Foothills Growth and Yield Association

Enhanced Management of Lodgepole Pine (EMLP2) Installation Establishment

(FRIAA Project OF-02-16)

Submitted to:

Dr. Dick Dempster
Director, Foothills Growth and Yield Association

Submitted by:

Hugh Lougheed RPF

Timberline
Natural Resource Group

31 March 2007

TNRG Contact:
Hugh Lougheed
175a Pembina Ave
Hinton, Alberta T7V 2B2
Phone: 780 865–4499
Fax: 780 865-4497
e-mail: hugh.lougheed@timberline.ca

Timberline
Natural Resource Group

31 March 2007

File: FGY-002

Dr. Dick Dempster
Foothills Growth and Yield Association
Foothills Model Forest

Re: Establishment Report for 2006 EMLP2 Installations

Dear Dick:

The enclosed report describes the establishment of 18 Enhanced Management of Lodgepole Pine installations on Foothills Growth and Yield Association member company Forest Management Agreement areas. This has been a challenging project on many fronts, both technically and logistically, and your support in fairly resolving issues is greatly appreciated.

Thank you for the opportunity to complete this work; I trust it will meet with your approval. If you have any questions, please feel free to contact me at (780) 865-4499.

Sincerely,

Timberline Natural Resource Group Limited

Hugh Lougheed
Branch Manager

175a Pembina Ave., PO Box 6689, Hinton, AB T7V 1X8 Tel (780) 865-4499 Fax (780) 865-4497
www.timberline.ca

1 Introduction

The Foothills Growth and Yield Association contracted J.S. Thrower and Associates Limited in late 2005 to undertake "reconnaissance, selection, sample plot installation, tree measurements, tree mapping and destructive sampling in 18 mixed pine-aspen sites regenerated after harvesting in the Lower and Upper Foothills Natural Subregions of western Alberta." This report provides a summary of the methods and results of that work.

2 Methods

The field measurements were taken as per Schedule A as amended in January 2007 (Attachment 1) and subsequent protocol development (destructive sampling and stem analysis memo, April 4, 2006, Attachment 2). One exception was field observation of bark thickness, which was not consistently measured. Field crews did consistently identify the radius/diameter lines on the disks, and bark thickness was measured in the ring lab bark. Although bark thickness observations are included for some disks, ring lab measurements of bark thickness are recommended for analysis purposes.

Of note, tree numbers are not necessarily sequential within a plot, and missing numbers are not missing trees. This was the result of the occasional double-tagging, trees browsed between tagging and stem mapping, or missed trees caught while doing stem mapping. Using pre-numbered tags resulted in not always having sequential tags available for missed trees.

3 Results

3.1 Installations Established

Installations were established on 6 FMAs; descriptions are provided in Table 1, and plot location plots for each installation in Attachment 3. Establishment and measurement followed the contract Schedule A. Initially member companies provided the FGYA with candidate sites, which were assessed by FGYA staff for suitability. A number of sites on the Hinton FMA were selected using this process. Subsequent to FGYA staffing changes, J.S. Thrower (now Timberline) staff undertook the reconnaissance of candidate sites.

The initial contract called for 30 installations, but this was later reduced to 18 installations given unexpectedly high tree counts and the resulting increase in establishment costs. The 18 installations were viewed by the FGYA Director and University of Alberta project collaborators to provide adequate replication within the desired age (10-20, 20-30 and 30-40 years) and site (Upper Foothills and Lower Foothills) strata. They provided 3 replicates in each of 6 strata combinations.

Table 1. EMLP2 installations overview information.

Age Class	Installation	FMA	Location	Date Measured	Natural Subregion	Ecological Description	Destructive Plots
10-20	2-008-0462	HWP	Emerson Rd km 80	15-Jan-06	LF	E 4 C	2, 4, 6
10-20	2-009-0048	HWP	Swansons South Rd km 72.5	1-Jan-06	UF	E 5 C	2, 4, 6
10-20	2-008-0443	HWP	Emerson Rd km 83	15-May-06	LF	E 5 C	
10-20	68130046	WCG	Calahoo Rd km 31	5-Jun-06 / 18-Jan-06	UF	C 5 C	2, 3, 6
10-20	S19904	CFG	4123 km RHS		UF	F 5 D	
10-20	ER 129-418	MWW	Eagle Tower Rd km 7.6	30-Jan-07	LF	C 4 C	
20-30	2-007-0596	HWP	Emerson Rd km 86	23-Jan-06	LF	D 6 B	
20-30	120	SDA	Sundance Rd km 60.1	15-Feb-06	UF	E 5 C	2, 4, 6
20-30	121	SDA	Sundance Rd km 60.3	10-Feb-06	UF	E 5 C	2, 4, 6
20-30	2-009-0060	HWP	Emerson Rd km 73	25-May-06	UF	C 3 C	
20-30	65070015	WCG	3.0 km W on Weyco Main from Bald Mtn Rd Junction	10-Jan-07	LF	C 5 C	
20-30	3-003-025A	HWP	3-3-102 Rd, 1.0 km past Erith bridge, RHS	Jan-07	LF	C 4 C	2, 4, 6
30-40	55	SDA	Sundance Rd km 61	5-Feb-06	UF	D 5 B	2, 4, 6
30-40	65070016	WCG	3.0 km W on Weyco Main from Bald Mtn Rd Junction	15-Jan-07	LF	C 4 C	
30-40	3-003-0011	HWP	Sundance Rd km 21.5, RHS 0.2 km	15-Nov-06	UF	C 4 C	
30-40	OG3-8-604	MWW	Goose km 57 (approx) 1 km SW of bridge	Feb, Mar-07	LF	F 6 D	2, 4, 6
30-40	1970	SLS	Hwy 68, S of Jumpingpound Demo Forest	Feb-07	LF	E 5 C	2, 4, 6
30-40	4-006-0682	HWP	Prest Creek Rd km	17-Jan-07	UF	D 6 B	

Destructive sampling was conducted on three installations selected within each age strata. Aside from Sundance sites chosen because of September 2006 snowfall damage, no set criteria were used to select installations for destructive sampling.

