Generating Metes and Bounds Maps in GIS

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Abstract

Surveyors use the metes and bounds method to describe and map the boundaries or lines of parcels, grading areas, easements, and similar lines. Surveyors routinely generate their maps using Computer Aided Drawing (CAD) software, which is a widely used software for engineers and designers. However, CAD does not provide or include real world coordinates to accurately tie the points or lines to the ground. Since most biologists now use Geographic Information Systems (GIS) as their primary resource data management and mapping tool, it is necessary to have the ability to generate metes and bounds data that can be provided to engineers in order to accurately transfer natural resource data. The authors have found an ArcView 3x extension that can readily convert shapefile polygons to a format that can be used to generate polylines and attributes that can be used to create a map with metes and bounds.
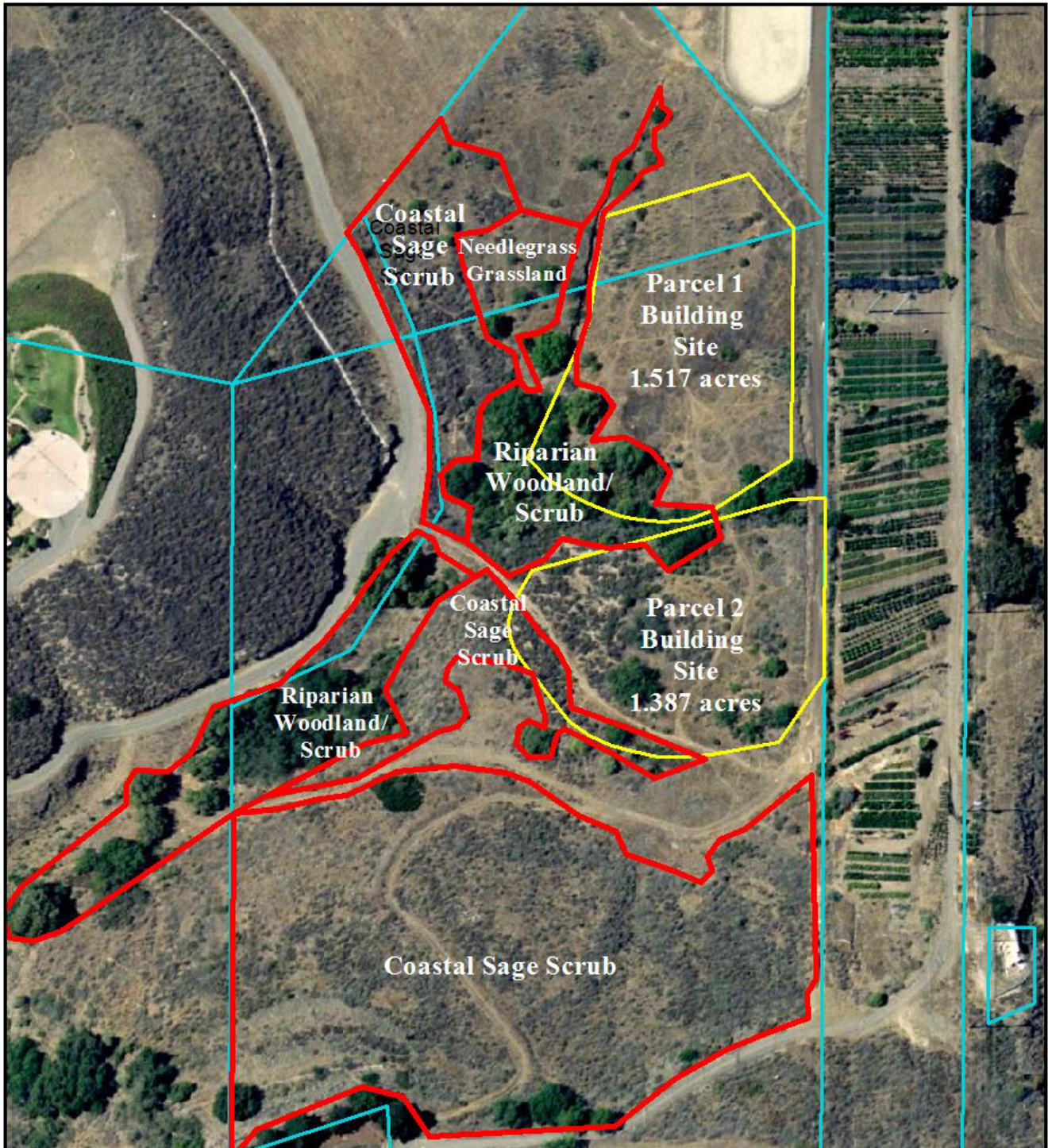
Introduction

