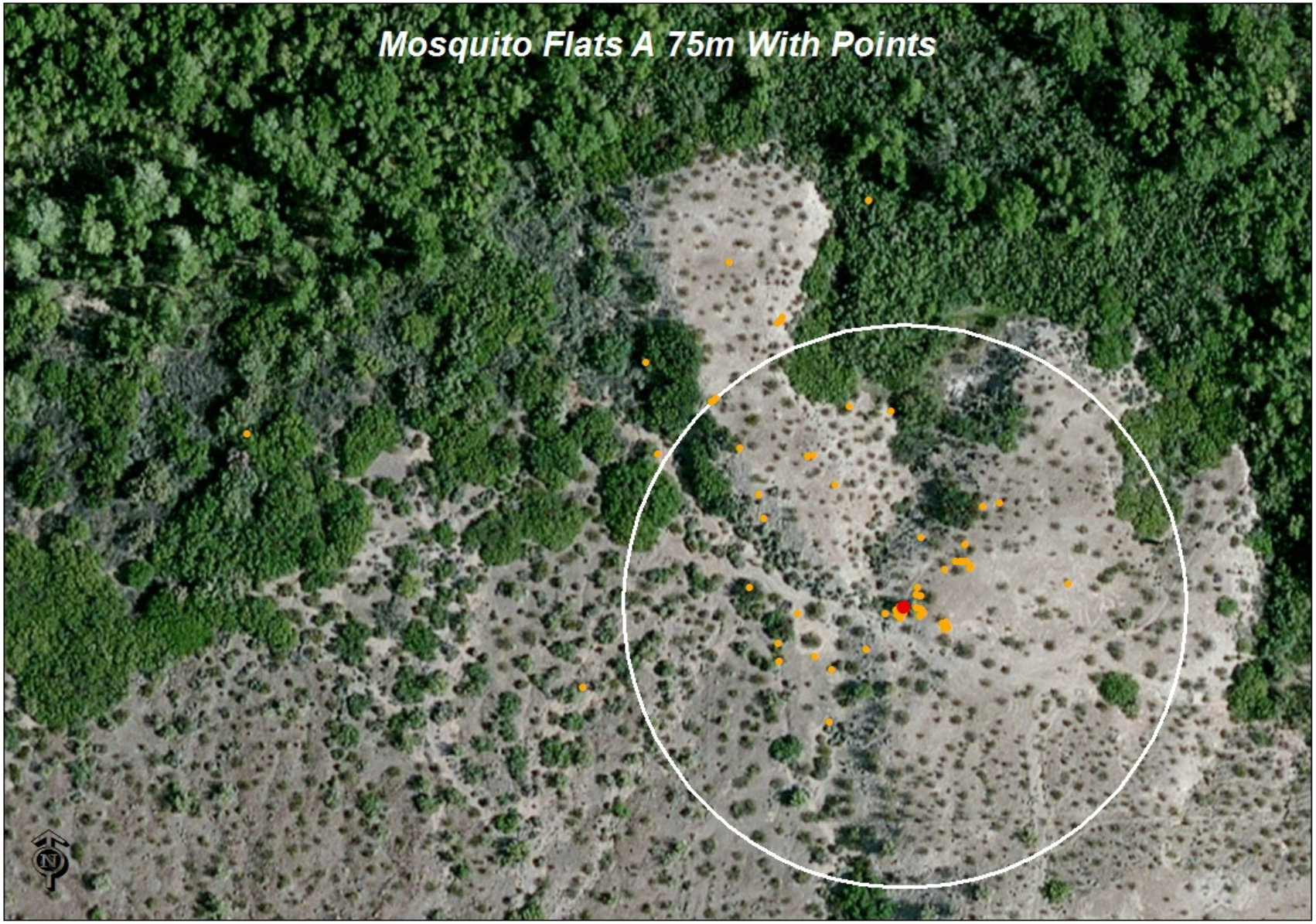

Fox Wash A 75m With Points

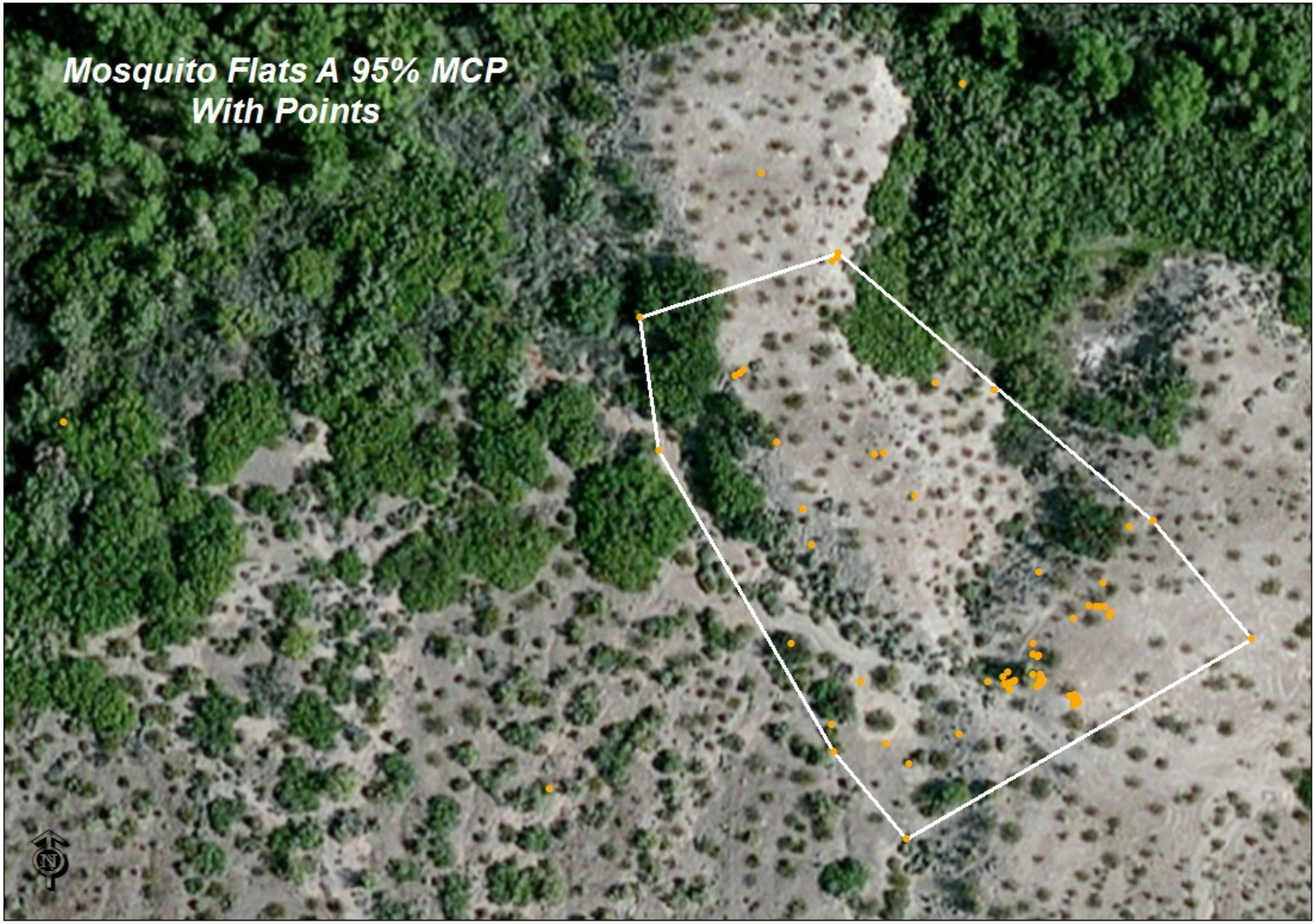
Fox Wash A 95% MCP
With Points

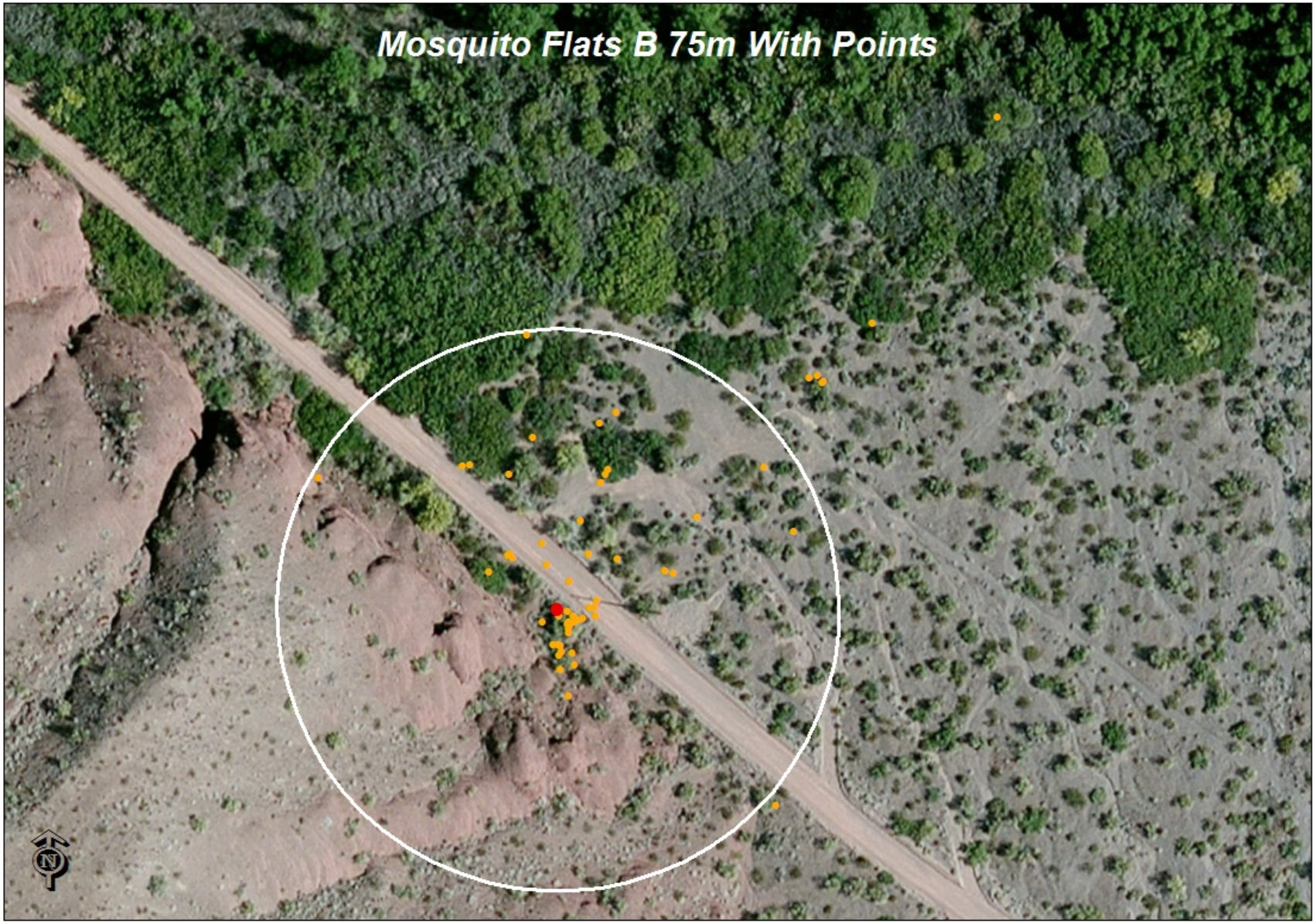

Kohen Ranch A 75m With Points
N

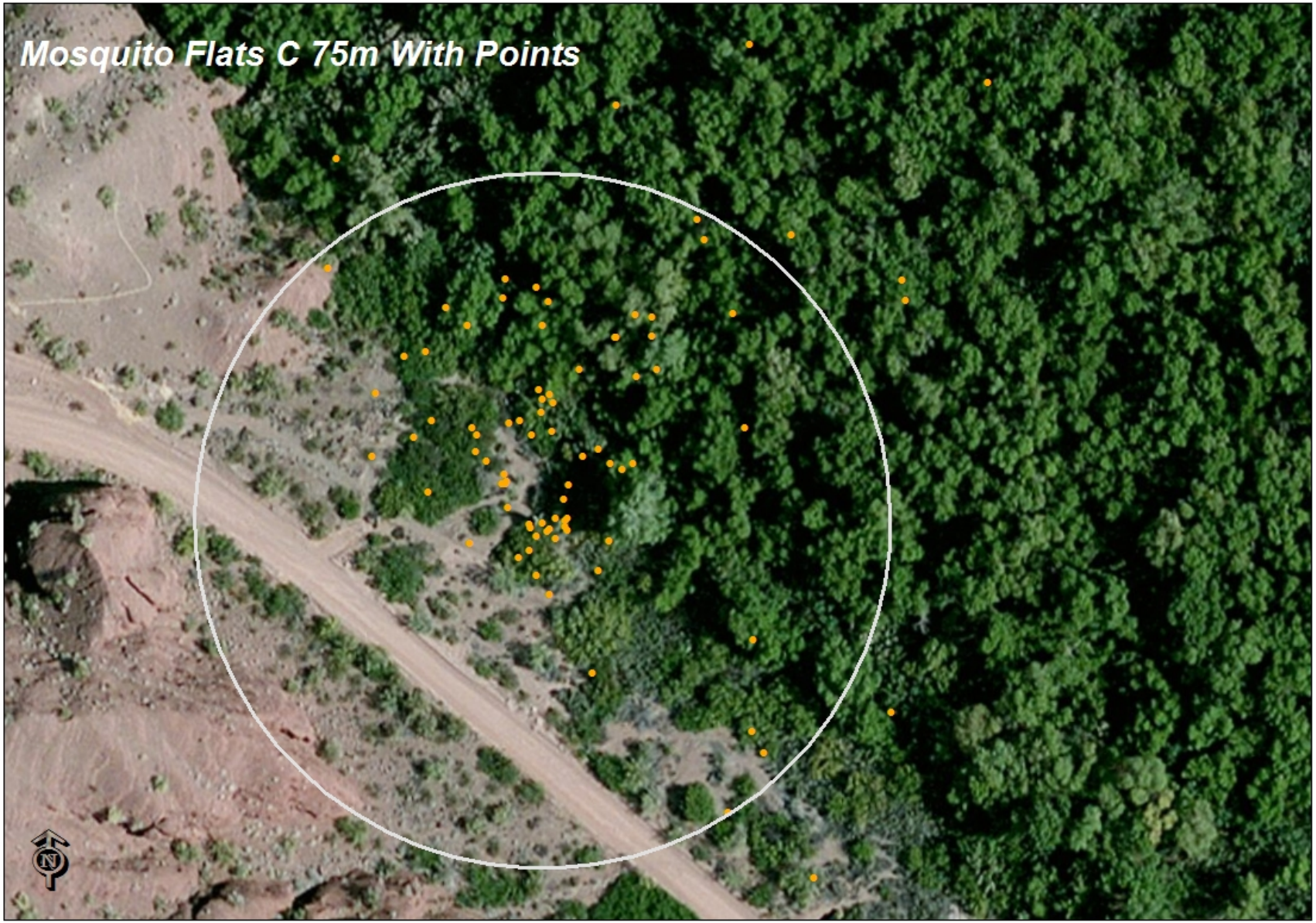

Kohen Ranch A 95% MCP
With Points

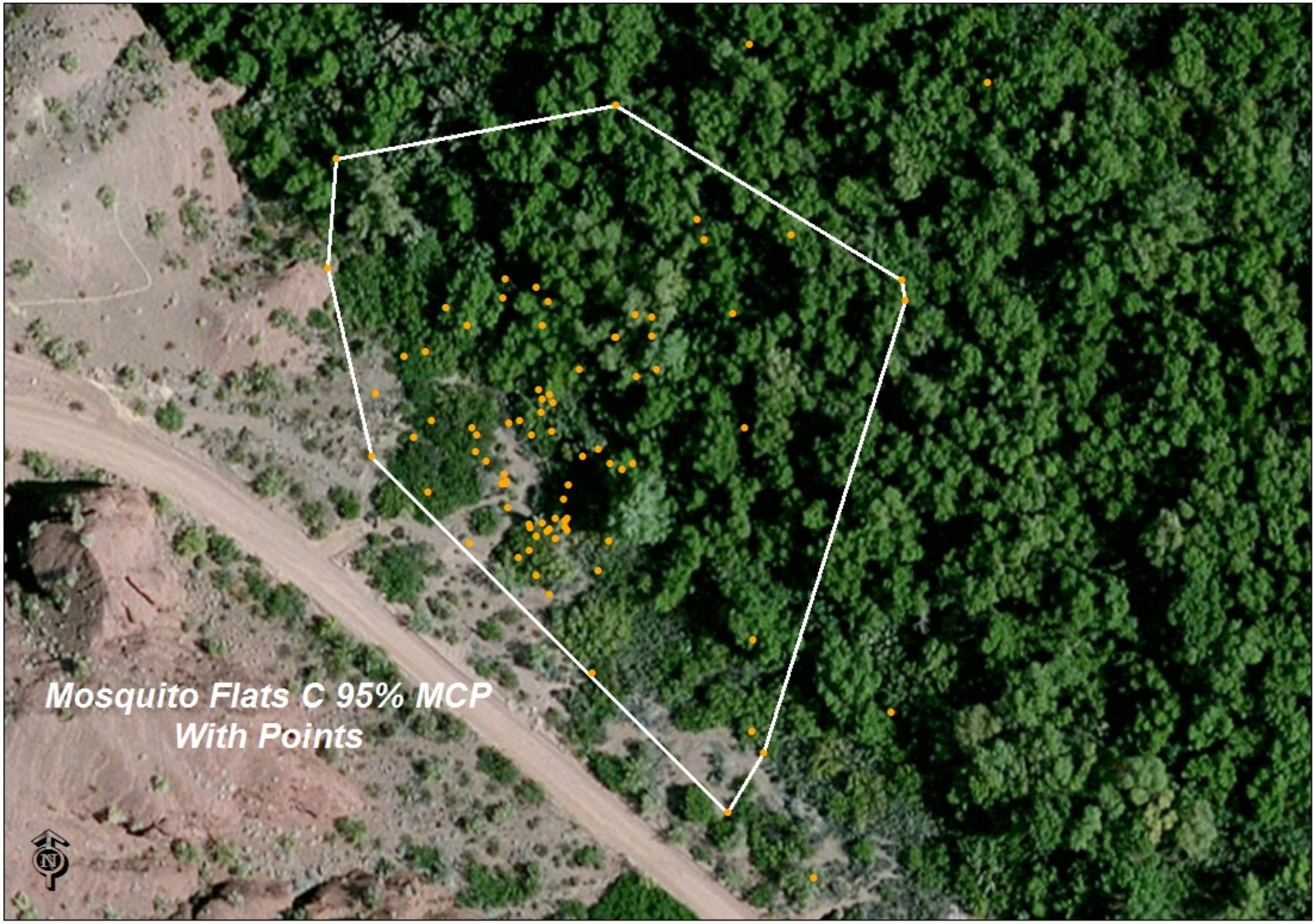

Kohen Ranch B 75m With Points