3.2 Data Description

All data provided to the FGYA is in an Excel file (EMLP2 data V3.0.xls), and includes mensuration, stem map, destructive sampling and tree ring data.

Tables 2 through 8 provide a description of data tables contained in "EMLP2 data V3.0.xls", including the table name, field name and field description (including measurement units and precision, where appropriate).

Table 2. Data table list and description.

Table	Description
Data Dictionary	Description of table and field definitions
Header	Installation header file, general information
Tree	Tree mensuration data
Destructive	Destructive sample field data
Neighbour	Neighbour tree data
BH Ring	BH disk ring data
Disk	Age and height for 5 sample disks per tree
LU Mortality	Lookup – Mortality description
LU CFF	Lookup - Crown Fullness %
LU Species	Lookup - Species
LU Sample Type	Lookup - Sample type
LU Dam	Lookup – Damage codes
LU Sev	Lookup – Severity description and details

Table 3. Header table, fields and description.

Field	Description
AGENCY	Company
LOCAL IDENTIFIER 1	Agency specific identifier, ie block
LOCAL IDENTIFIER 2	Alternate local identifier
PLOT NO	Plot number
PLOT CENTRE UTM EAST	NAD83 UTM coordinate Easting
PLOT CENTRE UTM NORTH	NAD83 UTM coordinate Northing
NATURAL SUBREGION	Natural Subregion
ECOSITE	Ecosite name
MOISTURE REGIME	Moisture regime
NUTRIENT REGIME	Nutrient regime
LEGAL DESCRIPTION	meridian-township-range-section
ISP NUMBER	Industrial sample plot identification
MENS REF YEAR	Reference year for mensuration data
DEST REF YEAR	Reference year for destructive sample data

Table 4. Tree table, fields and description.

Field	Description
AGENCY	Company
BLOCK	Company location identification
PLOT_NO	Plot number
TREE_NO	Tree number
SPECIES	Tree species (See LU Species)
HT	Total tree height (point of germination to top) (xx.x m, to lesser of +/- 0.2m or 2%)
HTLC	Height to live crown (point of germination to bottom of live crown) (xx.x m, +/- 5%)
HT_INCREM	Height increment (point of germination to lowest point of increment measurement) (xx.x m, to lesser of +/- 0.2m or 2%)
INCREM_RNG	Number of years in the height increment measure (normally 5)
DBH	Diameter at breast height (xx.x cm, +/- 0.1cm)
CROWN_POS	Crown position, (Suppressed, Intermediate, Codominant, Dominant) (+/- one class)
AVG_CROWN	Average crown radius (xx.x m, to lesser of +/- 0.3m or 5%)
TREE_STAT	Tree status (L=live,M=missing,S=snag)
MORTALITY	Mortality code (See LU Mortality)
SAMPLE_TYP	Sample type (See LU Sample Type)
DAM_1	Damage code 1 (See LU Dam)
SEV_1	Severity code 1 (See LU Sev)
DAM_2	Damage code 2 (See LU Dam)
SEV_2	Severity code 2 (See LU Sev)
COMMENTS	Comments
CFF	Crown Fullness Factor (See LU CFF)
DISTANCE	Distance to tree from CFF (xx.xx m, to nearest cm, +/- 5cm)
BEARING	True bearing to tree from CFF (xxx.xx degrees, to nearest .05 degree)
AGE	

Table 5. Destructive table, fields and description.

Field	Description
AGENCY	Company
LOCAL	
IDENTIFIER 1	Company location identification
PLOT NO	Plot number
TREE NO	Tree number, sequential by plot
HT DOWN	Height, felled (xx.x m, to nearest dm)
HTLC DOWN	Height to live crown, felled (xx.x m, to nearest dm)
COMMENTS	

Table 6. Neighbour table, fields and description.

Field	Description
AGENCY	Company
LOCAL IDENTIFIER 1	Company location identification
PLOT NO	Plot number
NEIGHBOUR TREE SPECIES	Neighbour tree species (see LU Species)
NEIGHBOUR HT	Neighbour tree height (xx.x m to lesser of +/- 0.2m or 2%)
NEIGHBOUR DBH	Neighbour tree diameter at breast height (xx.x cm to nearest mm)
SUBJECT 1	Tree_no of first subject tree
DISTANCE 1	Distance in m (xx.xx m +/- 5cm)
BEARING 1	True bearing in degrees from Neighbour Tree to Subject Tree (xxx degrees, to nearest degree)
SUBJECT 2	…
DISTANCE 2	
BEARING 2	
SUBJECT 3	
DISTANCE 3	
BEARING 3	
SUBJECT 4	
DISTANCE 4	
BEARING 4	
SUBJECT 5	
DISTANCE 5	
BEARING 5	

Table 7. BH Ring table, fields and description.

Field	Description
AGENCY	Company
LOCAL IDENTIFIER 1	Company location identification
PLOT NO	Plot number
TREE NO	Tree number, sequential by plot
RADIUS	"a" or "b" radius
MEAS YEAR	Year sample taken.
YEAR	Ring growth year
AGE	Age (years) at YEAR = number of rings from pith
RING WIDTH	Ring width in cm
CUMRAD	Cumulative radius in cm
MAX AGE	Age of disk at MEAS YEAR
MAX RING WIDTH	Maximum ring width of all rings in radius (cm)

Table 8. Disk table, fields and description.