Consultants and practitioners that routinely identify and map features on the ground typically now use GIS software that provides an accurate geographic position in real world coordinates. GPS units are routinely used to map such things as plant communities, trees, rare plants, wetland boundaries, etc. Some of these features are considered sensitive by resource agencies and planning departments charged with resource management, protection, and land use permitting. Developers often need to know where constraint areas, including easements, sensitive resources, hazard zones, etc., are so that their engineers can accurately design the project. Sometimes, these constraint areas will need to be protected, and a legal description of such areas will be needed.

Surveyors and engineers typically use CAD software to generate their design plans, including grading plans, plot plans, etc., and almost never use GIS software, but this is changing slowly. There needs to be a way for resource consultants, such as biologists, to transfer their resource maps to the engineers in a format that they can readily use without having to duplicate the mapping efforts already accomplished by the biology consultants. This paper will use one project as an example of the problems and a solution using ArcView GIS software.

The Ventura County Planning Division required a landowner wishing to divide his property into two parcels to deed restrict those portions of his property that contained sensitive plant communities as mitigation for potentially significant impacts to the environment. On behalf of the County, David Magney Environmental Consulting (DMEC) conducted a field survey and mapped and described the biological resources present. DMEC originally mapped these habitats onto a color aerial photograph using Micrografix Designer software. The County then required all the sensitive plant communities present onsite to be protected from any future development through a deed restriction. The County suggested that the deed restriction map should include a legal description such as according to survey descriptions typically used: i.e. metes and bounds, but that the boundaries had to be mapped by a qualified biologist approved by the County, such as DMEC.

A map DMEC created of the sensitive habitats onsite is illustrated on Figure 1, Map of Sensitive Habitats at Caldwell Property.

**Figure 1. Map of Sensitive Habitats at Caldwell Property**

Coastal Sage Scrub

Coastal Sage Needlegrass Grassland

Parcel 1 Building Site 1.517 acres

Riparian Woodland/ Scrub

Coastal Sage Scrub

Parcel 2 Building Site 1.387 acres

Riparian Woodland/ Scrub

Coastal Sage Scrub

Base map source: June 2002 - AirPhotoUSA & DMEC's 5 Oct 2000
Biological Resources CEQA Initial Study

70   0   70   140 Feet

Caldwell Tract 2732-1 Legend

Sensitive Habitat Areas

Parcel Boundaries

Building Site Boundary

N
W   E
S
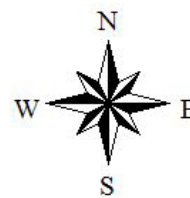
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For some reason, the County Planning Division did not accept this map for the purposes of supporting a deed restriction, and one that had metes and bounds would be more acceptable. However, it should be noted that the Assessor's Office or Recorder's Office does not require metes-and-bounds-type descriptions or maps to record deed restrictions, as they will not generate any type of maps showing the bounds of a deed restriction. They simply need a description of the restriction that follows the legal parcel.

Basically, metes and bounds descriptions include the distance and direction of a line. That is, a straight line of a typical survey will have two parts, bearing and distance. The bearing is an azimuth in degrees from north or south, and is always 90 degrees or less, measured from either true north or true south. The metes and bounds "polygon" are described in a clockwise fashion.