N


Mosquito Flats A 75m With Points
N

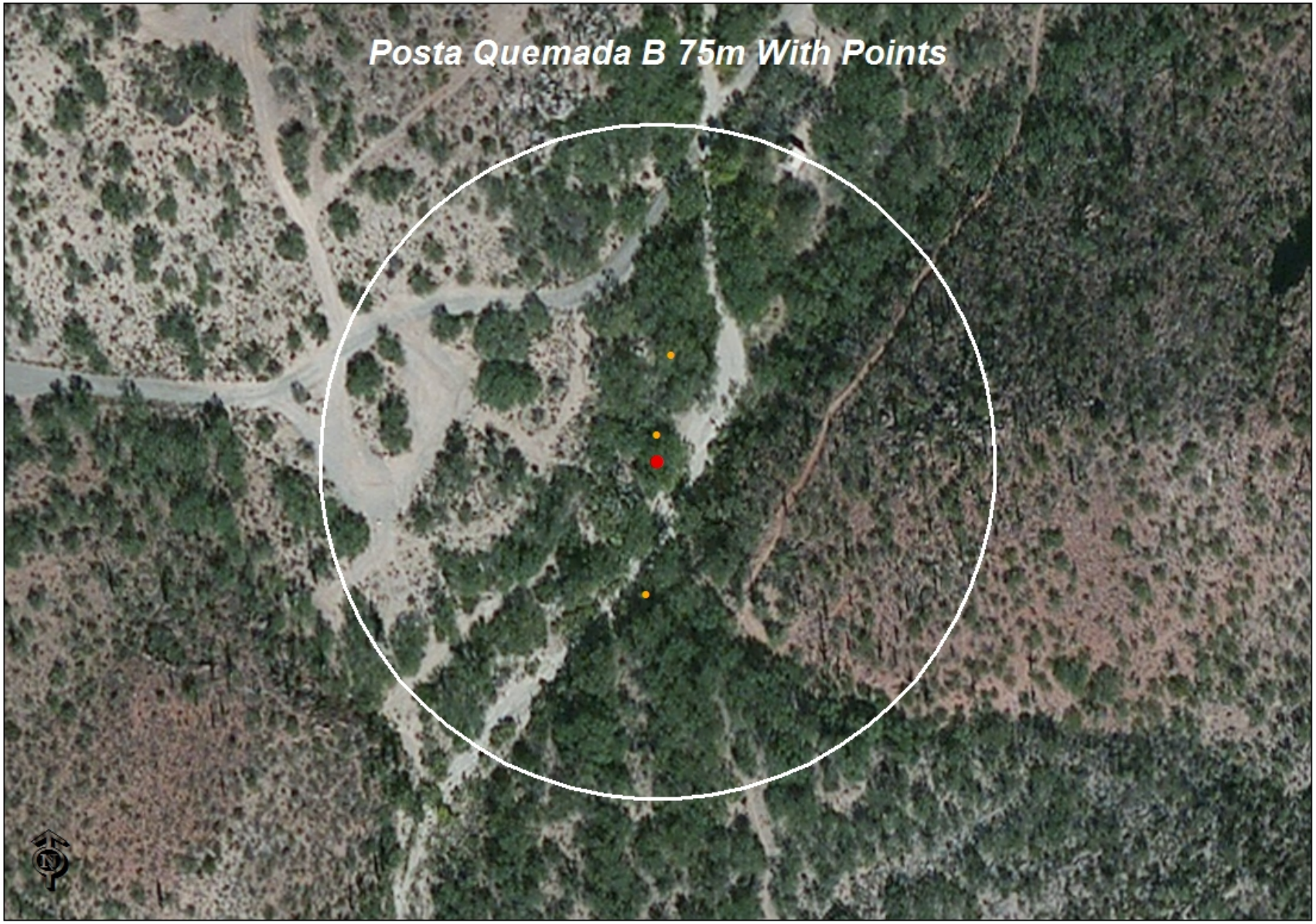

Mosquito Flats A 95% MCP
With Points
N

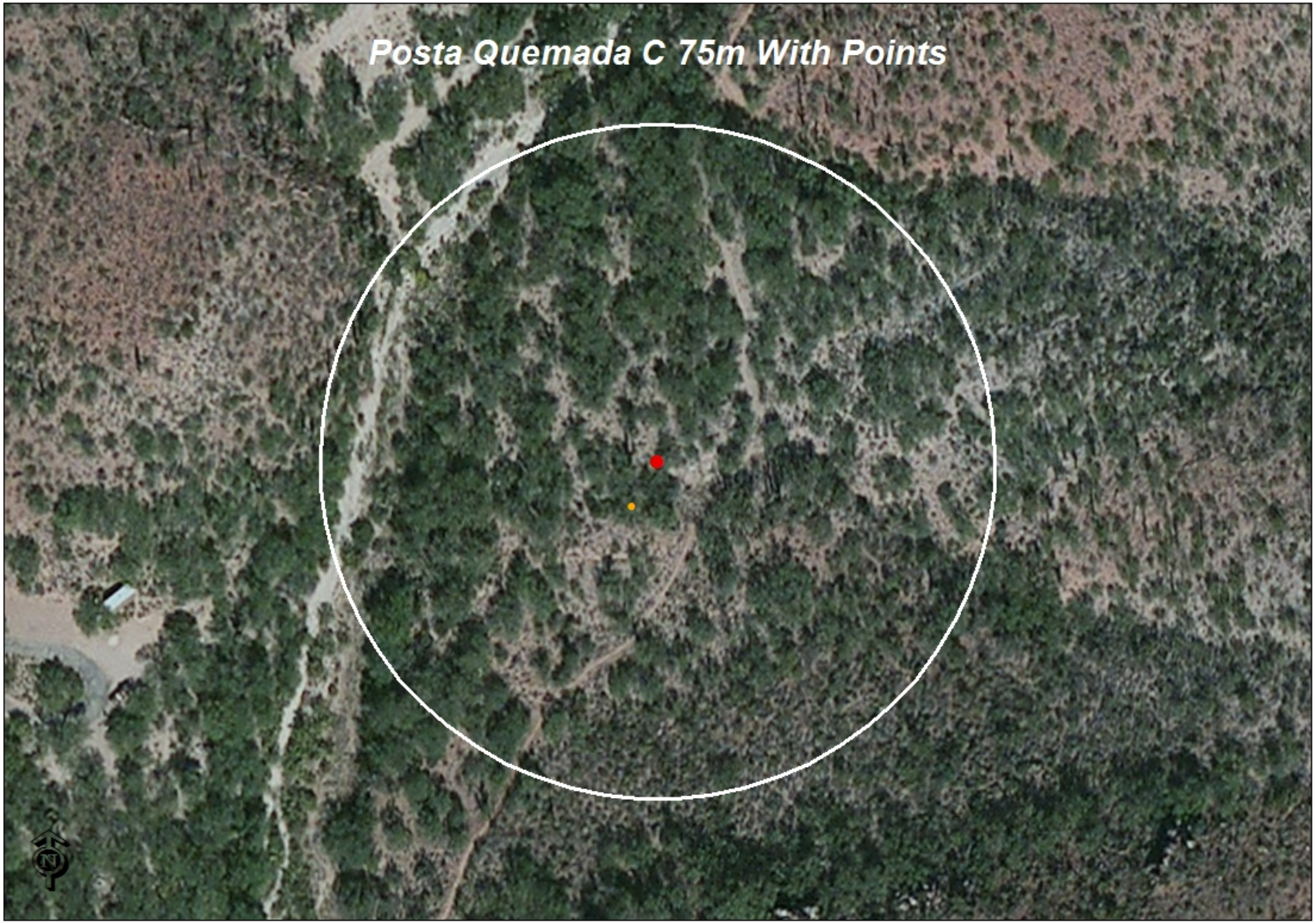

Mosquito Flats B 75m With Points
N

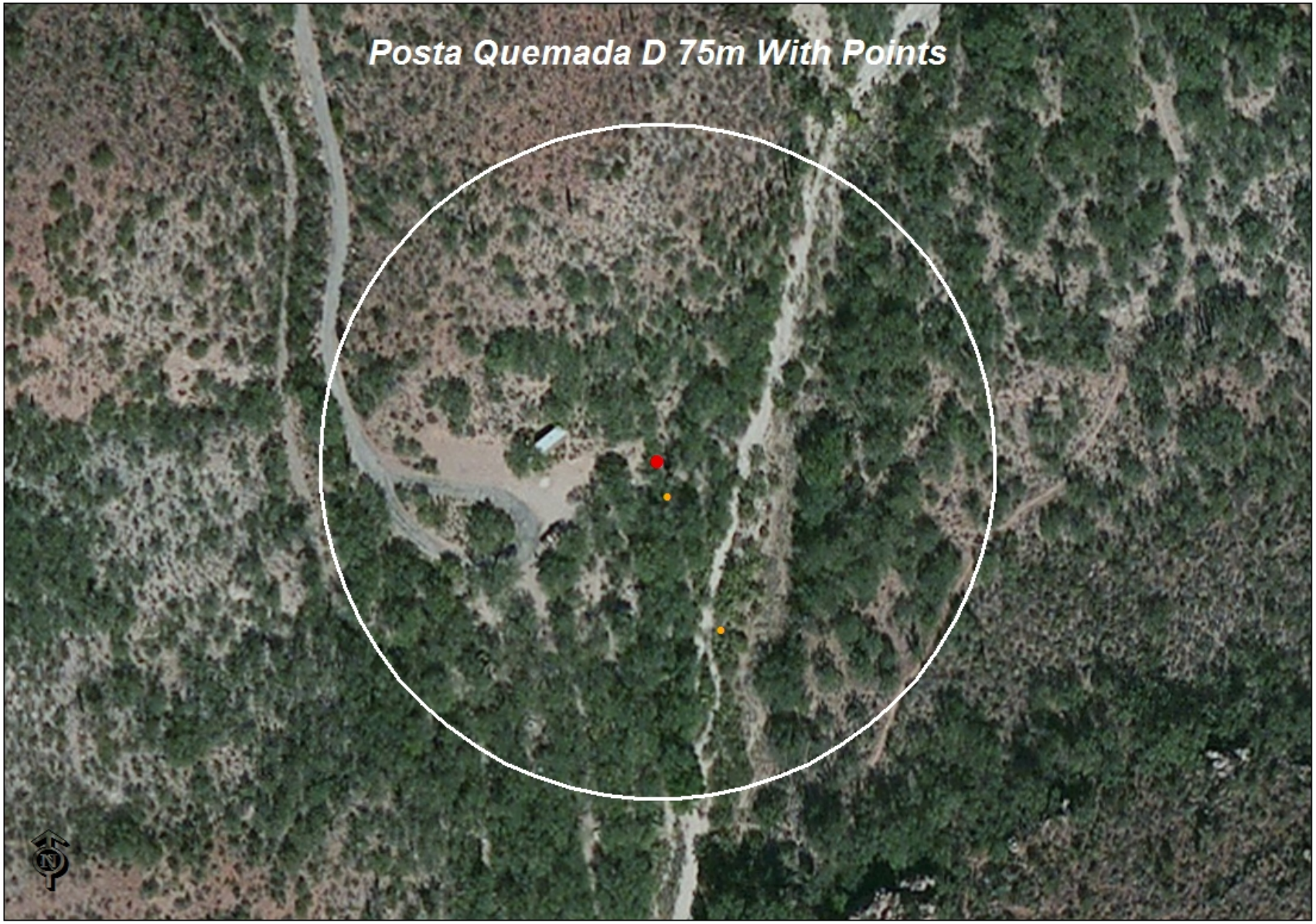

Mosquito Flats C 75m With Points
N


Mosquito Flats C 95% MCP
With Points
N

Mosquito Flats D 75m With Points