Field	Description
AGENCY	Company
LOCAL IDENTIFIER 1	Company location identification
PLOT NO	Plot number
TREE NO	Tree number, sequential by plot
HT 1	Height of disk 1 (xx.x m to nearest cm)
AGE 1	Age of disk 1 (years)
HT 2	Height of disk 2 (xx.x m to nearest cm)
AGE 2	Age of disk 2 (years)
HT 3	Height of disk 3 (xx.x m to nearest cm)
AGE 3	Age of disk 3 (years)
HT 4	Height of disk 4 (xx.x m to nearest cm)
AGE 4	Age of disk 4 (years)
HT 5	Height of disk 5 (xx.x m to nearest cm)
AGE 5	Age of disk 5 (years)
BT 1	Bark thickness at BH radius "a"
BT 2	Bark thickness at BH radius "b"

Attachment 1

Contract Schedule A

Schedule A – Amended

Description of Services

Introduction

The Consultant will undertake reconnaissance, selection, sample plot installation, tree measurements, tree mapping and destructive sampling in 18 mixed pine-aspen sites regenerated after harvesting in the Lower and Upper Foothills natural sub-regions of western Alberta.

Sampling will be conducted in stands or portions of stands with the following characteristics:

- Age 10 – 40 (years after harvest);
- Mesic soil moisture regimes;
- Minimum area of 4 ha reasonably homogeneous in soil moisture regime and ecosite;
- Pine density averages over about 1000 stems per ha per experimental site, with minimum densities per plot of about 400 stems per ha;
- Component of aspen present, with areas of low and high aspen densities (stems per ha); as well as areas exceeding minimum targets (see below);
- Minimum average aspen densities, depending on age, of about 2000 stems per ha (at 10-20 years) to 500 stems per ha (over 30 years);
- Adjacent or close to a drivable road.

Reconnaissance and Site Selection

Locations of candidate stands will be provided to the Consultant by the Company and members of the FGYA. The Consultant will conduct reconnaissance of approximately 24 such stands, and make a final selection of 18 stands meeting the above criteria and distributed as follows:

- 3 age classes (approximately 10-20, 20-30, 30+ years age);
- 2 natural sub-regions (Lower and Upper Foothills);
- 3 replicates (in each combination of age class and NSR).

Plot Location and Installation

The Consultant will locate within each selected polygon a stand area of uniform site conditions, avoiding non-mesic conditions, but preferably variable in relative composition of aspen and pine. The defined stand area (experimental site) will be characterized in terms of ecosite, soil moisture and soil nutrient regime. A soil pit will be excavated and described at each site.

The Consultant will locate 6 sample plots at each site. He will partition each site into areas of relative high, medium and low aspen density, locating 2 plots in each. The plots will be 300m^2 and circular (radius 9.77m). They will include an absolute minimum of 9 lodgepole pine trees, and usually include at least 12 lodgepole pine trees (assuming minimum densities at any point in the stand of about 400 stems per ha). The centre of each plot will be permanently staked and the position geo-referenced by GPS.

Three plots in each of 9 stands (3 stands for each 10-20, 20-30, and 30+ year age-class) will be designated in consultation with the Company for destructive sampling to obtain retroactive assessments of height and diameter increment for both pine and aspen. At least one stand (and 3 plots) so designated for destructive sampling will be located in each combination of age class and natural sub-region. The remaining plots will be maintained and demarcated for future re-measurement.

Tree Mapping, Tagging and Measurement

Plots will be mapped using laser hypsometer or comparable technology facilitating automated digital mapping and spatial analysis. All trees within the plot radius and > 1.3m in height will be numbered and measured for azimuth (to nearest 0.05 degrees) and distance (to nearest cm) from plot centre. The maximum acceptable error in the horizontal position of tree stems (measured at 1.3 m above ground level and using plot centre as datum) will be +/- 5cm.

All trees will be assigned a sample type and be assessed for species, dbh, total height (unless otherwise stated below), crown position, and status (dead or alive).

The 12 acceptable lodgepole pine trees closest to the plot centre will be designated as subject trees (sample type code "S") and flagged (in plots designated for destructive sampling), or otherwise permanently tagged. Acceptable subject trees must be live lodgepole pines, greater than 1.3m in height, NOT having damage codes DD, PD, PL, or PM (see below). Tags will be nailed to stems of large trees, and attached by wire to branches of small trees (i.e. trees < approximately 5cm dbh). All subject trees will be measured for: dbh, total height, crown position, status (will always be live), height increment, height to live crown, crown radius, crown fullness factor, damage incidence and damage severity.

The 3 largest-dbh aspen and 3 largest-dbh lodgepole pine trees within the $300m^2$ plot will be designated as top height trees (code "T") if acceptable, and measured in the field for breast-height age as well as all other variables identified above for subject trees. (Top height trees may or may not also be subject trees.) Acceptable top height trees must be live pine or aspen / balsam poplar, greater than 1.3m in height, NOT having damage codes DD, PD, PL, or PM (see below).

Additional neighbor trees (code "N") external to the mapped plot will be measured where necessary to assess competition around every "subject" tree. This will require measuring the height (unless otherwise stated below), diameter and distance (from subject tree) of any tree within a distance from the subject tree less than one-third of the average dominant / co-dominant height of the stand.

If the total number of trees > 1.3m mapped and recorded within a plot exceeds 100, heights may be sub-sampled on every 5^{th} tree once all top height trees, subject trees, a minimum of 30 pine, and a minimum of 30 aspen have been measured for height.

The following codes will be used and levels of accuracy (where specified) required for assessing tree attributes.

Tree Sample Type: For measurement and demarcation purposes, each tree will be recorded as belonging to one of the following sample types: subject (S), top height (T), subject and top height (ST), neighbour (N), other or remaining (R).