Methods

DMEC, like many environmental consulting firms, does not use CAD software; rather, we use ArcView GIS software to map geographic features such as plant communities, wetland boundaries, plant populations, wildlife resources, etc., typically using either georectified aerial photography or topographic maps to ensure accurate mapping of the resources or features. GPS units are typically used to gather point locations and feature boundaries, which are then converted into shapefiles. Most engineering and design firms use CAD software but rarely use GIS.

DMEC routinely needs to convert CAD files for projects, which usually include topographic contours, grading limits, project boundaries, and other project features, which are used to create resource constraint maps. CAD files rarely include real world coordinates, and even surveyor maps rarely include these data even though a surveyors' map is tied to a known point, such as a recorded benchmark.

One issue we needed to resolve was how to capture curving sections of a shapefile. When digitizing the sensitive areas, we often had sides of the polygon that were very short. These short sides do not work well in the metes and bounds system: there is just too much information. Our shortest segment was about 6 feet long; therefore, we arbitrarily made segments as long as possible given the vegetation, parcel lines, and physical features to create a readable metes and bounds description and map.

A second issue we had to deal with was that part of a parcel line corresponding to the edge of sensitive habitat was a curve described by the arc of a circle, with the parameters R = radius of the circle, L = length of the arc, and Δ (Delta) = the angle between the endpoints of the arc with the center of the circle. These data could have been obtained from metes and bounds of the parcels, but these data were lacking. Instead, we drew a circular graphic in ArcView that matched the curve (and got the radius R), saved that to a shapefile using **Xtools**, used that polygon to get the centroid = center point of the circle using **Xtools**, converted the polygon to a circular polyline using **Xtools**, trimmed the polyline to give an appropriate arc, and got the length of the arc (L) using **Xtools**. To get the angle delta we added points for the ends of the arc to the shapefile with the circle center point, and then used the "**Bearing and Distance Extension 1.1**" to get the bearings from the center to the endpoints, and did the math.

We found in the ESRI scripts website an extension written by the State of Massachusetts **NWS/DEM** (Norcross Wildlife Society[?] and Massachusetts Department of Environmental Management) **Data Editing** that yields distances and bearings for polygon or line shapefiles. This is an ArcView 3.x extension. The distances and bearings are written to a text file as a list. It must be stressed that these distances and bearings do not constitute an actual survey, as they can be generated from bad, un-groundtruthed data as well as good data. However, if you trust your data…go for it.

Figure 2, Screen Capture of ArcView 3.3 screen with the Data Editing GUI button, illustrates the GUI button that is associated with the **NWS/DEM Data Editing** extension, while Figure 3 captures the nested extension menus.