Posta Quemada B 75m With Points


Posta Quemada C 75m With Points


Posta Quemada D 75m With Points
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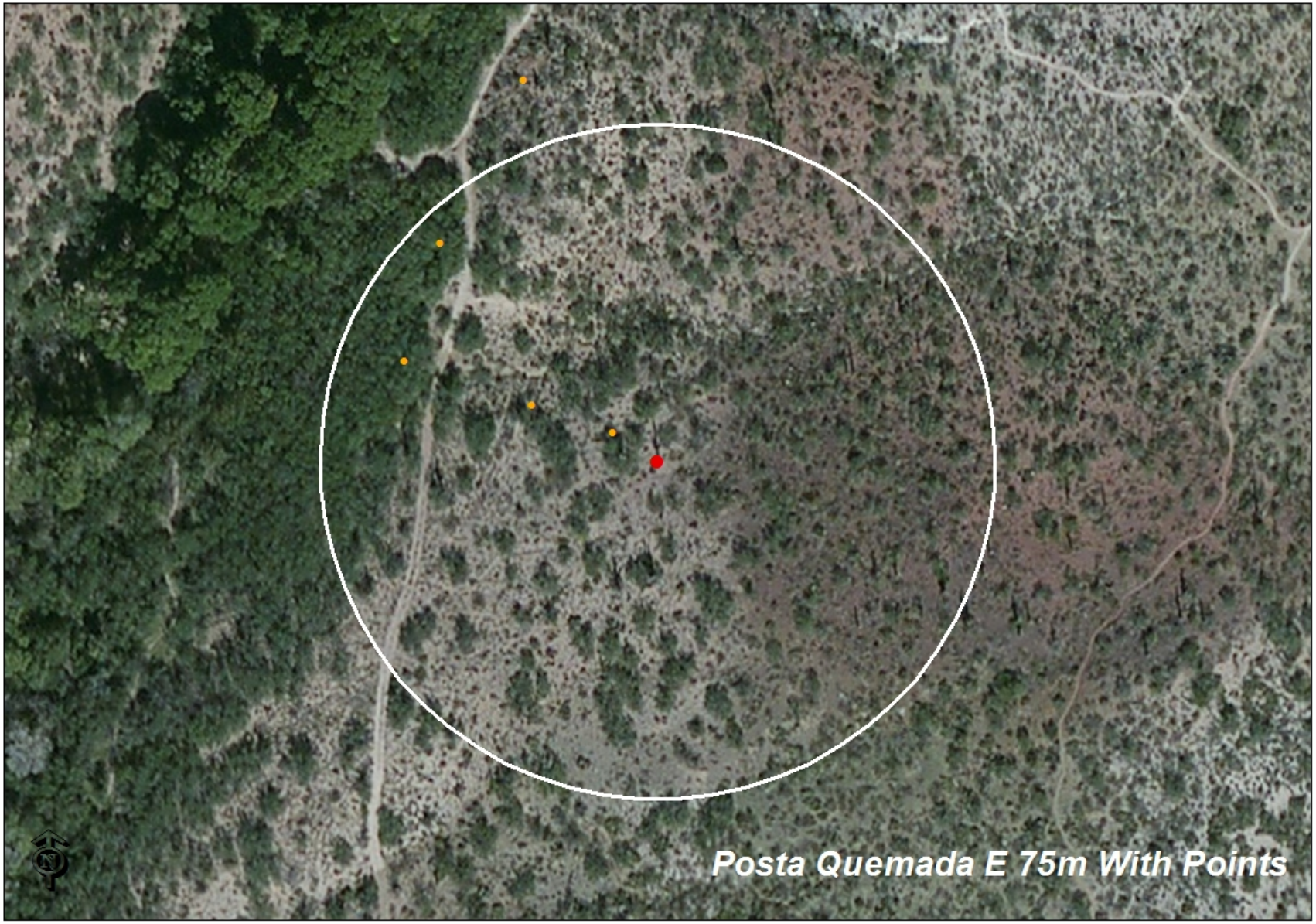
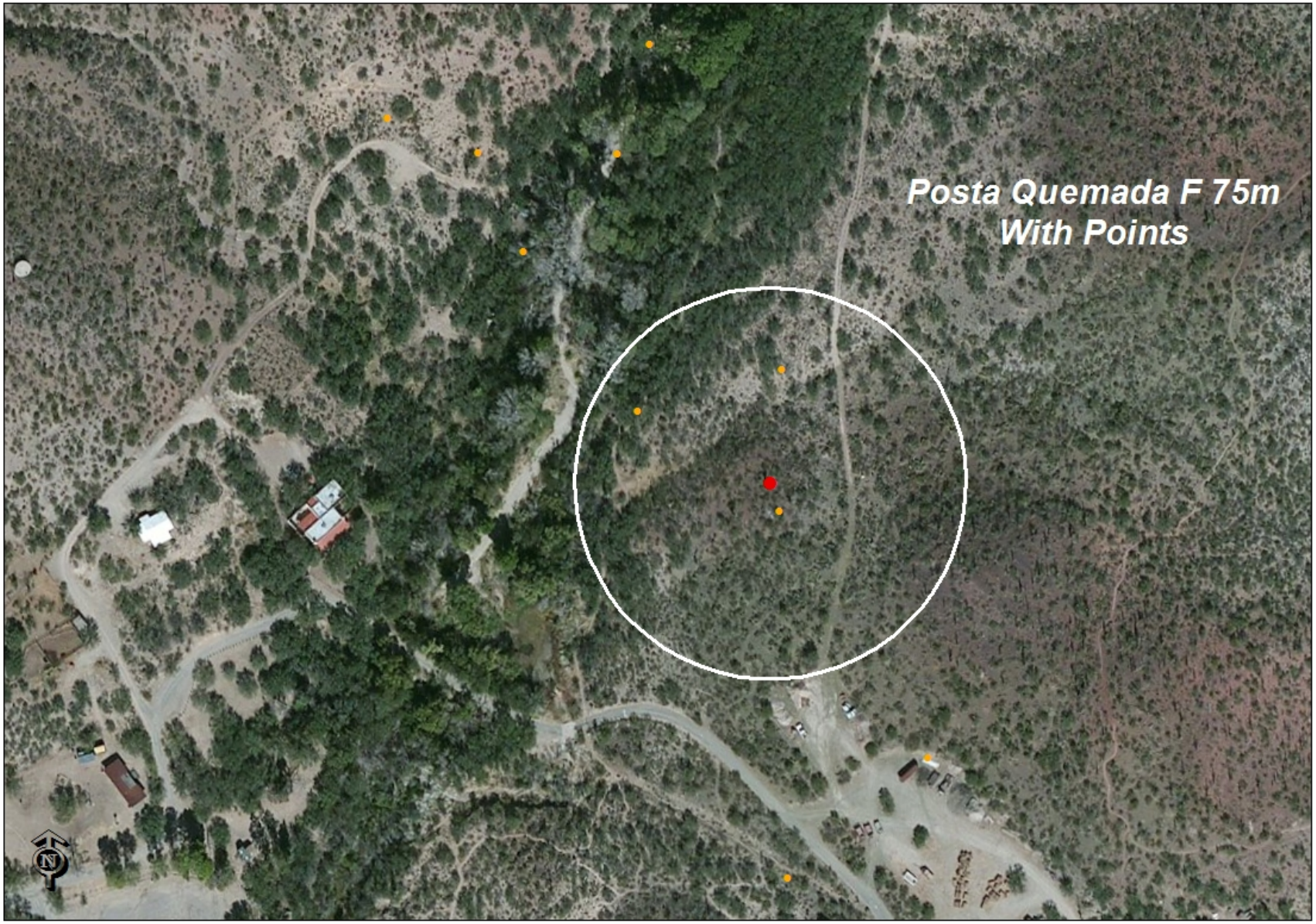
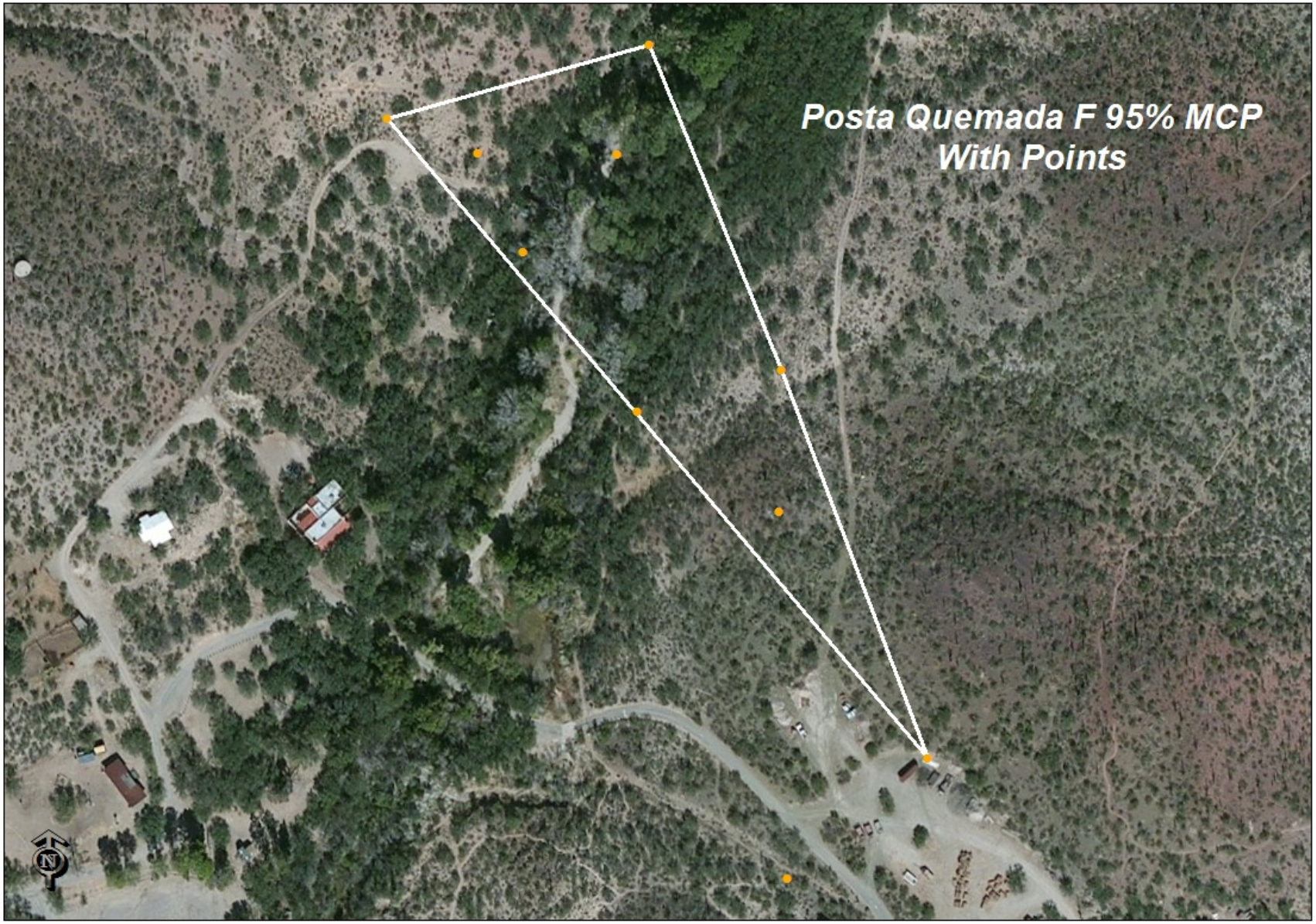
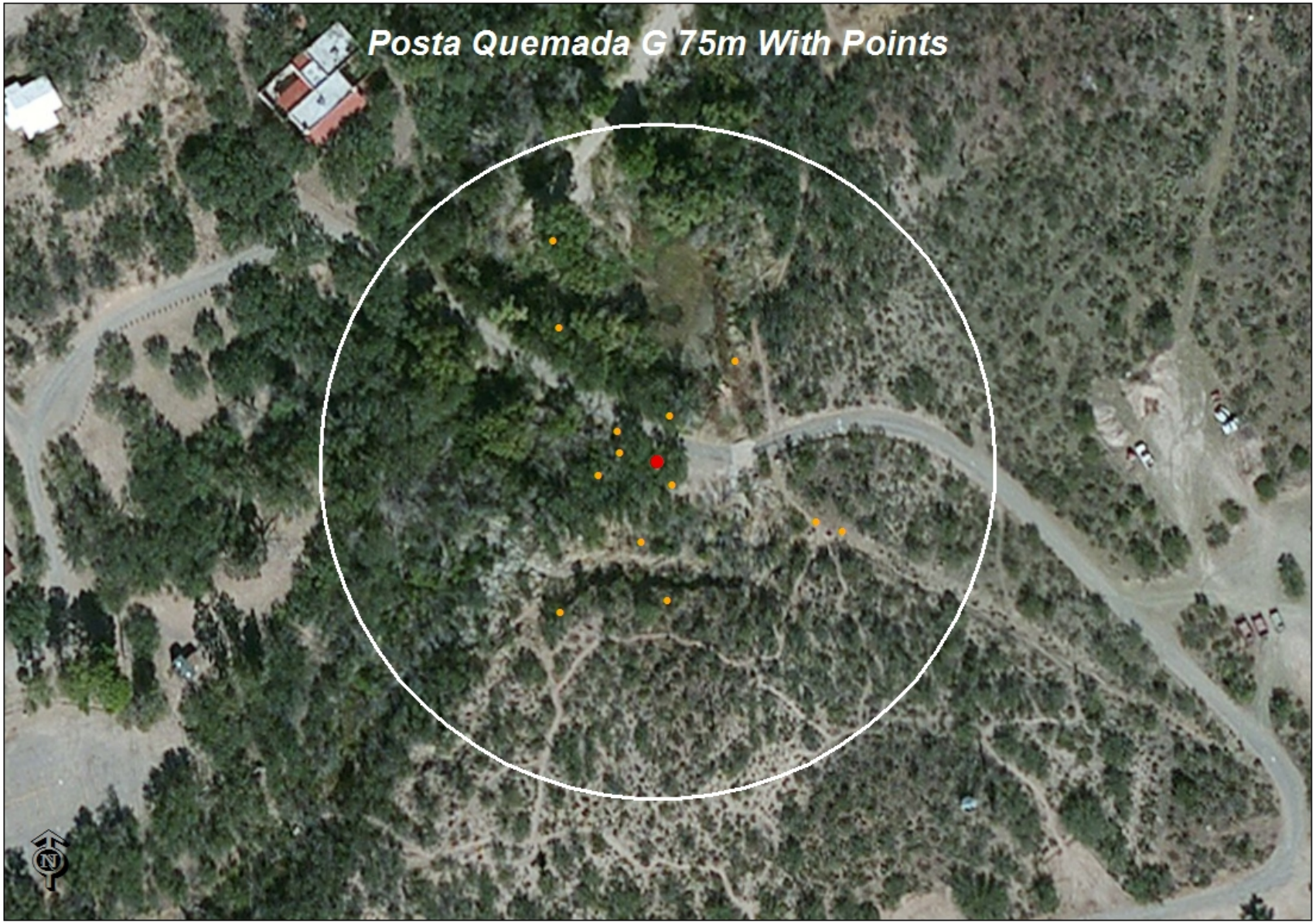
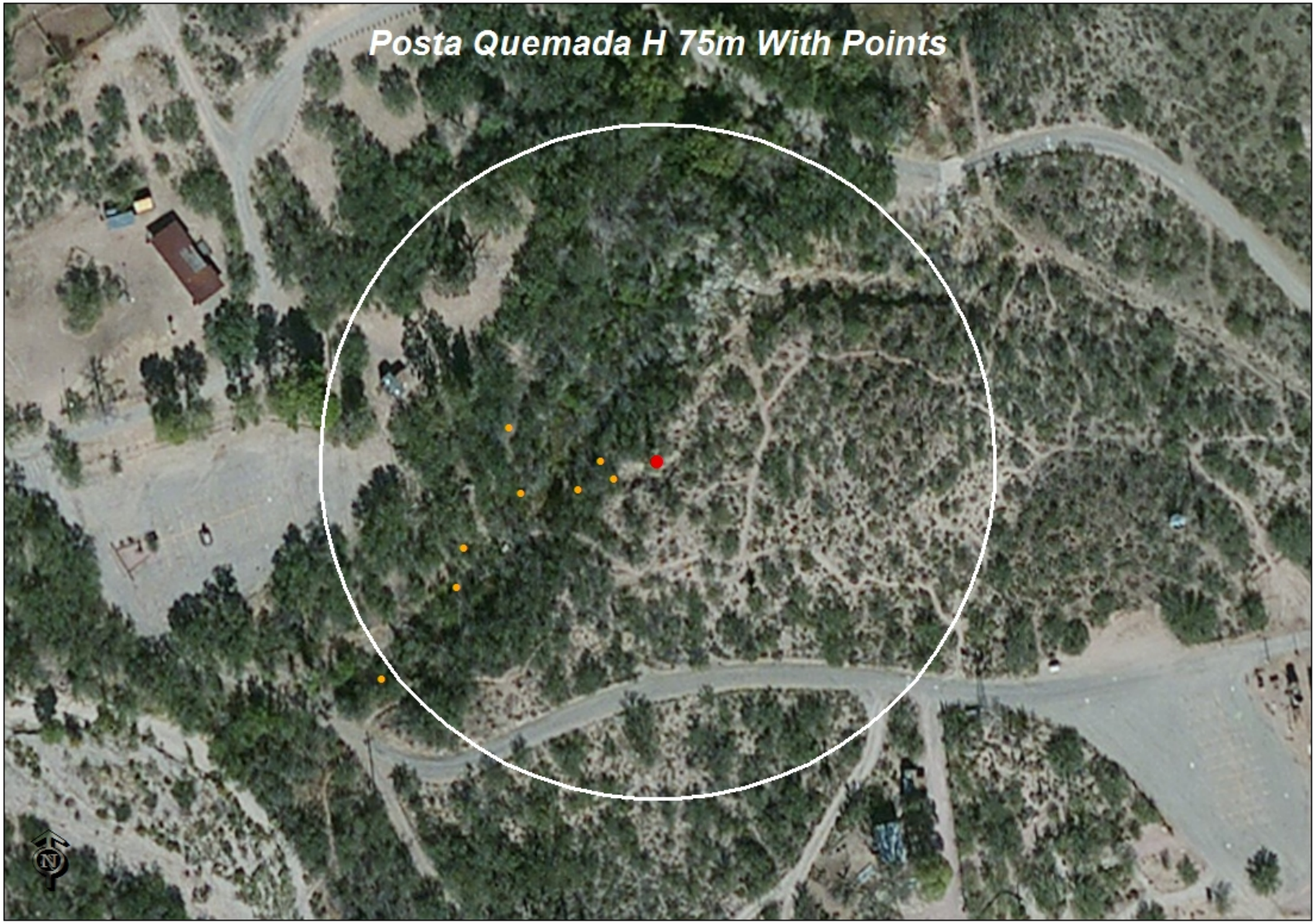