Species: codes are as follows:

Code	Species
FA	Sub-alpine Fir
FB	Balsam Fir
LT	Tamarack (Larch)
PJ	Jack pine
PL	Lodgepole Pine
SB	Black Spruce
SE	Englemann Spruce
SW	White Spruce
PB	Balsam (Black) Poplar
AW	Aspen (White) Poplar
BW	White Birch

DBH: Record the diameter at breast height (1.3 m from the point of germination) in cm to nearest 0.1cm. In case of any defect at the point of measurement such as swellings or large branches, diameter is taken immediately below or above the defect and a comment noting the defect and measurement height is made.
DBH accuracy: +/- 0.1cm

Total Height: Record the current total height for each tagged tree in metres, to the nearest 0.1m (fire-origin sites) or 0.01m (post-harvest sites). Heights are measured from the germination point (root collar) to the tallest live portion of the crown, excluding the terminal bud.

Height accuracy: lesser of +/- 0.2m or 2%

Height Increment: Select a node at a recognizable number of internodes below the terminal bud in the range of 1 (minimum) to 5 (maximum); record the height to this node, and the number of internodes between it and the terminal bud. Use the maximum number of internodes providing that (a) the internodes are clearly recognizable and (b) the lowest node is above breast-height (1.3m). Height measurement accuracy as for total height.

Height to Live Crown: This is the height from the ground level to the base of the continuous live crown.

Height to Live Crown accuracy: +/- 5%

Average Crown Radius: Measured by assessing the distance from the tree bole to the edge of the crown margins (drip zone), taken in four cardinal point directions (north, south, east and west) from the stem out and recorded as an average of the four directions.

Average Crown Radius accuracy: lesser of +/- 0.3m or 5%

Crown Class: The position of an individual tree within the canopy of the stand. The crown class is assessed on a plot-by-plot basis, not on the stand as a whole. (i.e.: a 20m tree in one plot may be designated a co-dominant while a 20m tree in an adjacent plot may be designated a dominant). Do not record for trees with broken tops or severe lean.

Allowable crown class codes:

Code	Crown Class	Description
D	Dominant	Crowns extend above the general level of the canopy
C	Co-dominant	Crowns form the general level of the canopy.
I	Intermediate	Crowns below but extending into the bottom of the general level of the canopy
S	Suppressed	Crowns entirely below the general level of the canopy

Crown Class accuracy: +/- one class (no more than 10% error per plot)

Damage Incidence and Severity:
Record a maximum of 2 damage incidence codes. (If more than 2, select the 2 that have the highest severities.). Identify the severity of each.

Damage Incidence Codes:

Code	Description	Code	Description
AH	Animal - Horse trampling	ID	Insects - Defoliators
AL	Animal – Rabbit/hare	IB	Insects - Wood borers
AT	Animal – Bear	IT	Insects - Terminal weevils
AC	Animal - Beaver	IR	Insects – Root collar weevils
AR	Animal – Ungulate rubbing	IA	Insects – Aphids
AB	Animal – Ungulate browsing	IO	Insects - Other
AS	Animal – Squirrel	PD	Physical defects – Dead or damaged top
AP	Animal – Porcupine	PL	Physical defects - Dead top with lateral assuming dominance
AO	Animal – Other	PM	Physical defects – Broken or missing top
DN	Disease - Needle rust	PC	Physical defects - Crook or Sweep
DH	Disease - Hypoxylon canker	PT	Physical defects – Mechanical
DA	Disease - Atropellis canker	PF	Physical defects - Forked tree
DR	Disease - Armillaria mella	PB	Physical defects - Leaning or bent tree
DC	Disease - Conks	PR	Physical defects - Rot or decay
DD	Disease - Die back	PS	Physical defects - scar or cat face
DM	Disease - Dwarf mistletoe	WH	Weather – Hail
DB	Disease - Blister rust	WF	Weather – Frost heaving
DW	Disease - Western gall rust	WC	Weather – Frost crack
DI	Disease – Witches' broom	WN	Weather - Snow or ice
DO	Disease - Other	WR	Weather - Red belt
		WB	Weather – Blow-down

Severity Codes:

1: Minimal: Tree expected to fully recover with little effect on tree growth or form. If incidence is disease such as gall rust or mistletoe, it is limited to lateral branches.

2: Moderate: Growth rate likely to be reduced and / or tree form adversely affected. If incidence is disease such as gall rust or mistletoe, it is apparent on the bole.

3: Severe: Tree will probably die or be rendered non-merchantable due to extensive bole damage, defect or disease.

Destructive Sampling and Stem Analyses

On those plots designated for destructive sampling, the 12 lodgepole pine "subject" trees, plus the 12 acceptable aspen trees closest to the plot centre, will be cut for stem analysis. Acceptable aspen trees must be alive and NOT having damage codes DD, PD, PL, or PM (see above).

Before falling, each sample tree will be marked at stump and breast height (0.15 and 1.3m above germination point respectively); DBH and height will be measured standing.

After falling, each sample tree will be re-measured for total height (from germination point), and height to live crown (first live branch).

A cookie (disc, 3-4cm thick) will be taken at stump height (0.15m) and at DBH. In addition, the remaining length of the tree will be divided by 4 to give 3 more equally separated sections. (In trees less than 3m tall this procedure may be varied to include an intermediate cut between stump and breast-height.) This then will ensure that every tree has five cookies. Each cookie will be marked with permanent marker, indicating plot and tree number as well as section number and height above germination point, and placed in a suitable breathable bag (poly woven). The bag will be tied closed with ribbon and transported to the JST tree ring laboratory for stem analysis.

At the laboratory each disk will be sanded with progressively finer sandpaper grits until the tree rings are easily visible. The lab technician will confirm with the project leader how to identify the one radius where the measurements will be taken. This location will be marked with a pencil line. On all disks each tree ring along the pencil line will be marked with a pen and counted using a hand lens. Breast-height disks will be measured using the Velmex UniSlide, and the age and growth increments will be measured for every year under high-powered magnification.

Data Submission

Data will be submitted in an electronic format acceptable to the Company. Site / plot header information, tree measurements, and stem analyses data may be submitted as separate tables providing that they can easily be linked in a relational database. This will require consistent formatting of all variables, and use of identical referential codes (site, plot and tree numbers) in all 3 data sets.