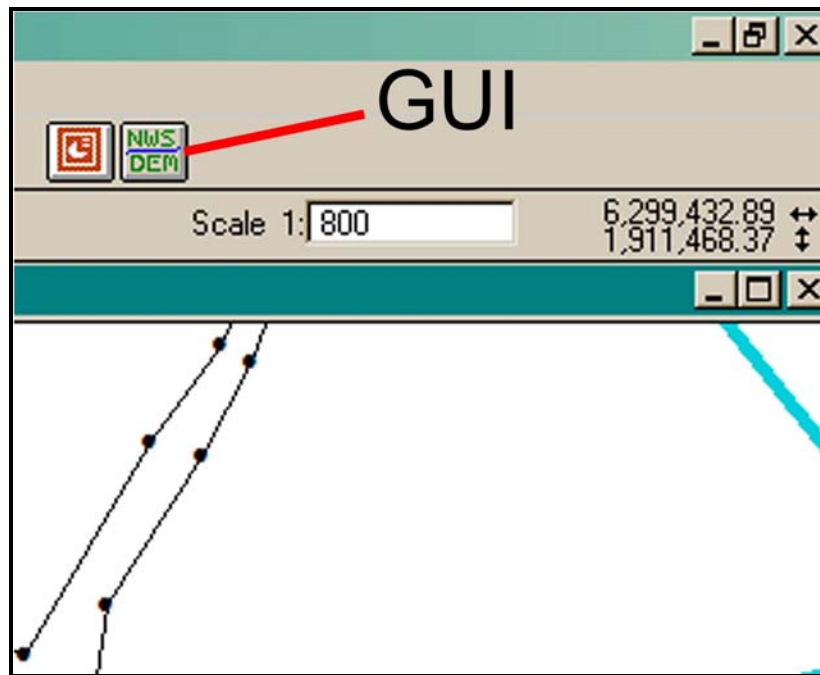**Figure 2. Screen Capture of ArcView 3.3 