Posta Quemada E 75m With Points


Posta Quemada F 75m
With Points

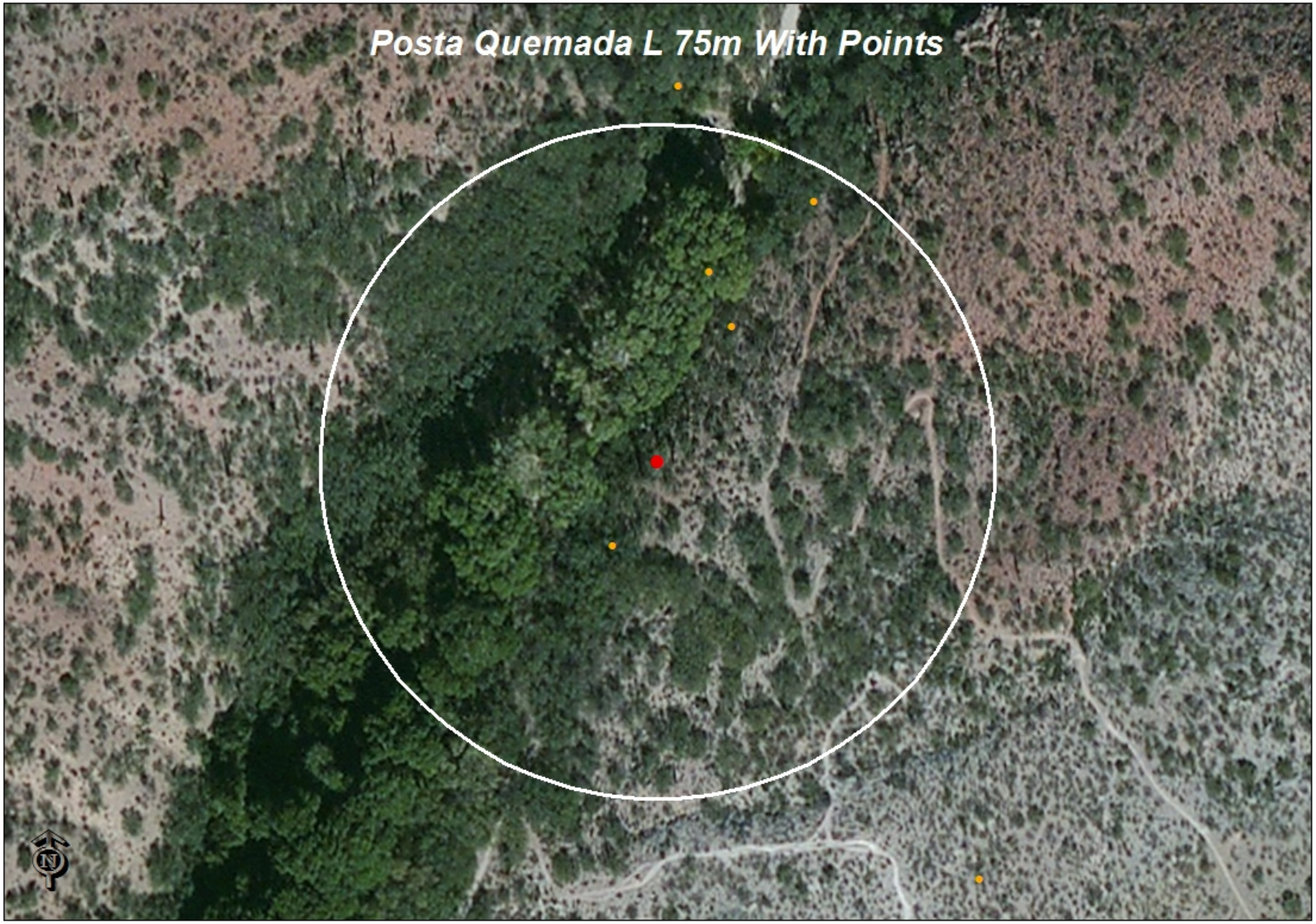

Posta Quemada F 95% MCP
With Points


Posta Quemada G 75m With Points
N

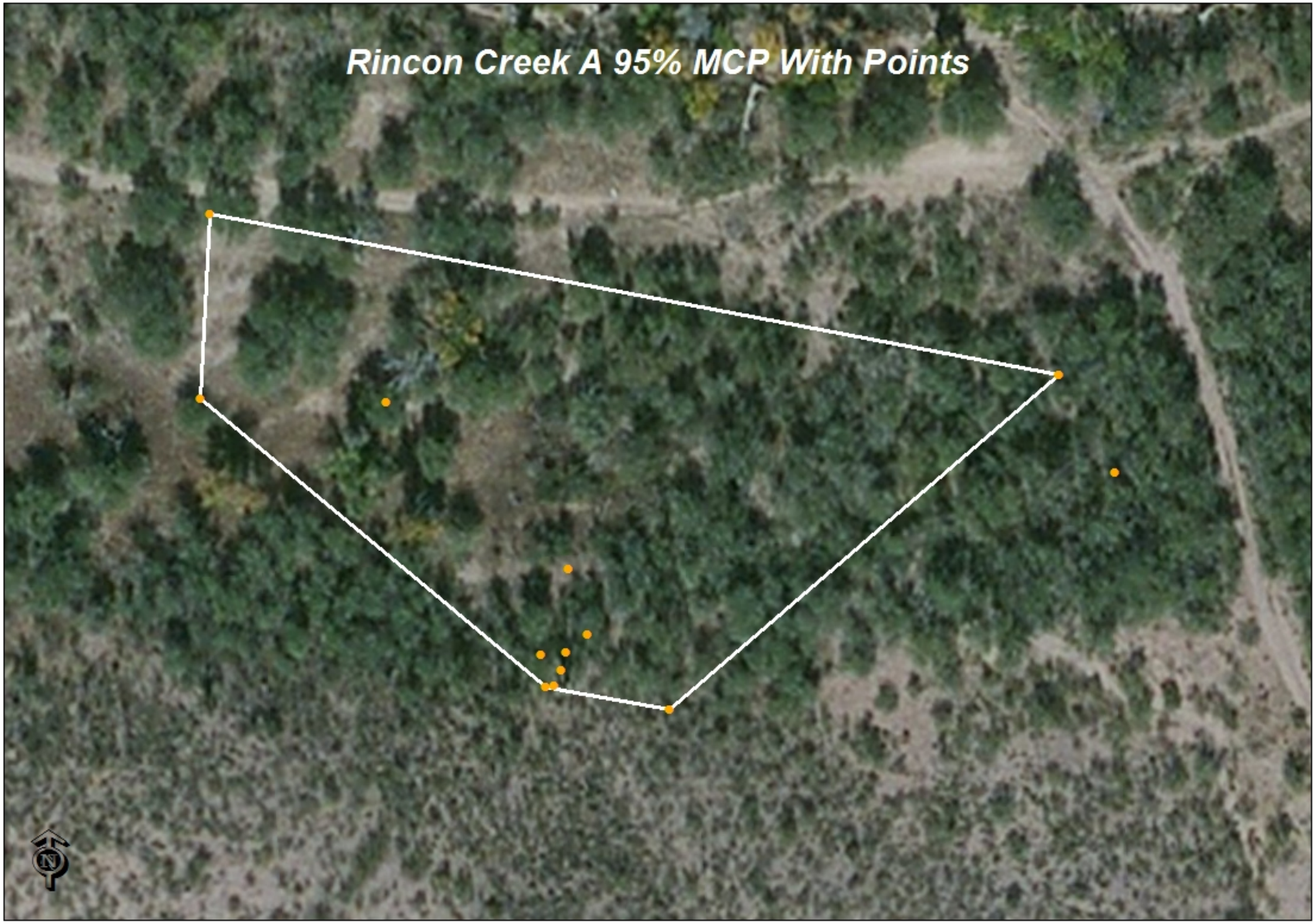

Posta Quemada H 75m With Points
N

Posta Quemada I 75m With Points
N

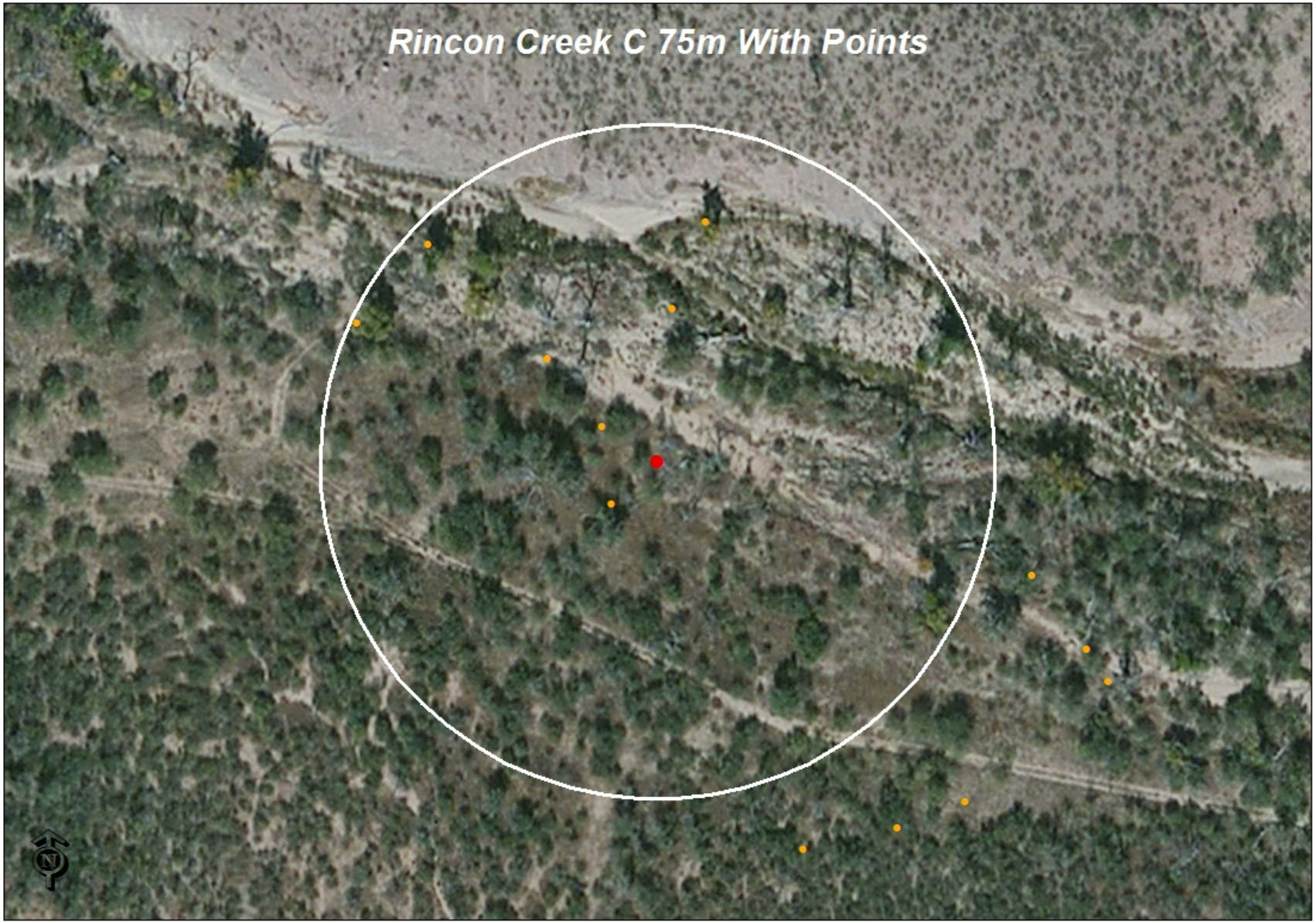
Posta Quemada J 75m With Points


Posta Quemada L 75m With Points
N

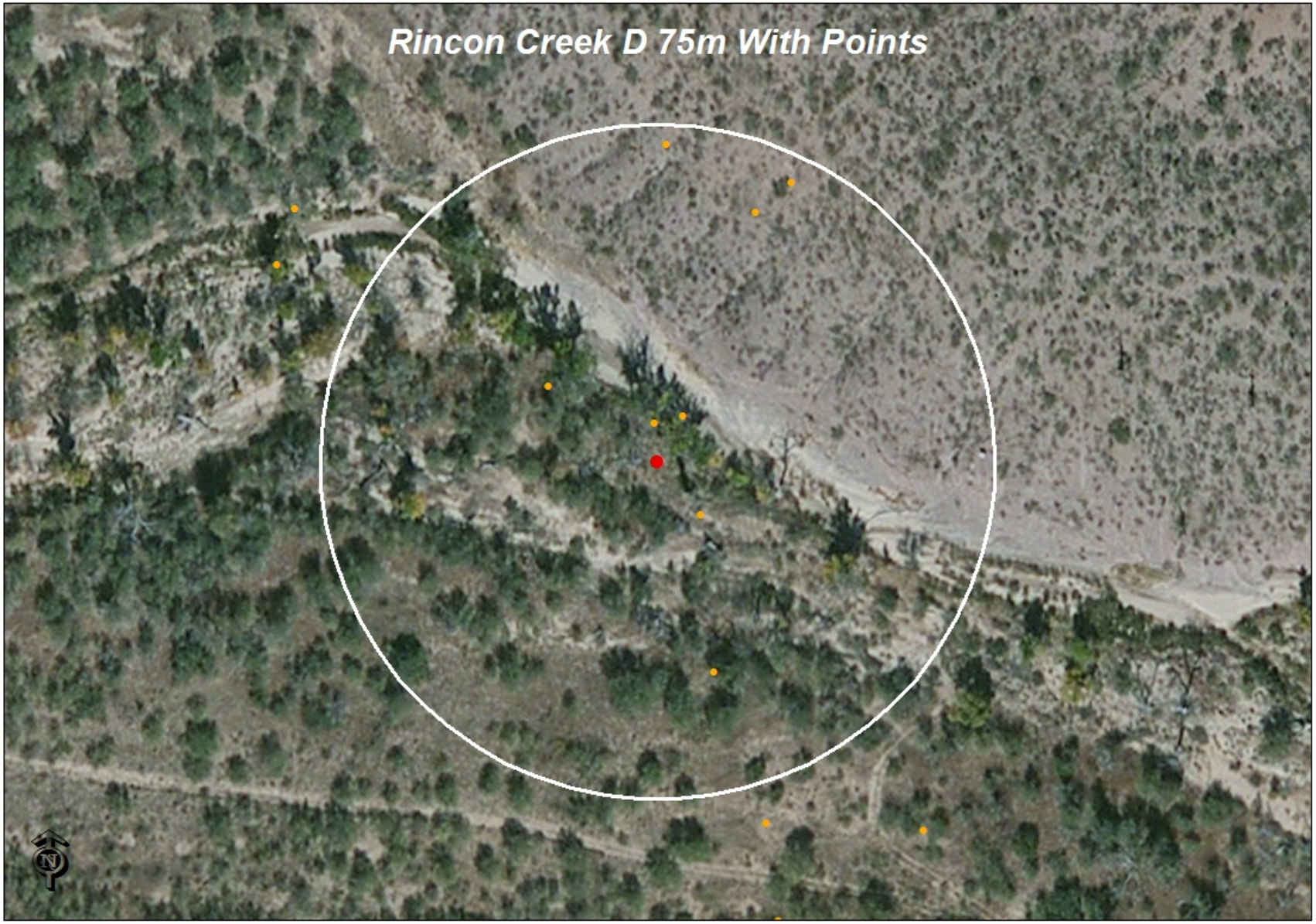
Rincon Creek A 75m With Points
N

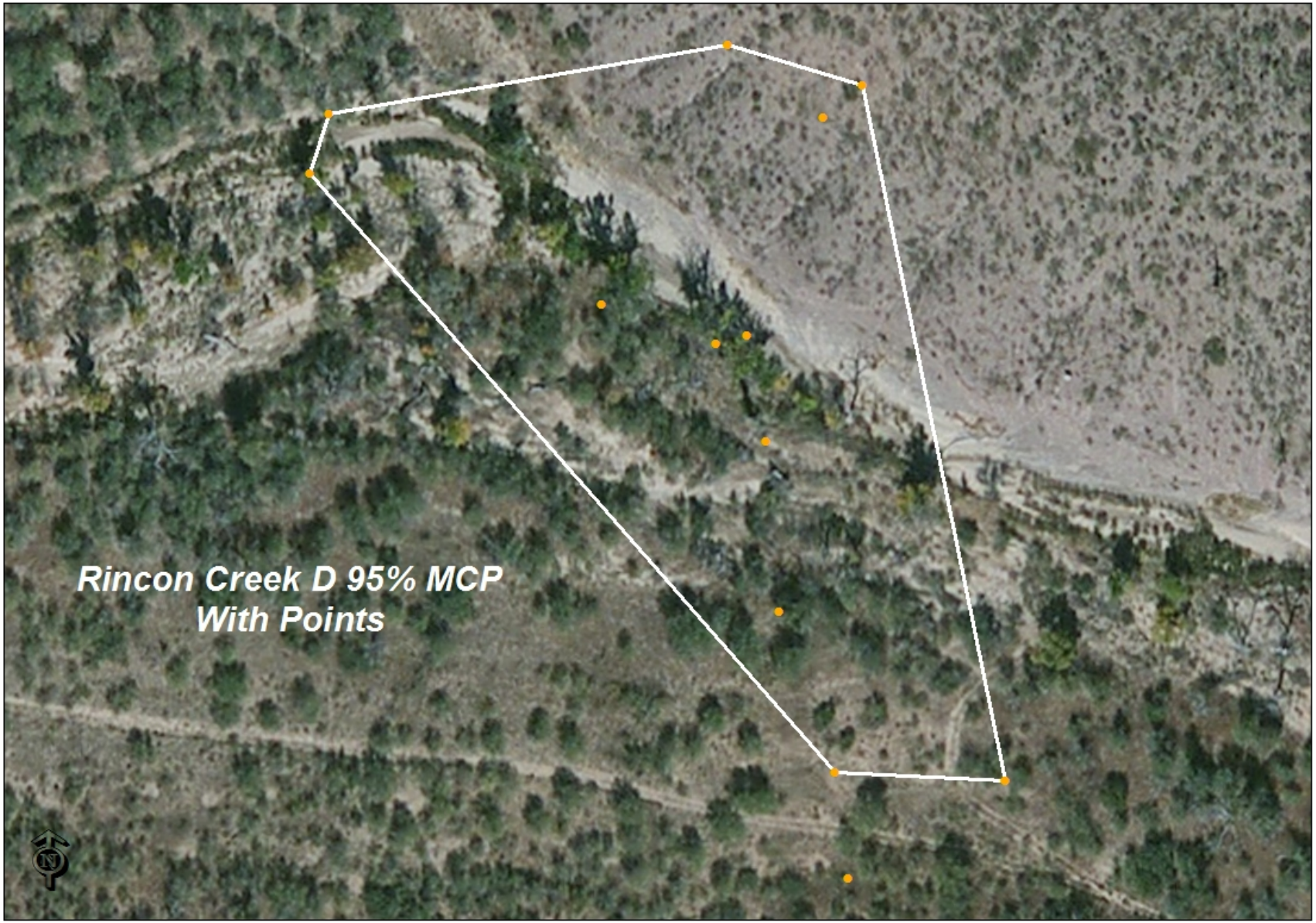