Attachment 3

Destructive Sampling and Stem Analysis

Memo

To: Hugh Lougheed, Darren Bath, Margie Buhler
CC: Bryon Muhly, Dick Dempster
From: Scott MacKinnon
Date: April 4, 2006
Re: FGY-002 destructive sampling and stem analysis

Hugh,

After discussing with Ian, Margie, and you, I've put together the measurement procedures for the FGY-002 disks. It outlines the field procedures (as they relate to the lab measurements) and the lab procedures.

Thanks,
Scott

Field Procedures:

1. Place an arbitrary mark with a felt pen on the edge of the BH disk.
2. Use the Excel "Random Azimuth Generator" file to obtain a random azimuth between 0 and 170 degrees, to the nearest 10 degrees.
3. Using the arbitrary felt mark as 0 degrees, measure to the random azimuth with a protractor.
4. Draw a pencil line from the random azimuth across the pith to the other side of the disk.
5. If some defect is encountered along this line that would prevent accurate ring width measurements from being obtained in the lab (e.g. branch whorl, check, rot, etc.), return to Step 2 to obtain a new random azimuth. Continue until a suitable random diameter is located.
6. Measure and record the bark thickness at either end of the random diameter. This is measured from the outside edge of the last late wood ring to the outside edge of the bark.

Lab Procedures:

BH Disks Currently In the Lab:

1. Sand the disk surface until the rings are easily visible for measurement purposes.
2. Place an arbitrary mark with a felt pen on the edge of the disk.
3. Use the Excel "Random Azimuth Generator" file to obtain a random azimuth between 0 and 170 degrees, to the nearest 10 degrees.
4. Using the arbitrary felt mark as 0 degrees, measure to the random azimuth with a protractor, and then draw a pencil line from the random azimuth across the pith to the other side of the disk.
5. If some defect is encountered along this line that would prevent accurate ring width measurements from being obtained in the lab (e.g. branch whorl, check, rot, etc.), return to Step 3 to obtain a new random azimuth. Continue until a suitable random diameter is located.
6. Measure the ring widths with the Velmex UniSlide:
    a. Measure the first radius, starting at pith and proceeding along the pencil line to the cambium in one direction.

   b. Measure the opposite radius, again starting at pith and moving to the cambium along the pencil line in the opposite direction.
   c. If the two age counts are not equal, remeasure one or both radii until an equal age count is obtained.
7. Record the ages on the data summary sheet.
8. Measure and record the bark thickness at either end of the random diameter (this will be measured in the field for all future BH disks). This is measured from the outside edge of the last late wood ring to the outside edge of the bark.

Future BH Disks:

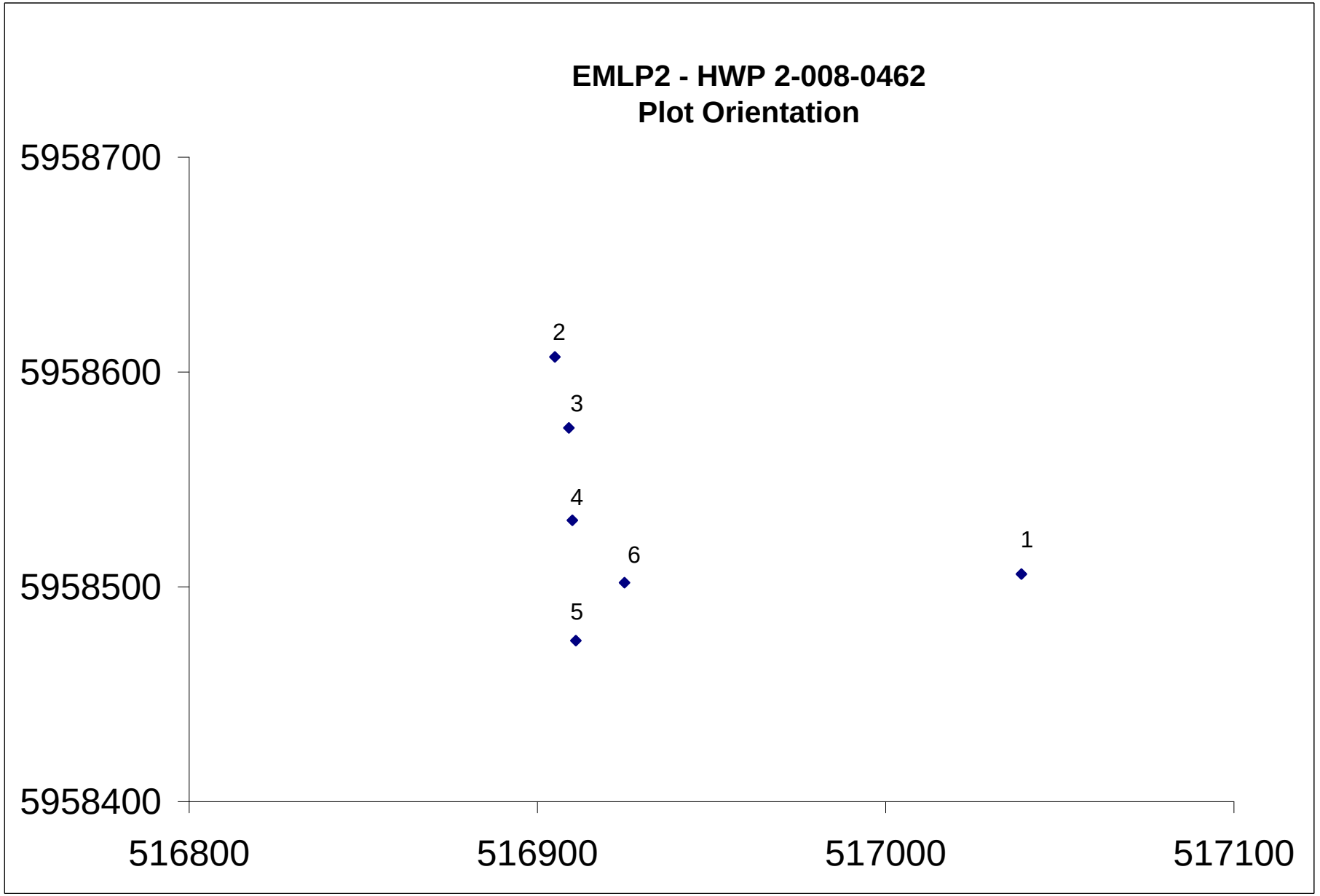
1. Mark the bark of the BH disk at either end of the pencil line with a felt pen.
2. Sand the disk surface until the rings are easily visible for measurement purposes.
3. Redraw the pencil line on the disk to connect the two felt marks and pith.
4. If some defect is encountered along this line that would prevent accurate ring width measurements from being obtained (e.g. branch whorl, check, rot, etc.):
   a. Change the pencil line by 10 degrees.
   b. Alternate this adjustment between an increase of 10 degrees and a degrees of 10 degrees each time an adjustment is made.
5. Measure the ring widths with the Velmex UniSlide:
   a. Measure the first radius, starting at pith and proceeding along the pencil line to the cambium in one direction.
   b. Measure the opposite radius, again starting at pith and moving to the cambium along the pencil line in the opposite direction.
   c. If the two age counts are not equal, remeasure one or both radii until an equal age count is obtained.
6. Record the ages on the data summary sheet.