Screen with the Data Editing GUI Button**
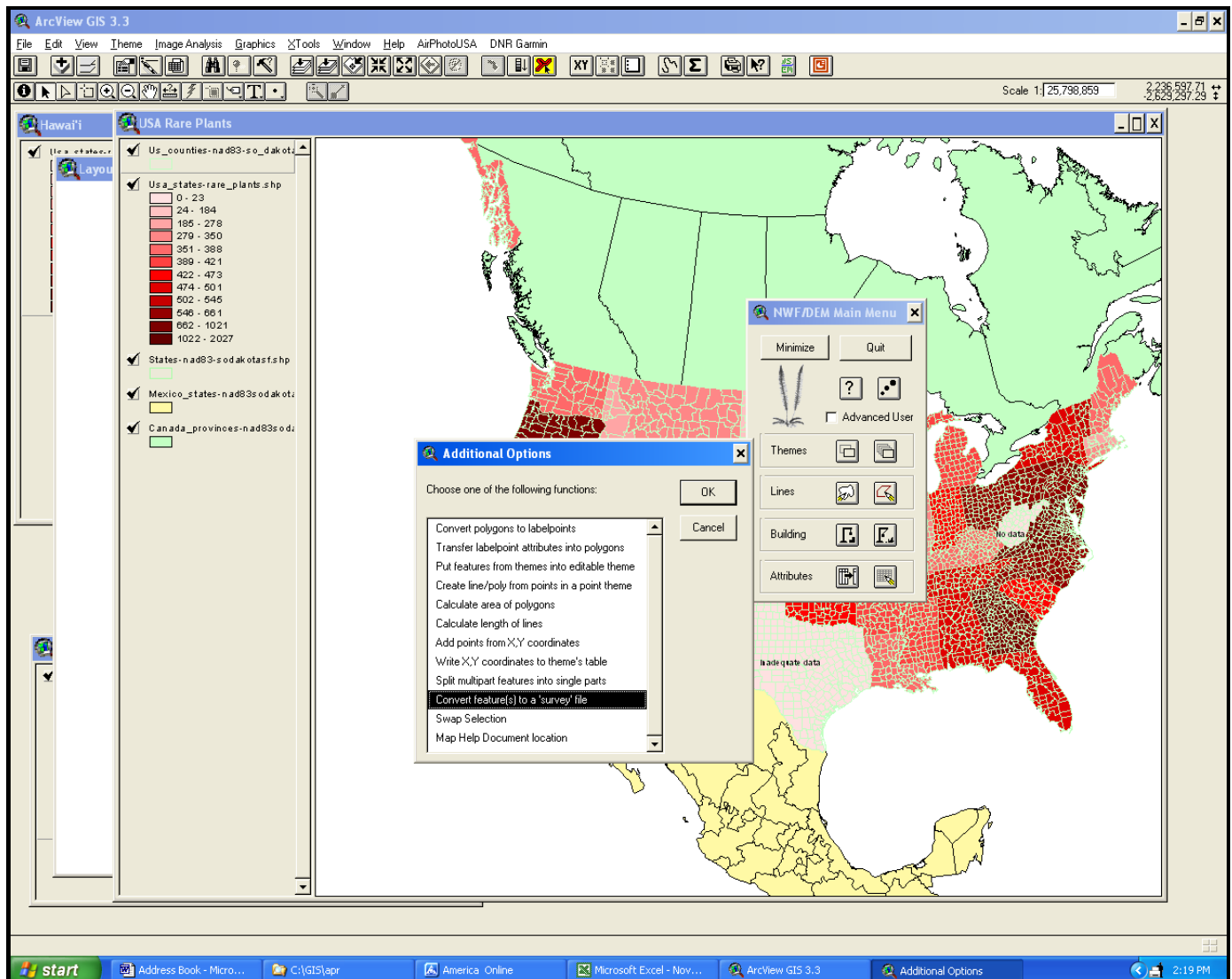