Rincon Creek A 95% MCP With Points
N

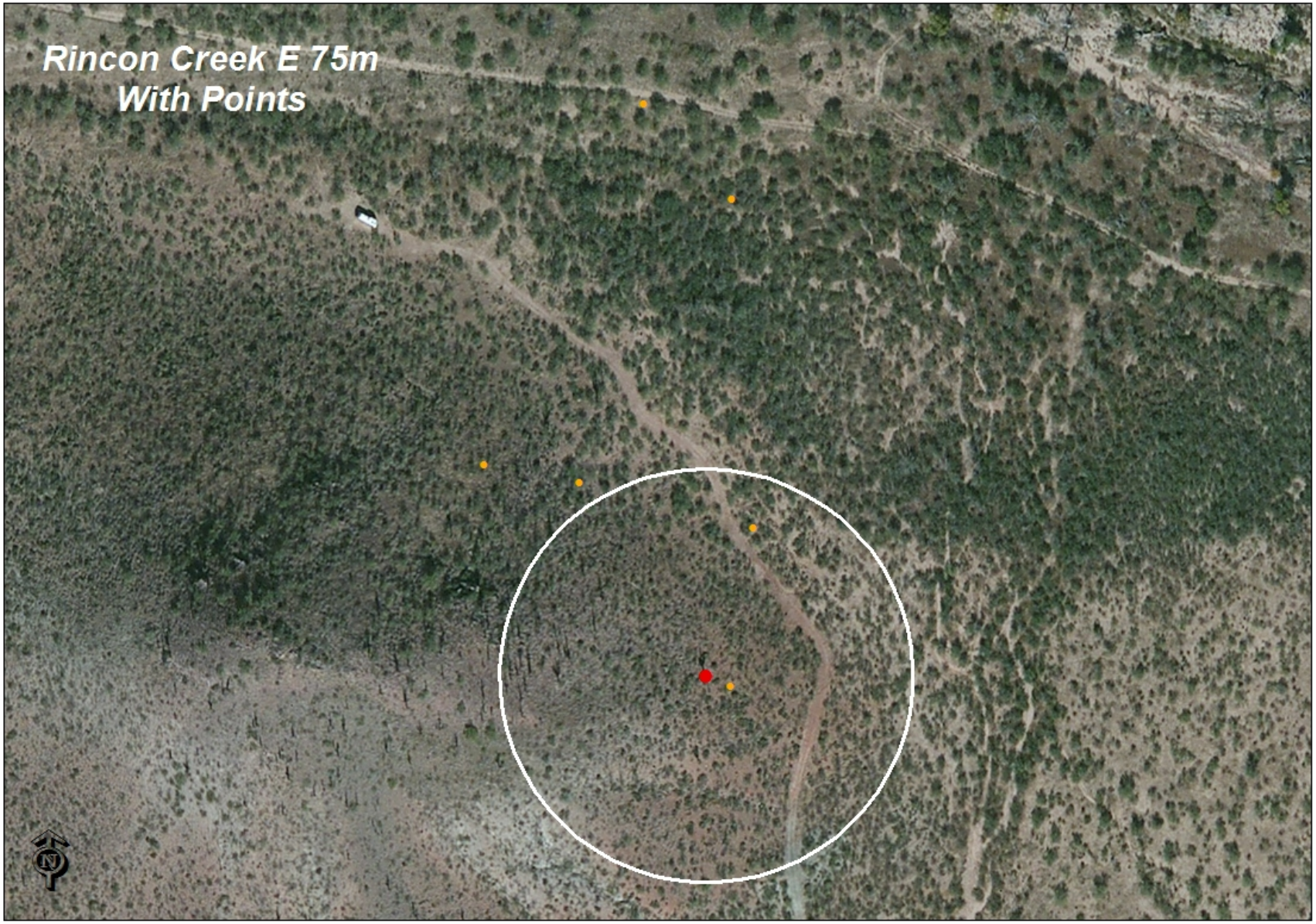
Rincon Creek B 75m With Points


Rincon Creek C 75m With Points

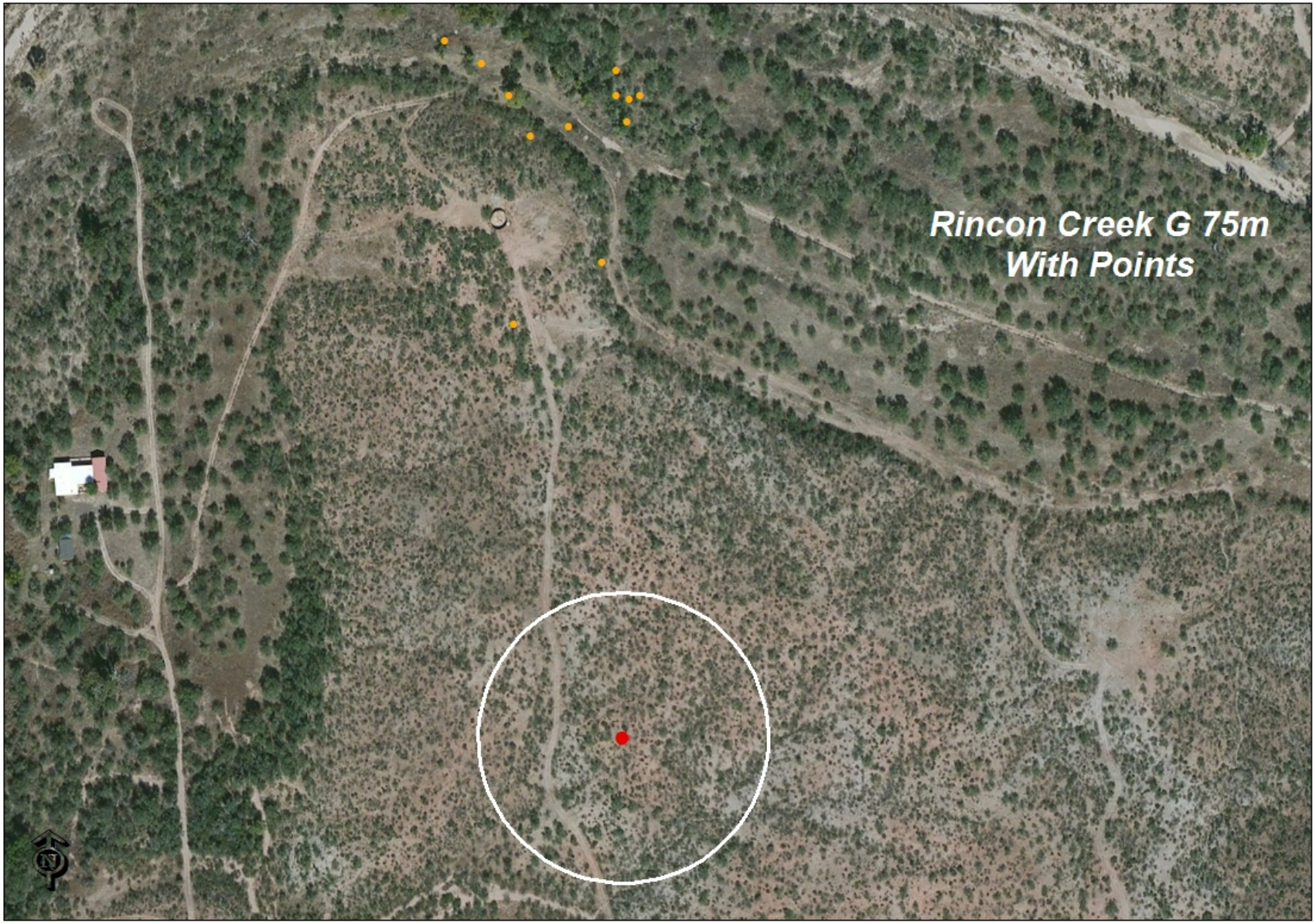
Rincon Creek C 95% MCP
With Points
N

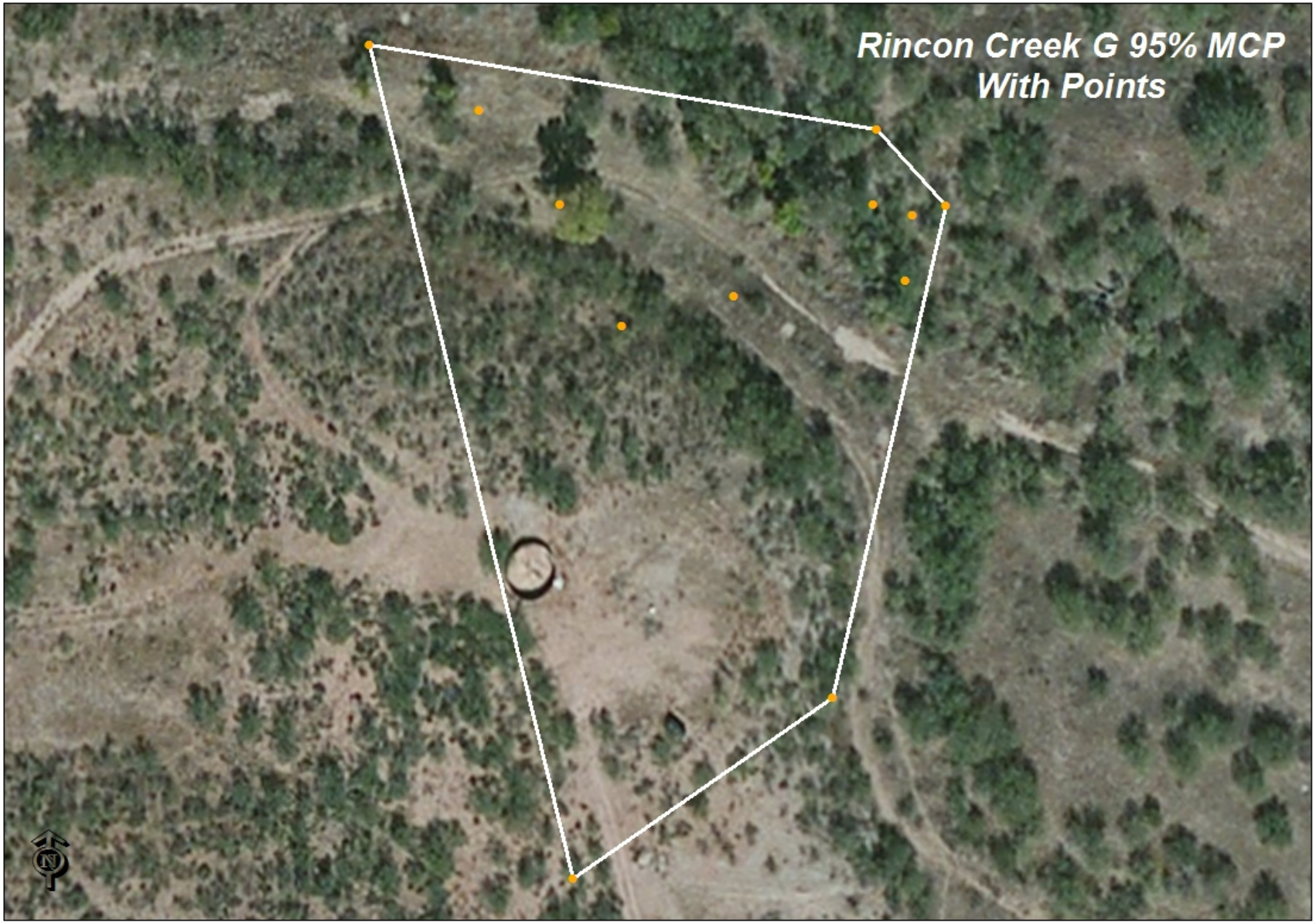

Rincon Creek D 75m With Points
N


Rincon Creek D 95% MCP
With Points

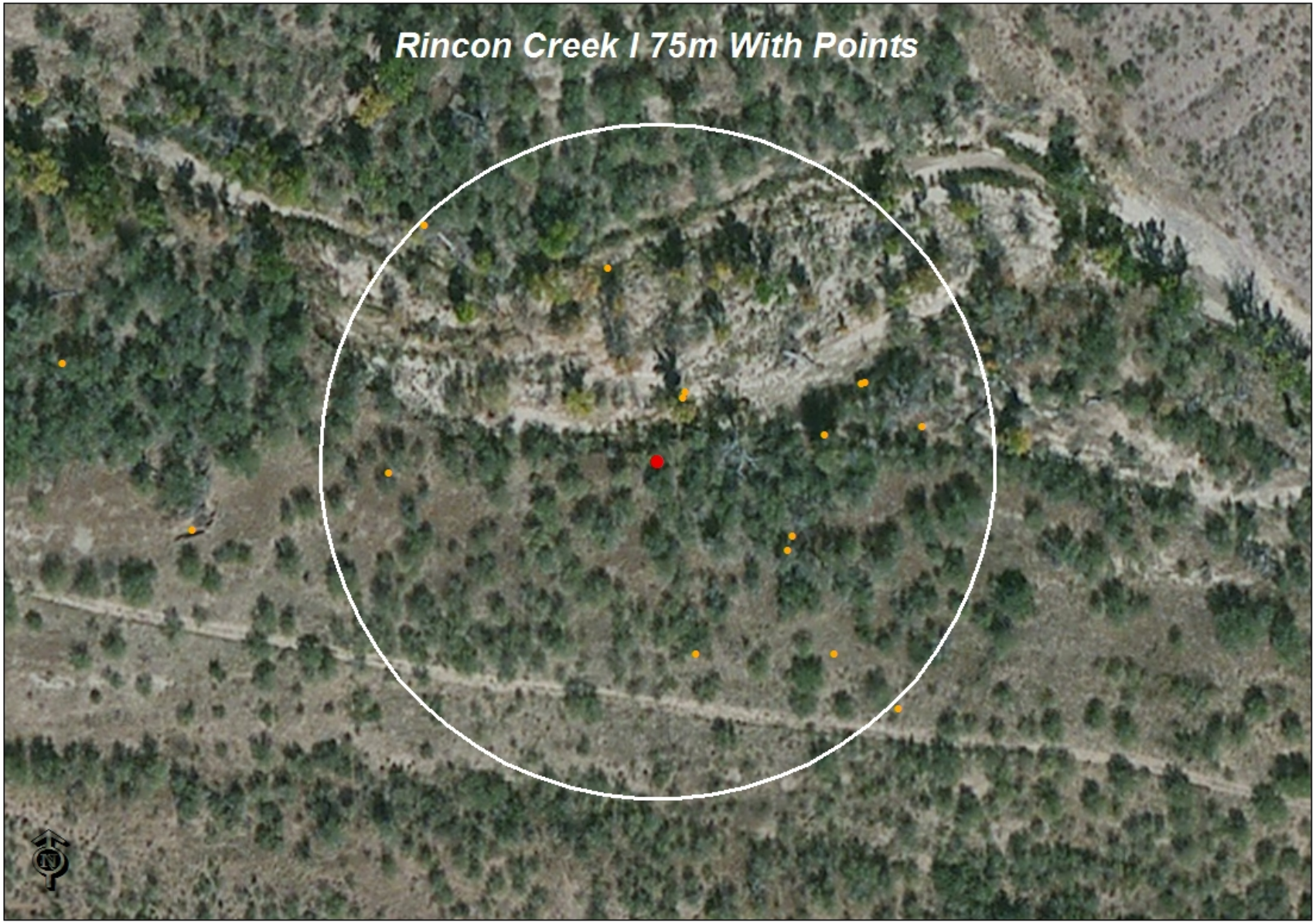

Rincon Creek E 75m
With Points
N

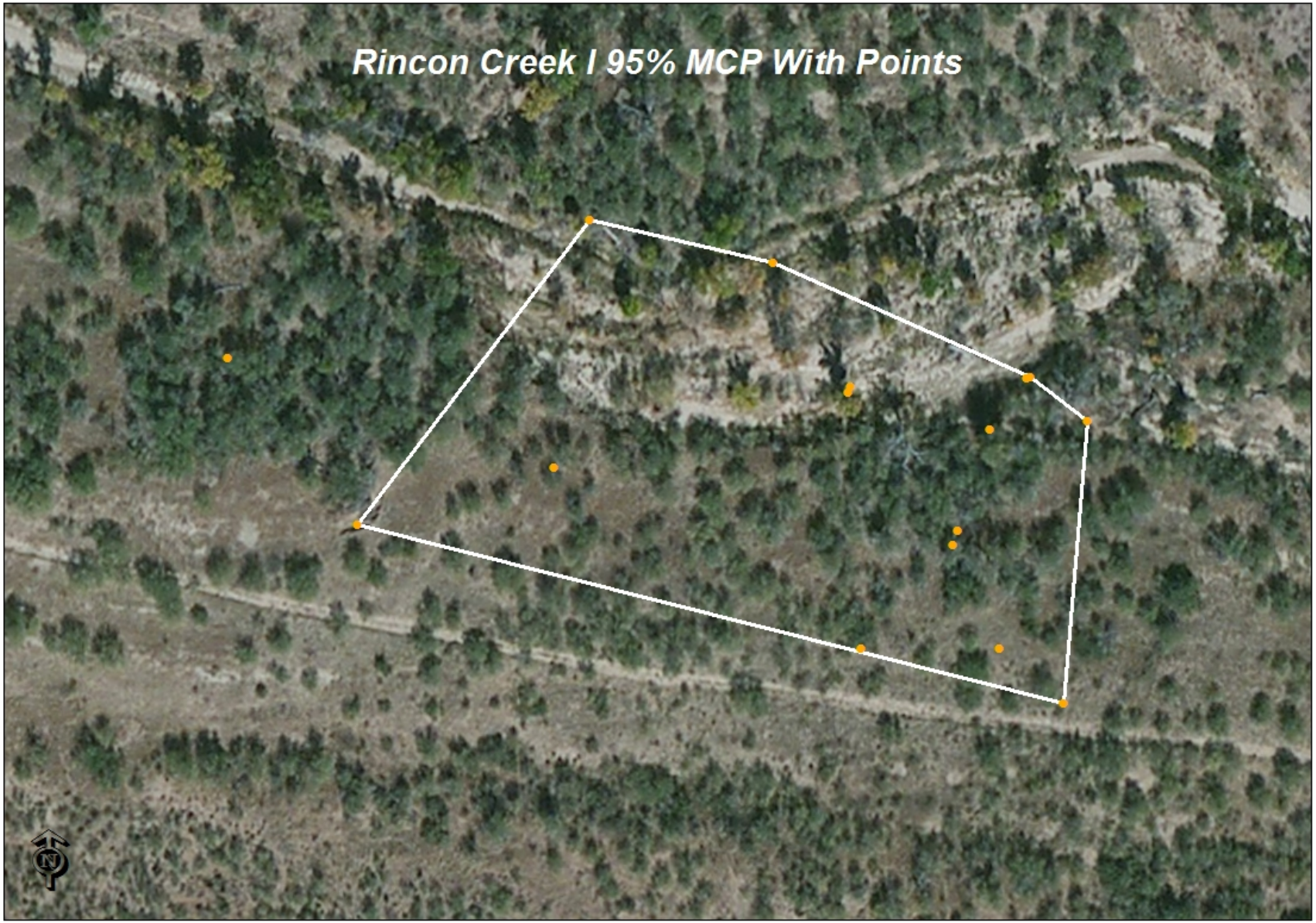
Rincon Creek F 75m With Points
N