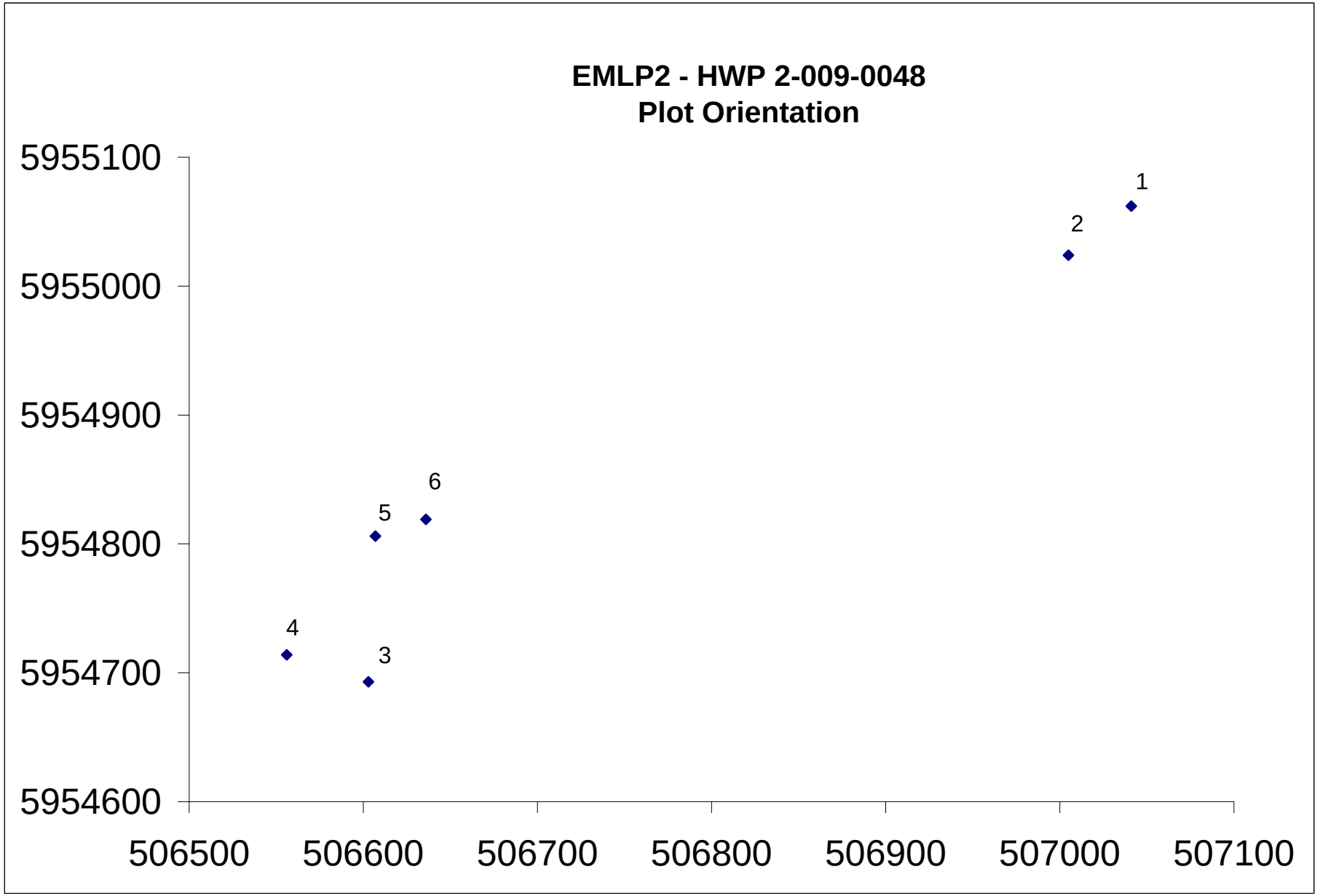
All Other Disks:

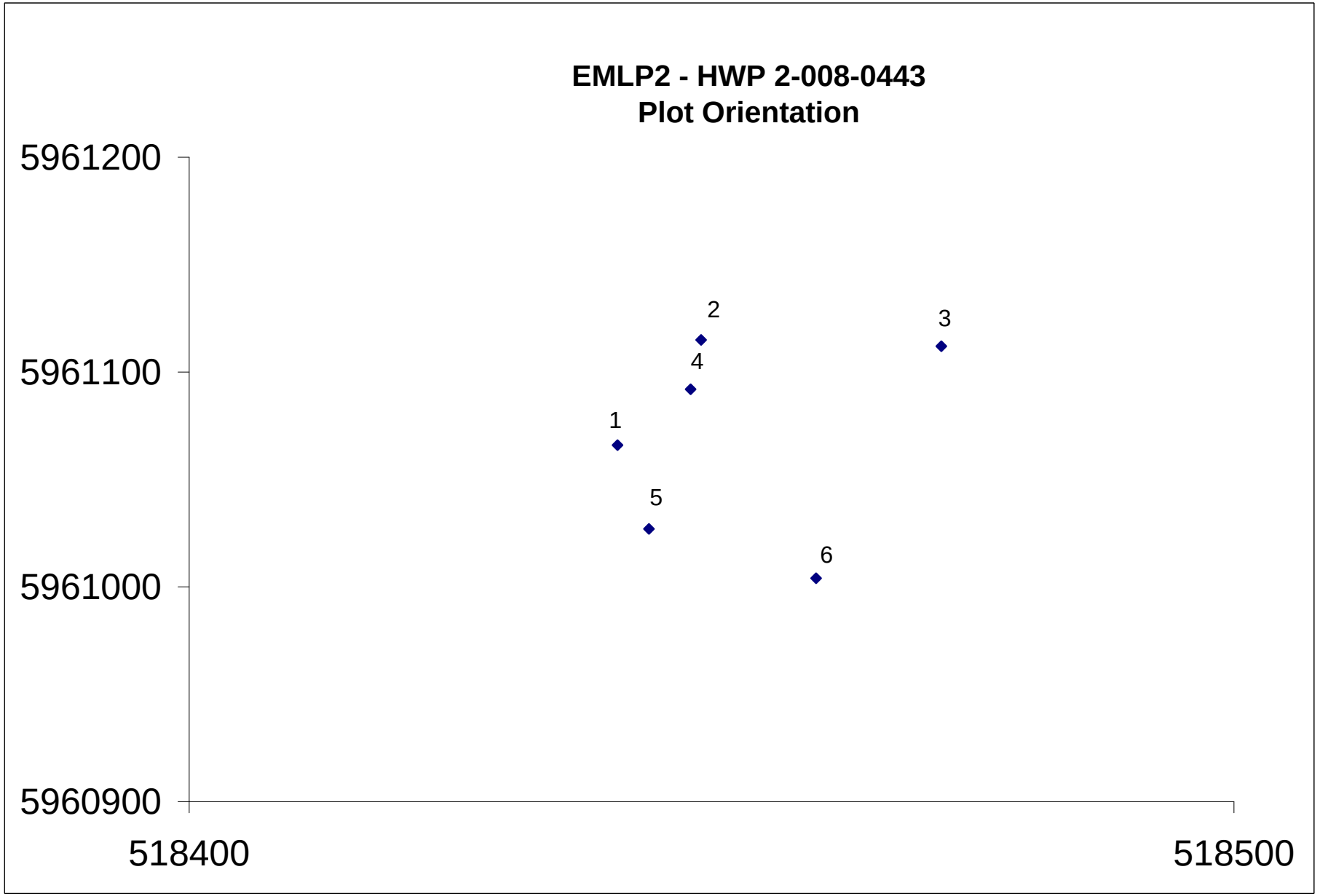
1. Sand the disk surface until the rings are easily visible for measurement purposes.
2. Choose a radius that will offer the best age count (i.e. wide clear rings, etc.), and mark it with a pencil line.
3. Count the rings under magnification, starting at pith and proceeding along the pencil line to the cambium. Record the age on the data summary sheet.
4. Choose a second radius (one that has a different apparent ring pattern, if present), and count the rings under magnification.
   a. If the two ring counts are equal, no further action is required.
   b. If they are different, follow the rings around the circumference to determine the source of the difference. Determine and record the correct age for the disk depending on what is found (e.g. a ring was missed during the count of one radii, or there is a missing ring along one of the radii).