Figure 3. Screen Capture of Data Editing Extension Menus

Distances and bearings were then written as graphics onto the appropriate view, and that view used in a layout. We left the text horizontal for clarity, rather than rotating it to parallel its appropriate line segment, because so many of the segments were relatively small.

Extensions Used

Xtools

Bearings and Distances 1.1

NWS/DEM Data Editing (http://www.mass.gov/dem/programs/GIS/de/help/mainmenu.htm)

Results

While it took a number of hours to find the appropriate extension, learn how to use the extension, and test it, the end result was a useful map (or set of maps). By using the three extensions listed above, an ArcView 3.x user can generate metes and bounds descriptions from their polygon shapefiles in a relatively short period of time (several hours) and not need to involve a licensed surveyor or engineer. However, the fact that the metes and bounds were created by software and not from on-the-ground surveying should be clearly disclosed.

Following are two resulting maps, one showing the general overview of the survey area, and the other depicting the actual metes and bounds generated from the Data Editing extension. While it may be possible to accomplish much of this in ArcView 8 or 9, or other ESRI products, the cost can be quite high to obtain all the necessary software, which may be beyond the financial means of many GIS users.

N

W · E

S

Area 1

Area 2

Area 3

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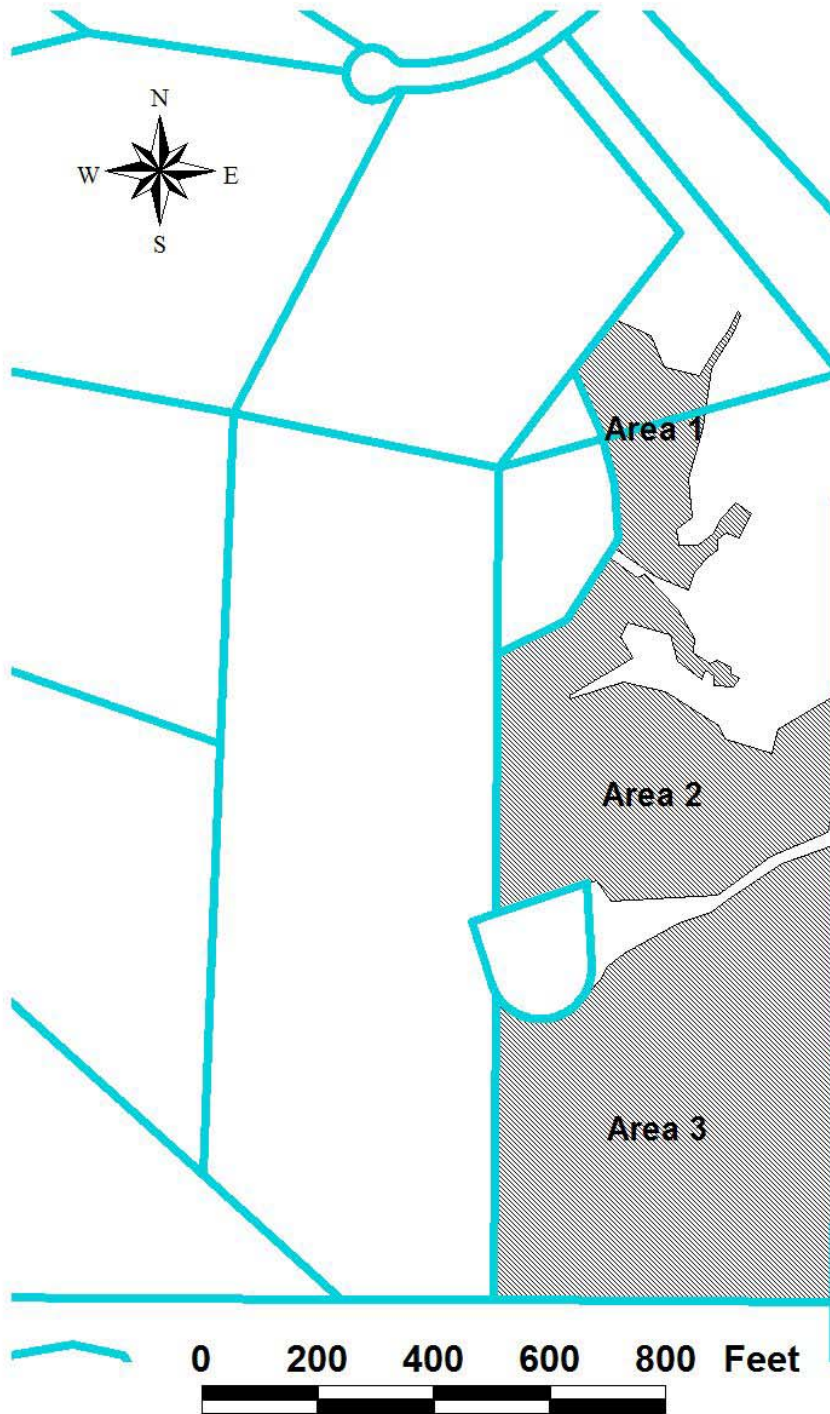
LEGEND