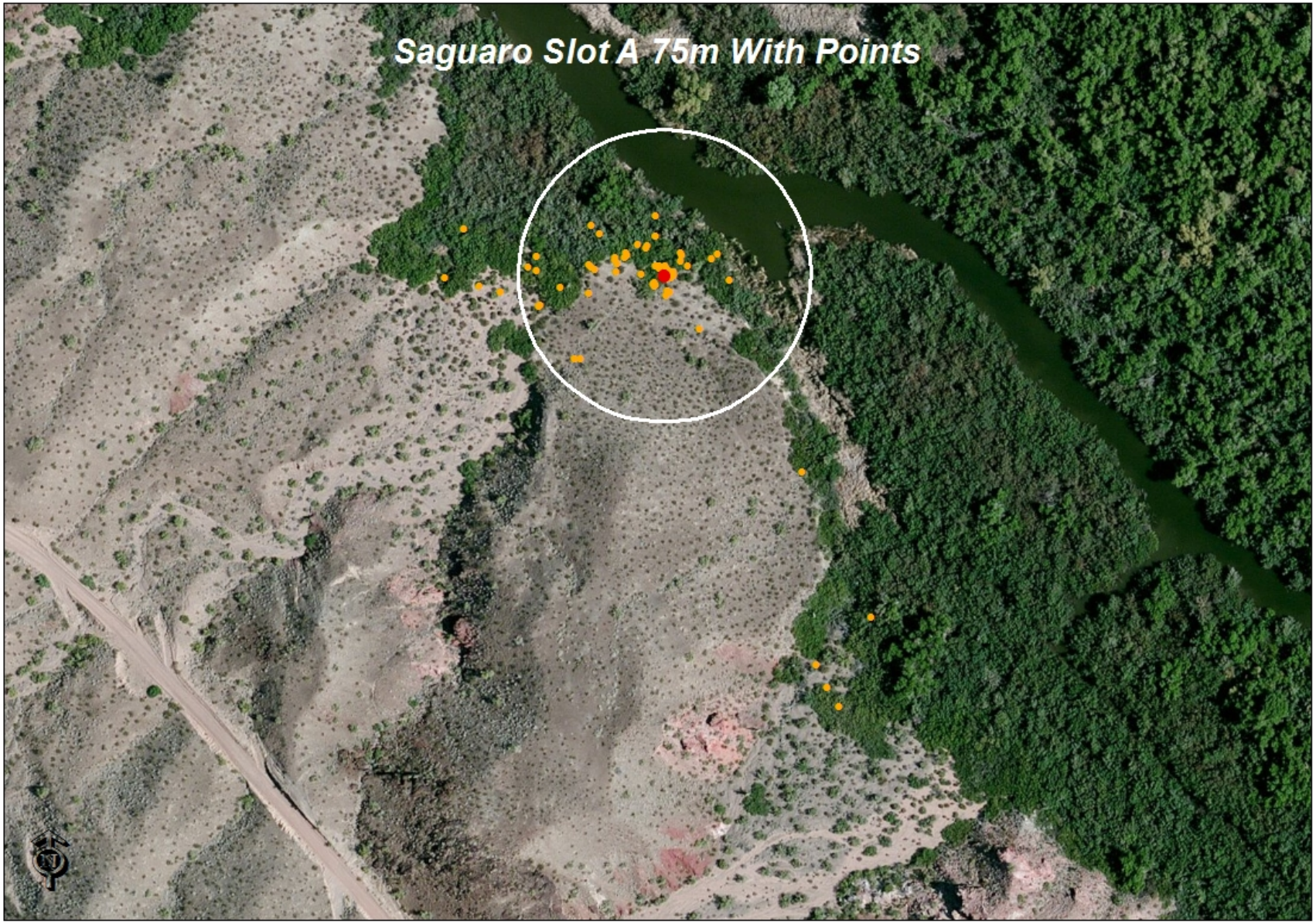

Rincon Creek G 75m
With Points

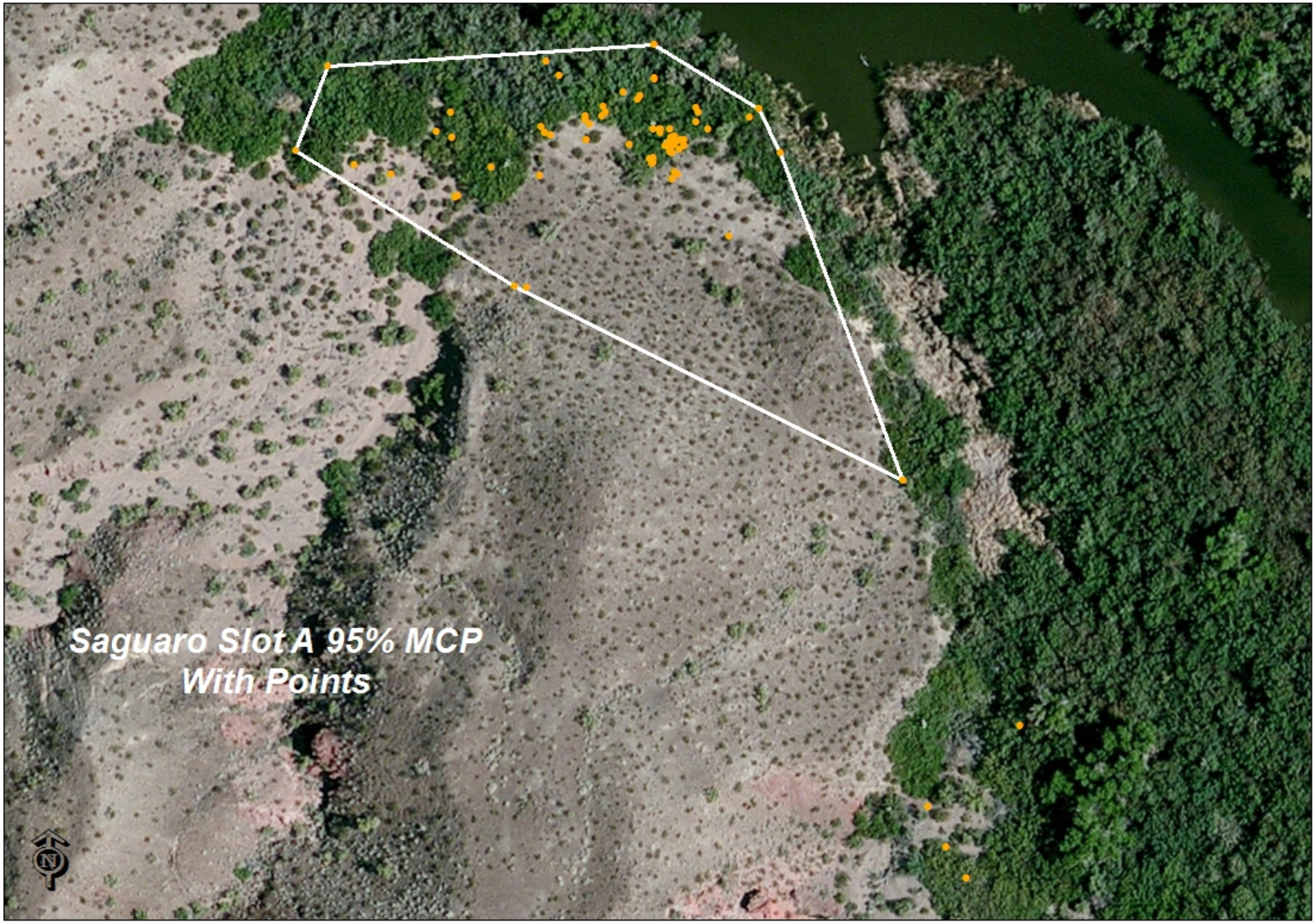

Rincon Creek G 95% MCP
With Points
N

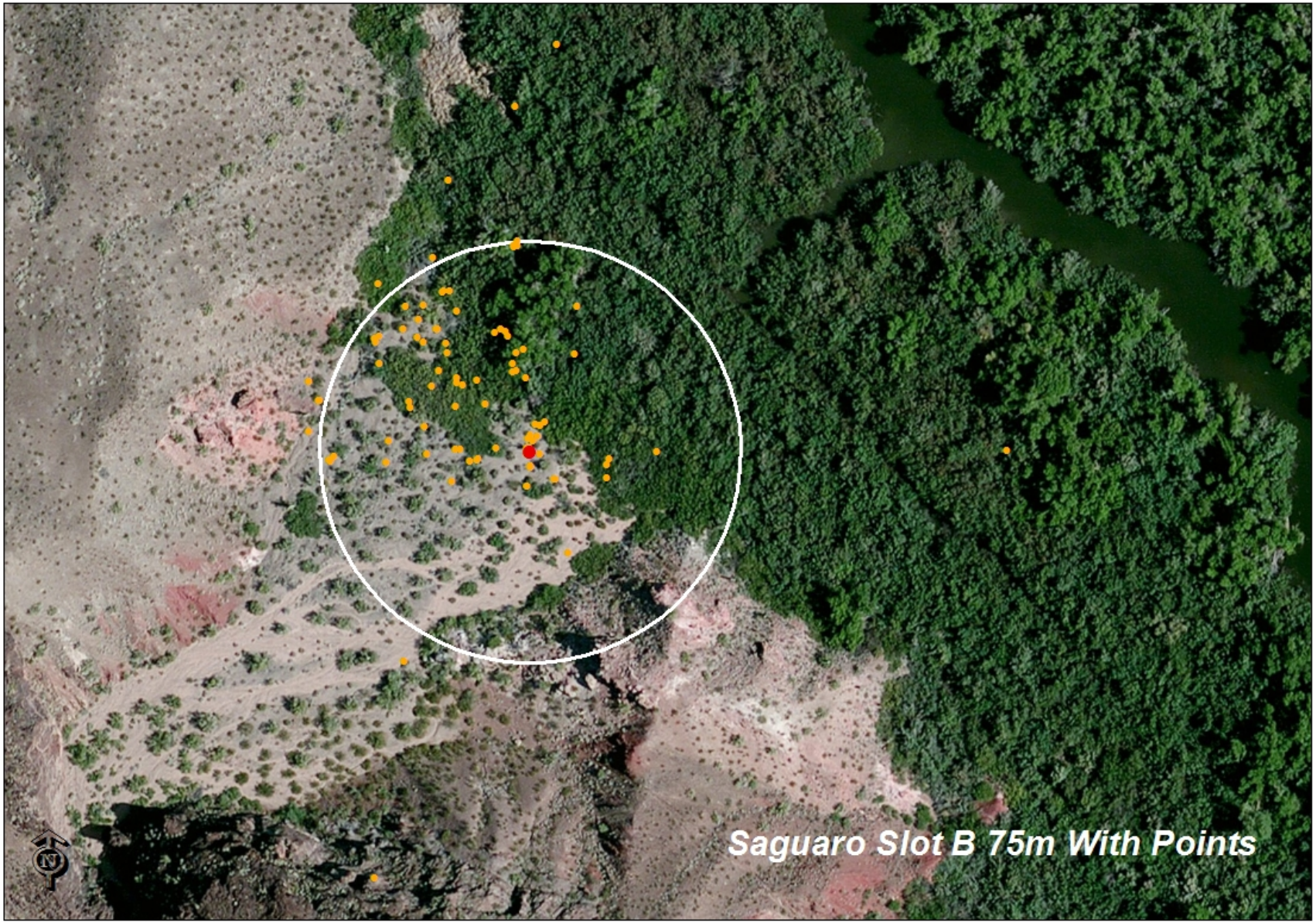
Rincon Creek H 75m With Points
N

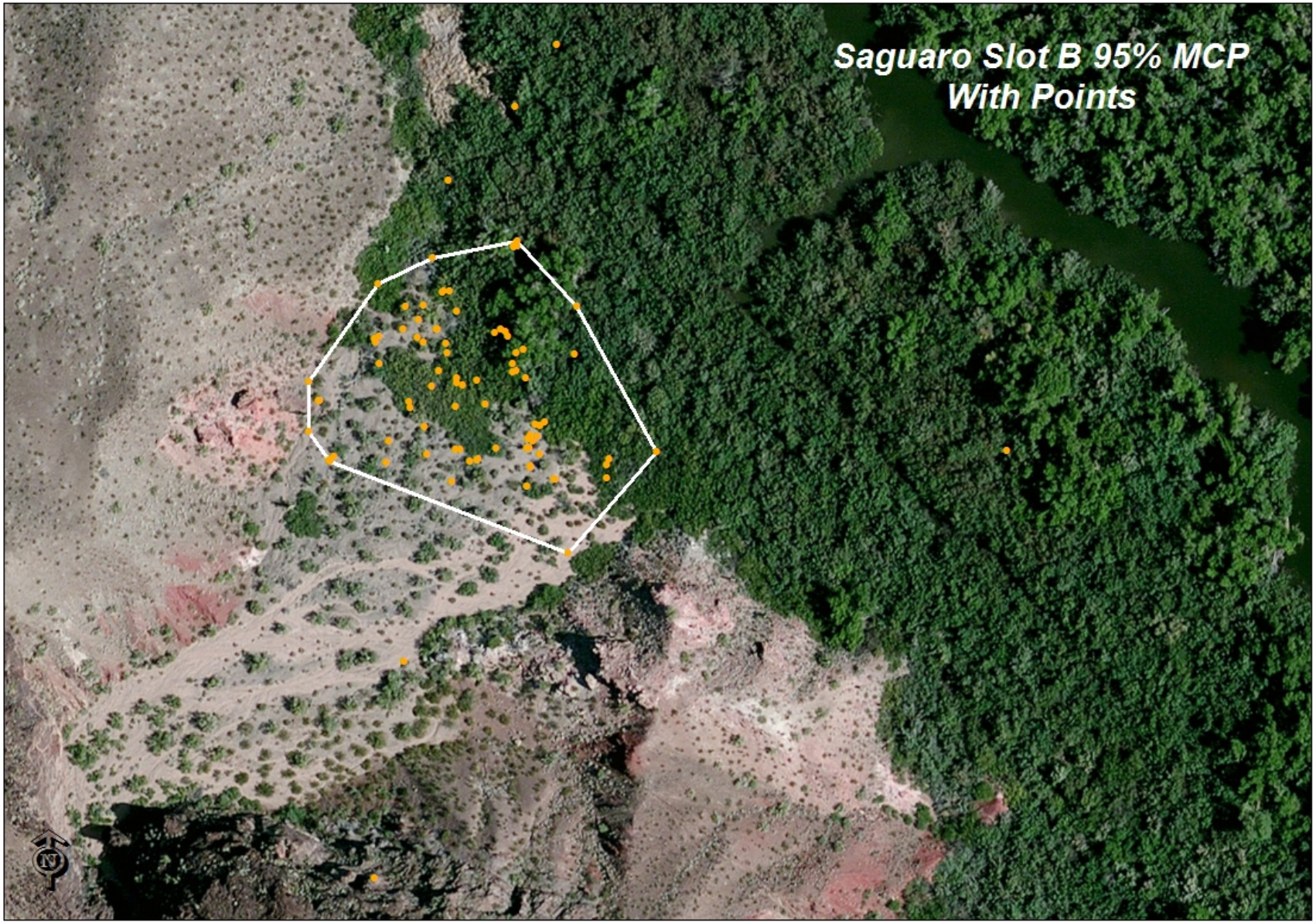

Rincon Creek I 75m With Points
N

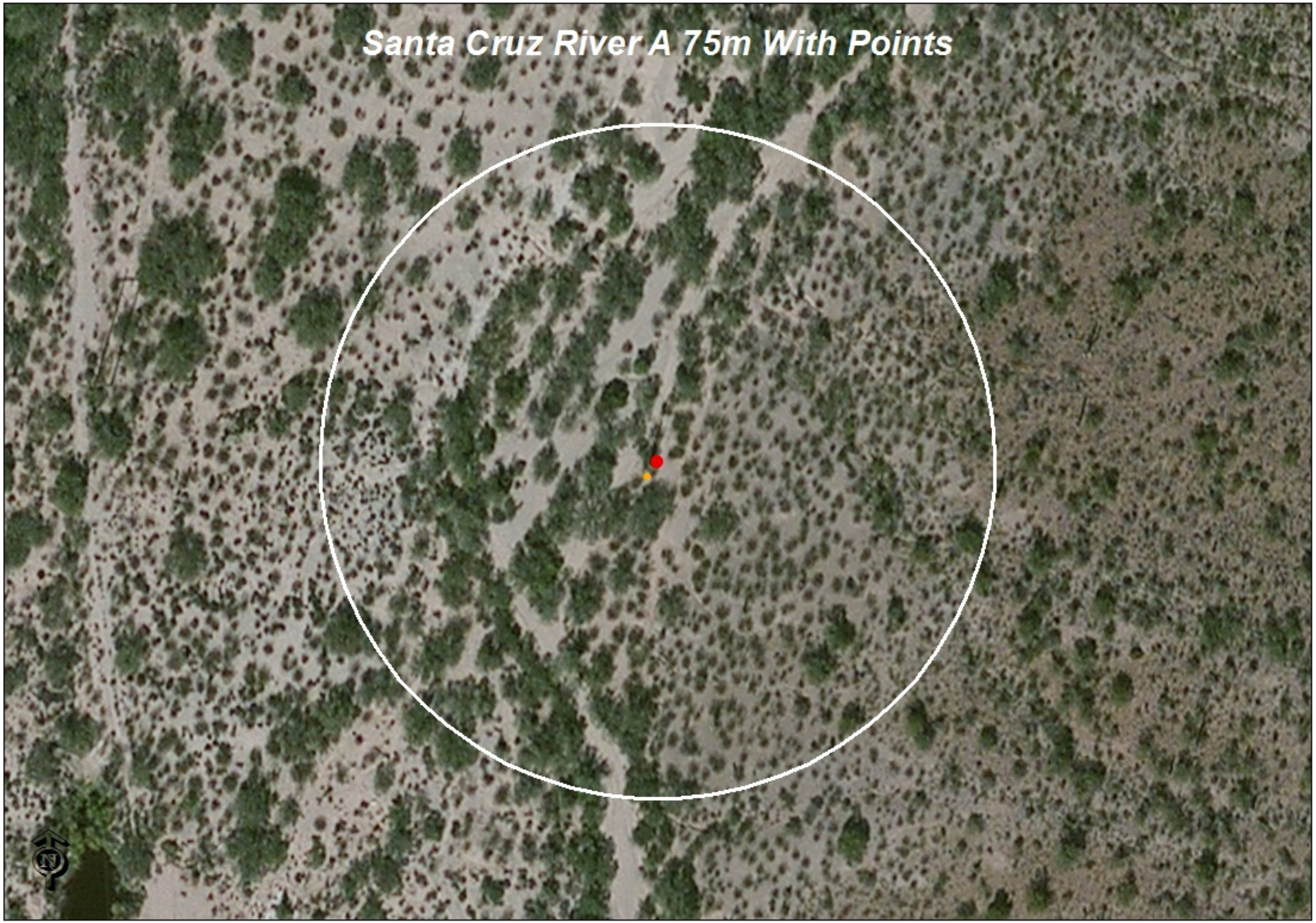

Rincon Creek I 95% MCP With Points
N


Saguaro Slot A 75m With Points


Saguaro Slot A 95% MCP
With Points
N


Saguaro Slot B 75m With Points
N


Saguaro Slot B 95% MCP
With Points
N


Santa Cruz River A 75m With Points

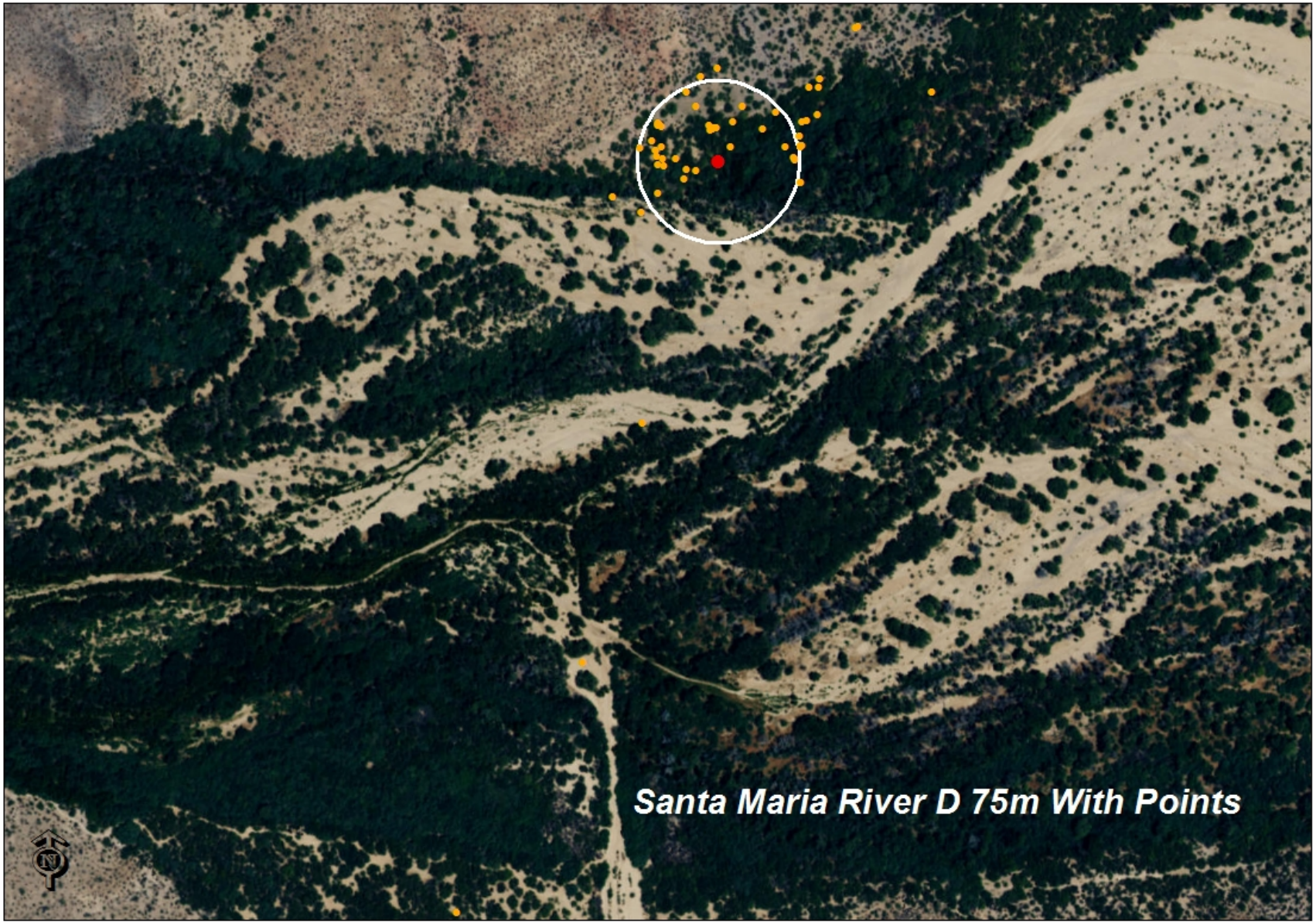
Santa Cruz River B 75m No Points

Santa Cruz River C 75m No Points

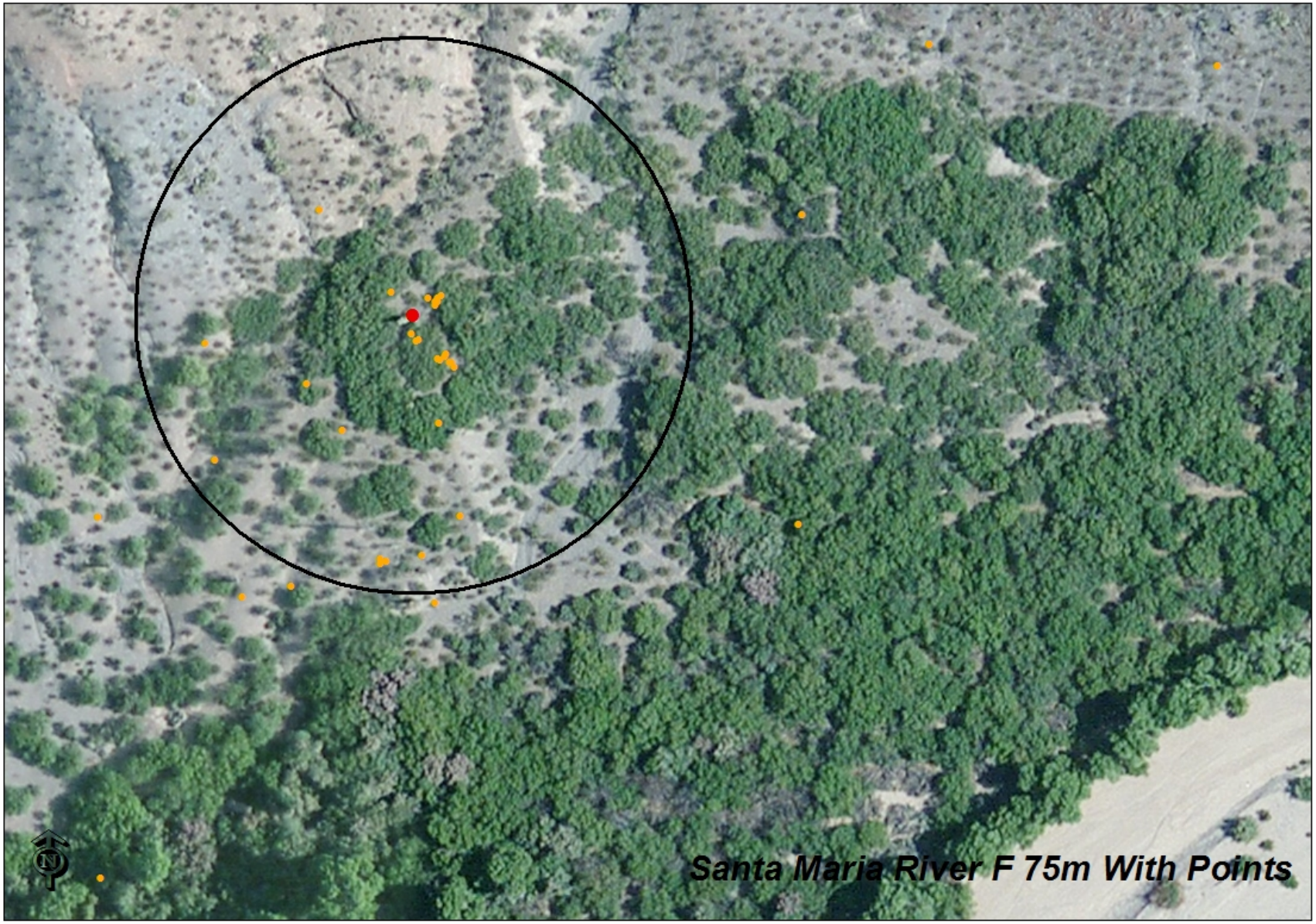
Santa Cruz River D 75m No Points
N

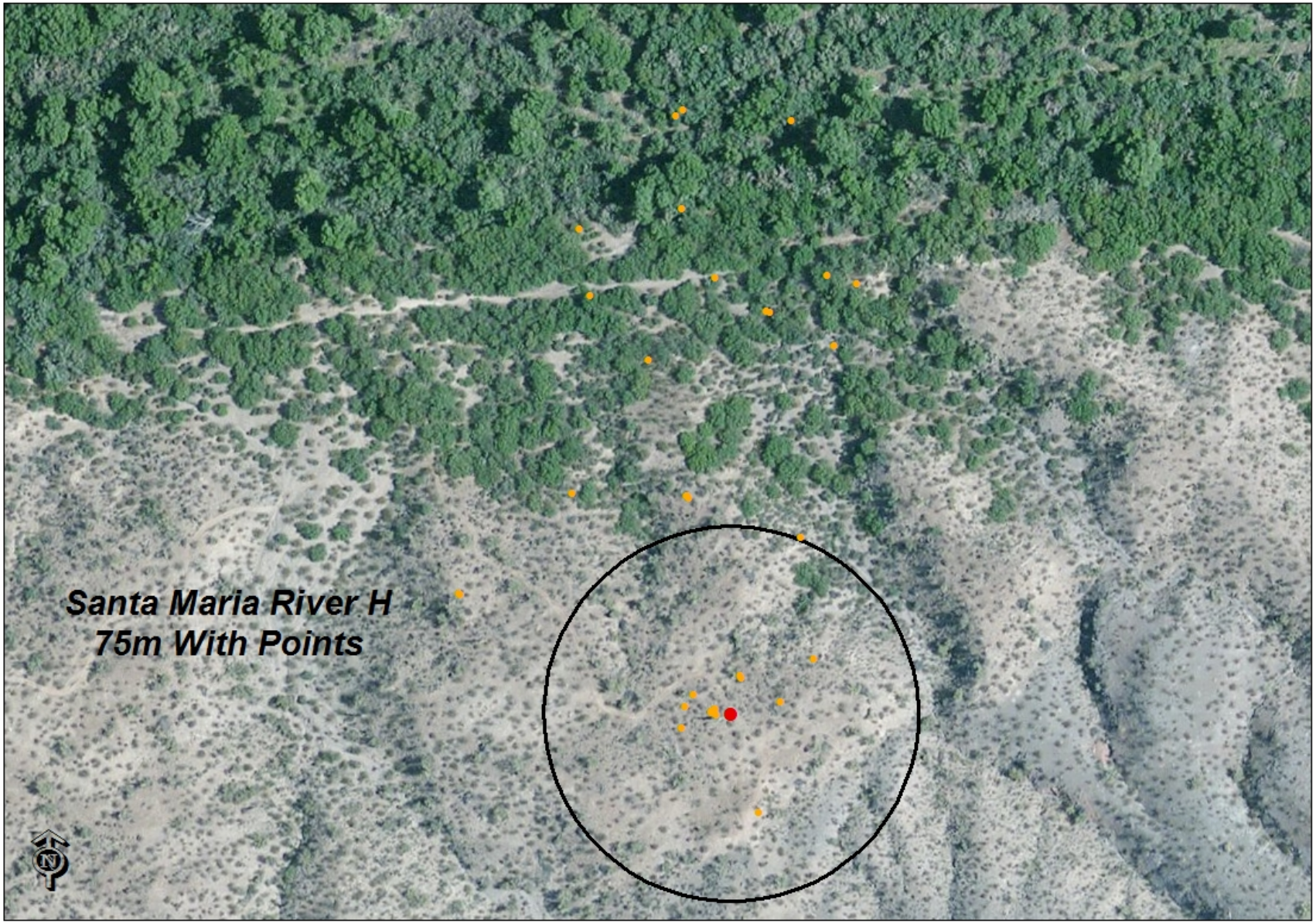
Santa Cruz River E 75m No Points

Santa Maria River C 75m With Points

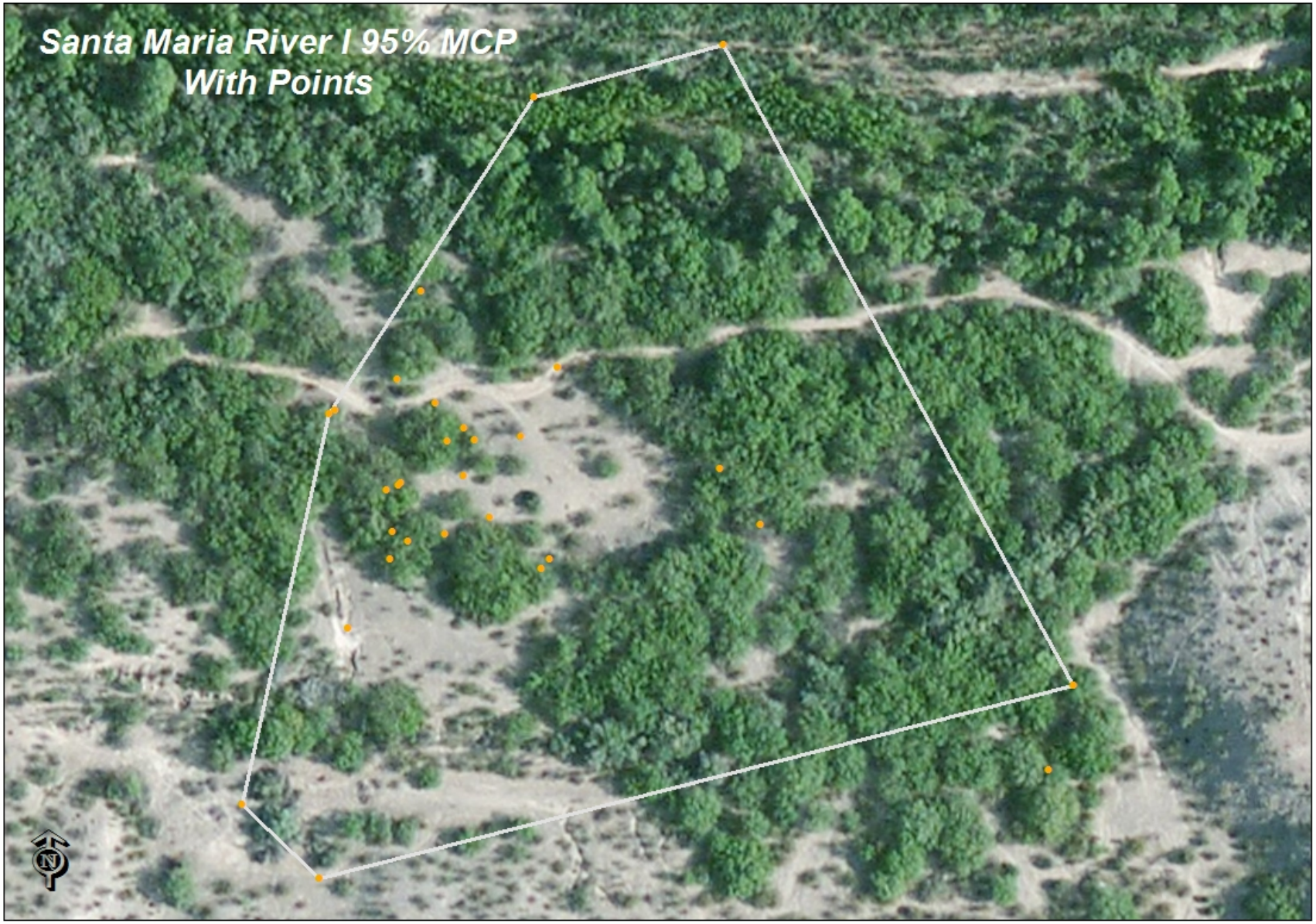

Santa Maria River D 75m With Points

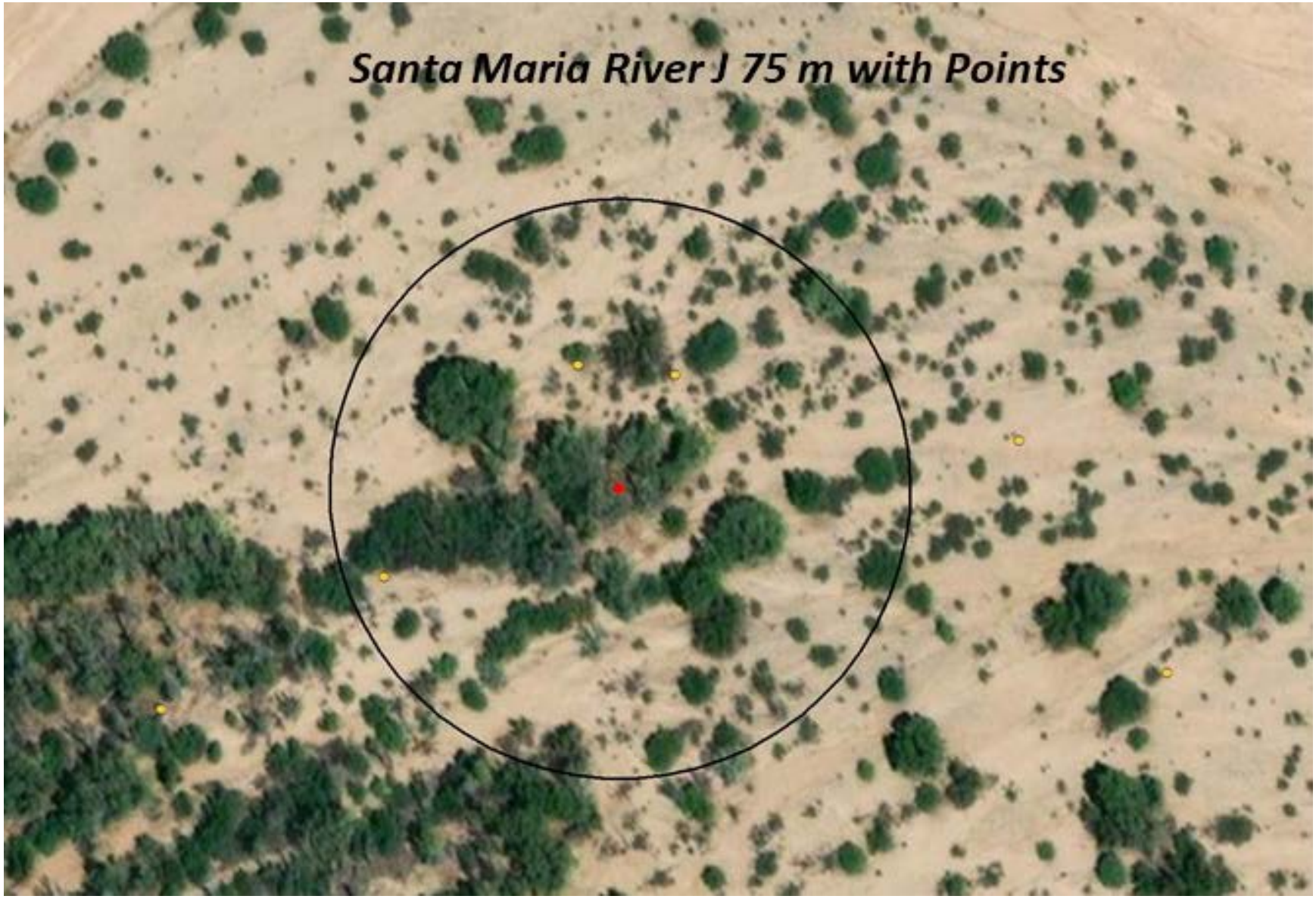
Santa Maria River D 95% MCP