☐ **Parcel Boundaries**
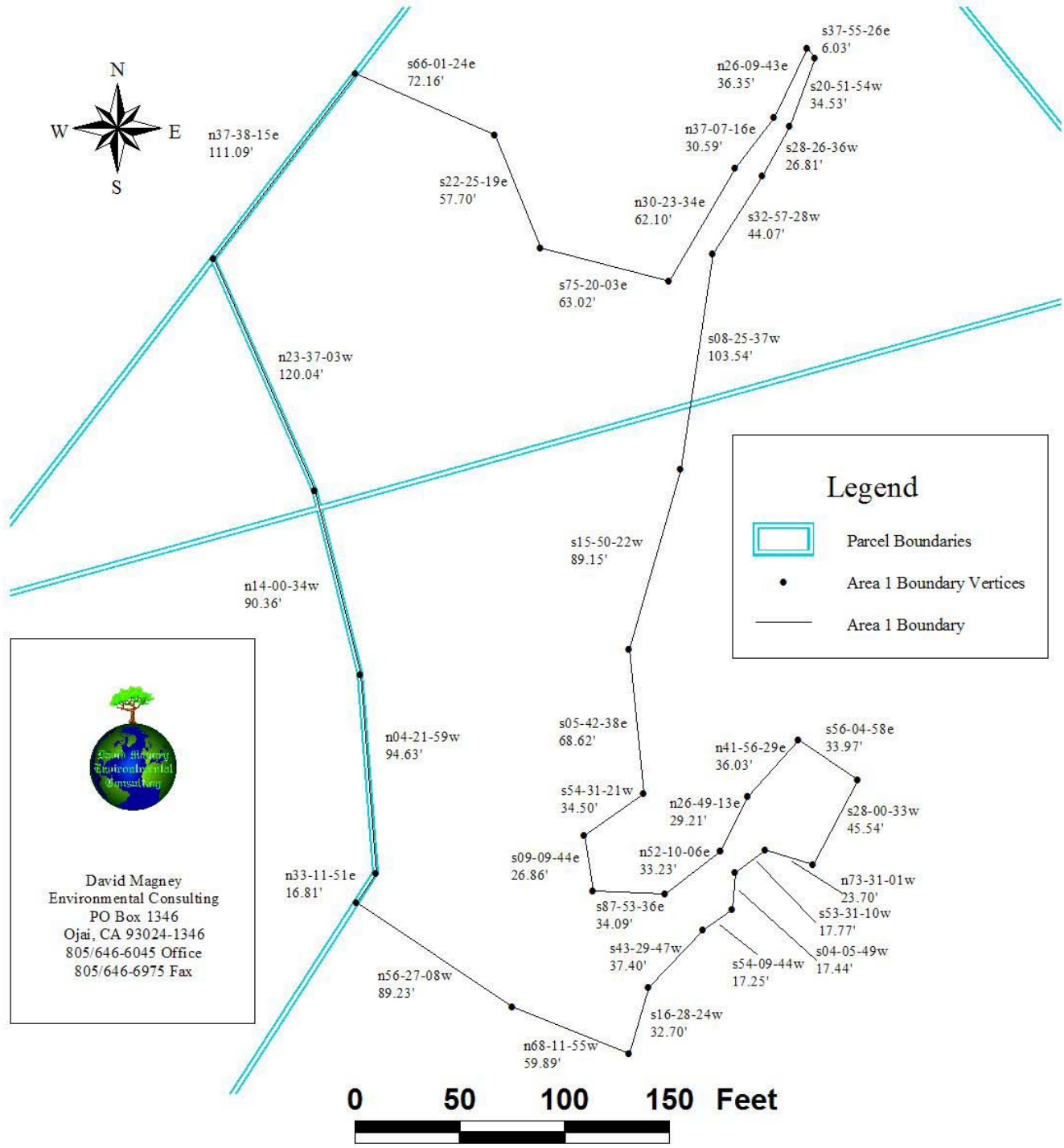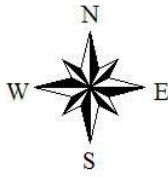▨ **Sensitive Areas**

0   200   400   600   800   **Feet**

Exhibit "A" Overview
Sensitive Areas of Lot 15 of Tract 2732 -1
(APNs 519-0-071-17, 519-0-082-08)

NAD 1983, CA State Plane Zone 5, feet

N
W E
S

s37-55-26e
6.03'

s66-01-24e
72.16'

n26-09-43e
36.35'

s20-51-54w
34.53'

n37-38-15e
111.09'

n37-07-16e
30.59'

s28-26-36w
26.81'

s22-25-19e
57.70'

n30-23-34e
62.10'

s32-57-28w
44.07'

s75-20-03e
63.02'

s08-25-37w
103.54'

n23-37-03w
120.04'

s15-50-22w
89.15'

n14-00-34w
90.36'

Legend

Parcel Boundaries

Area 1 Boundary Vertices

Area 1 Boundary

s05-42-38e
68.62'

s56-04-58e
33.97'

n41-56-29e
36.03'

n04-21-59w
94.63'

s54-31-21w
34.50'

n26-49-13e
29.21'

s28-00-33w
45.54'

s09-09-44e
26.86'

n52-10-06e
33.23'

n73-31-01w
23.70'

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n33-11-51e
16.81'

s87-53-36e
34.09'

s53-31-10w
17.77'

s43-29-47w
37.40'

s04-05-49w
17.44'

s54-09-44w
17.25'

n56-27-08w
89.23'

s16-28-24w
32.70'

n68-11-55w
59.89'

0   50   100   150 Feet

Exhibit "A", Detail "1"
Sensitive Area 1 of Lot 15 of Tract 2732-1
(APNs 519-0-071-17, 519-0-082-08)

NAD 1983, CA State Plane Zone 5, feet