With Points


Santa Maria River F 75m With Points
N


Santa Maria River H
75m With Points
N

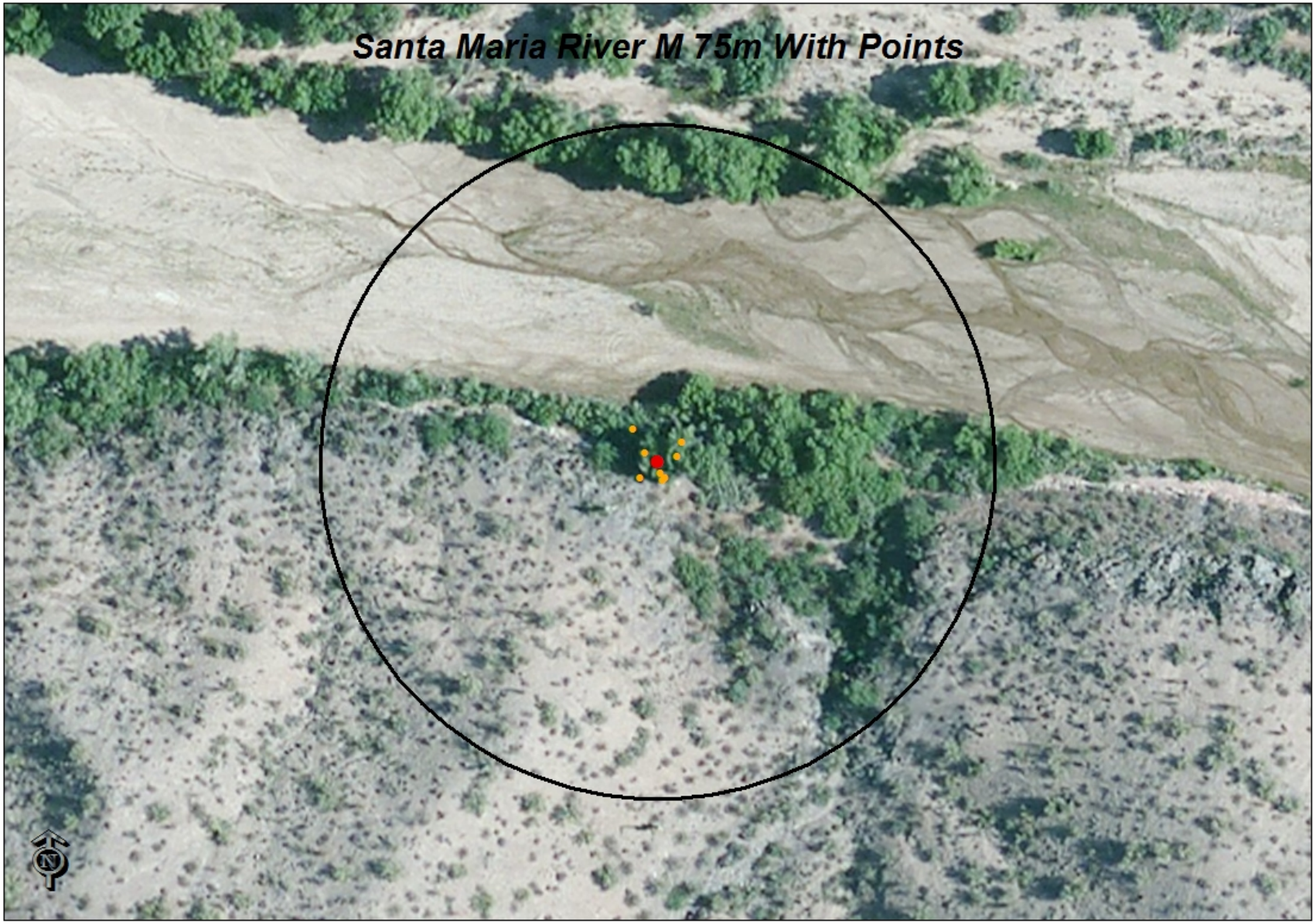
Santa Maria River I 75m With Points
N

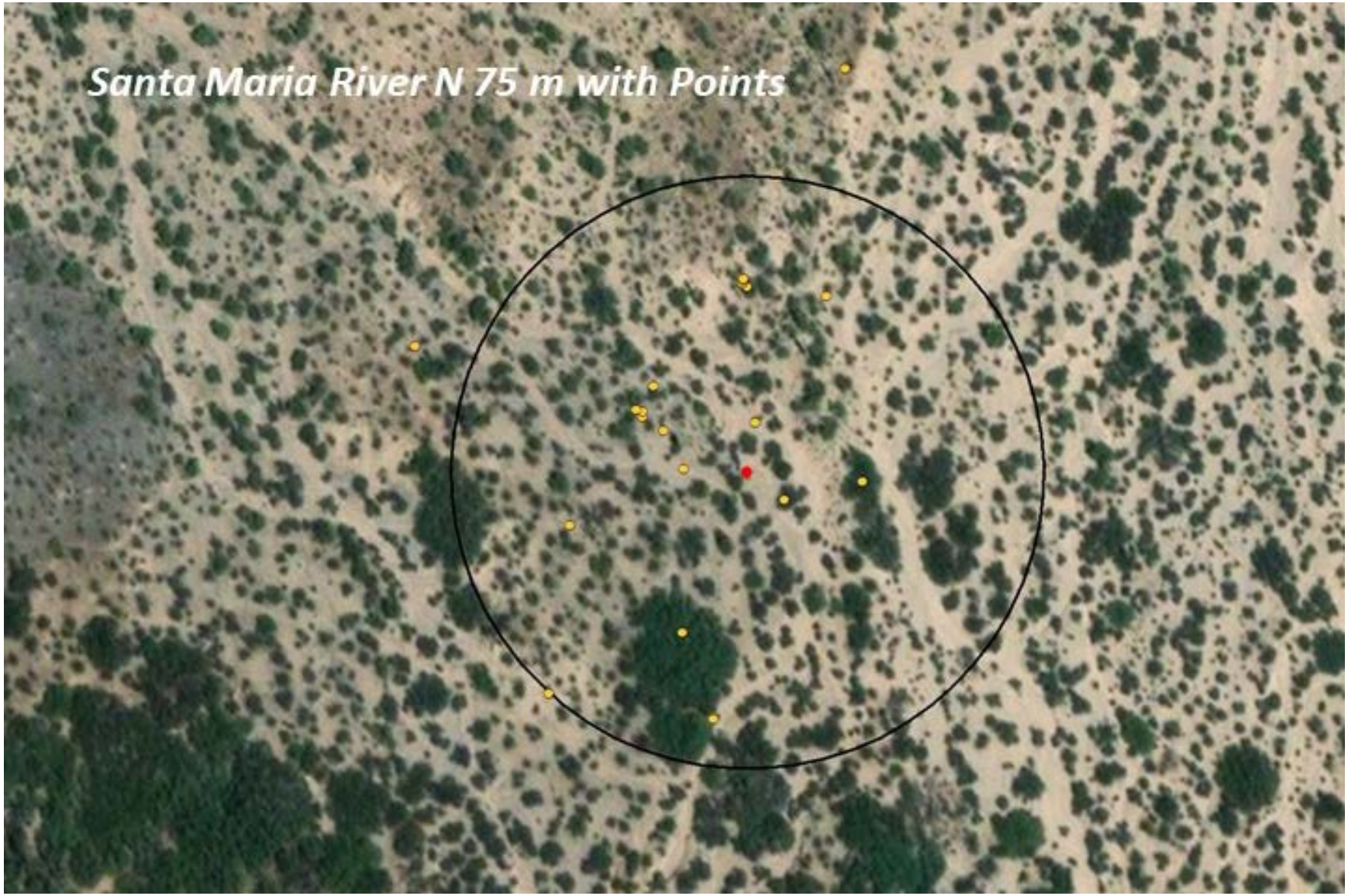

Santa Maria River I 95% MCP
With Points
N


Santa Maria River J 75 m with Points

Santa Maria River K 95% MCP
With Points

Santa Maria River L 75 m with Points


Santa Maria River M 75m With Points
N


Santa Maria River N 75 m with Points

Santa Maria River N 95% MCP
With Points
N