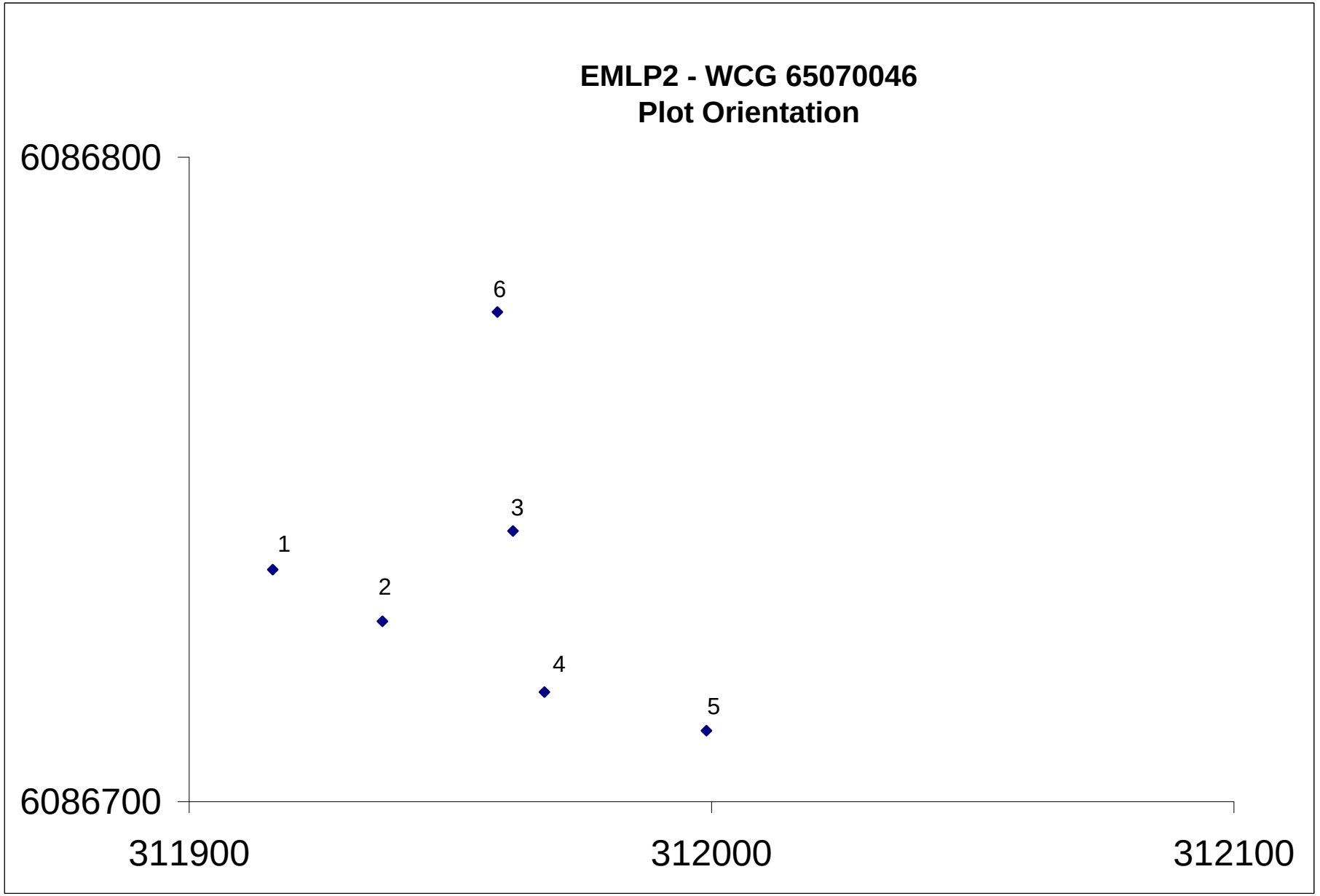
Attachment 3

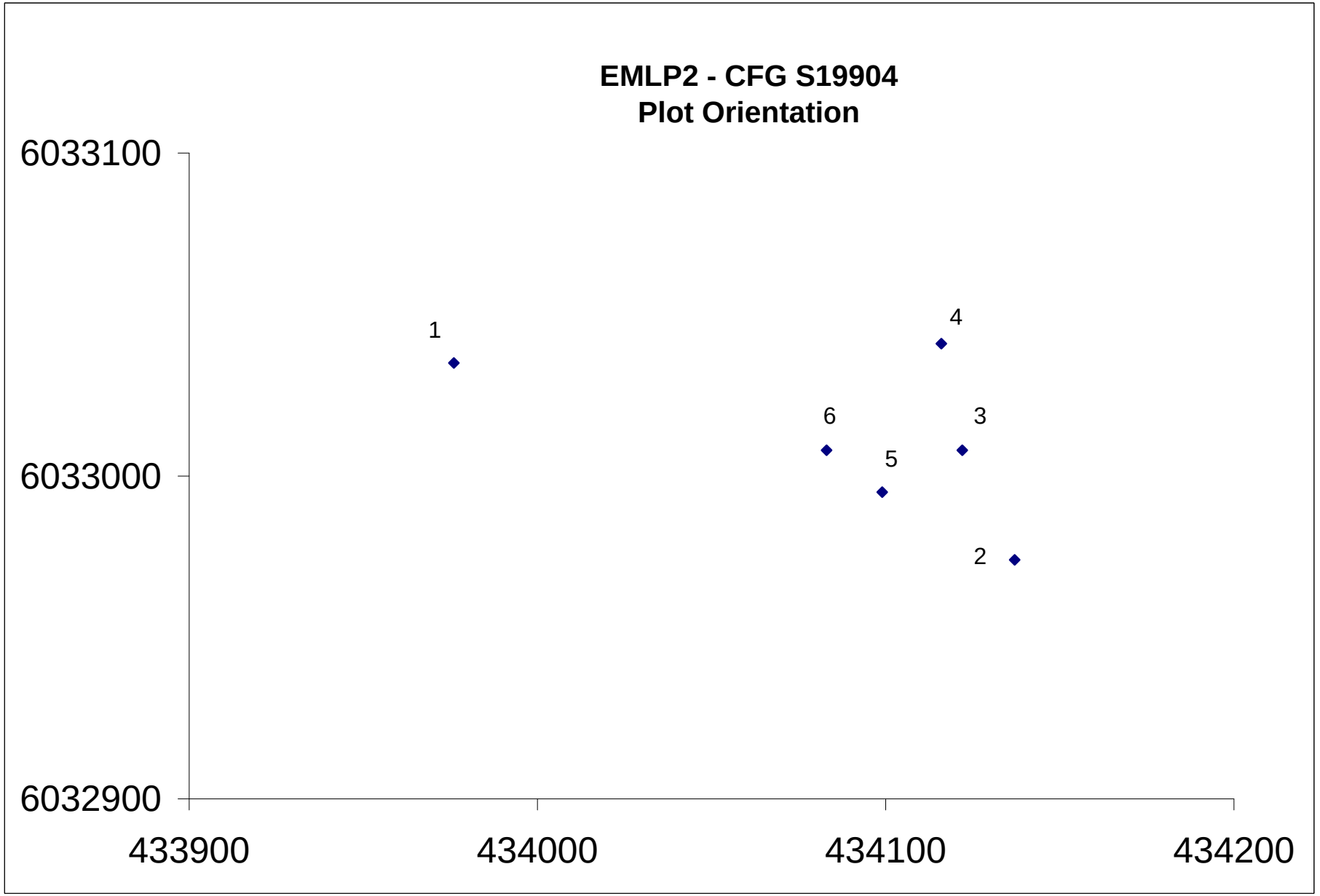
Plot Locations

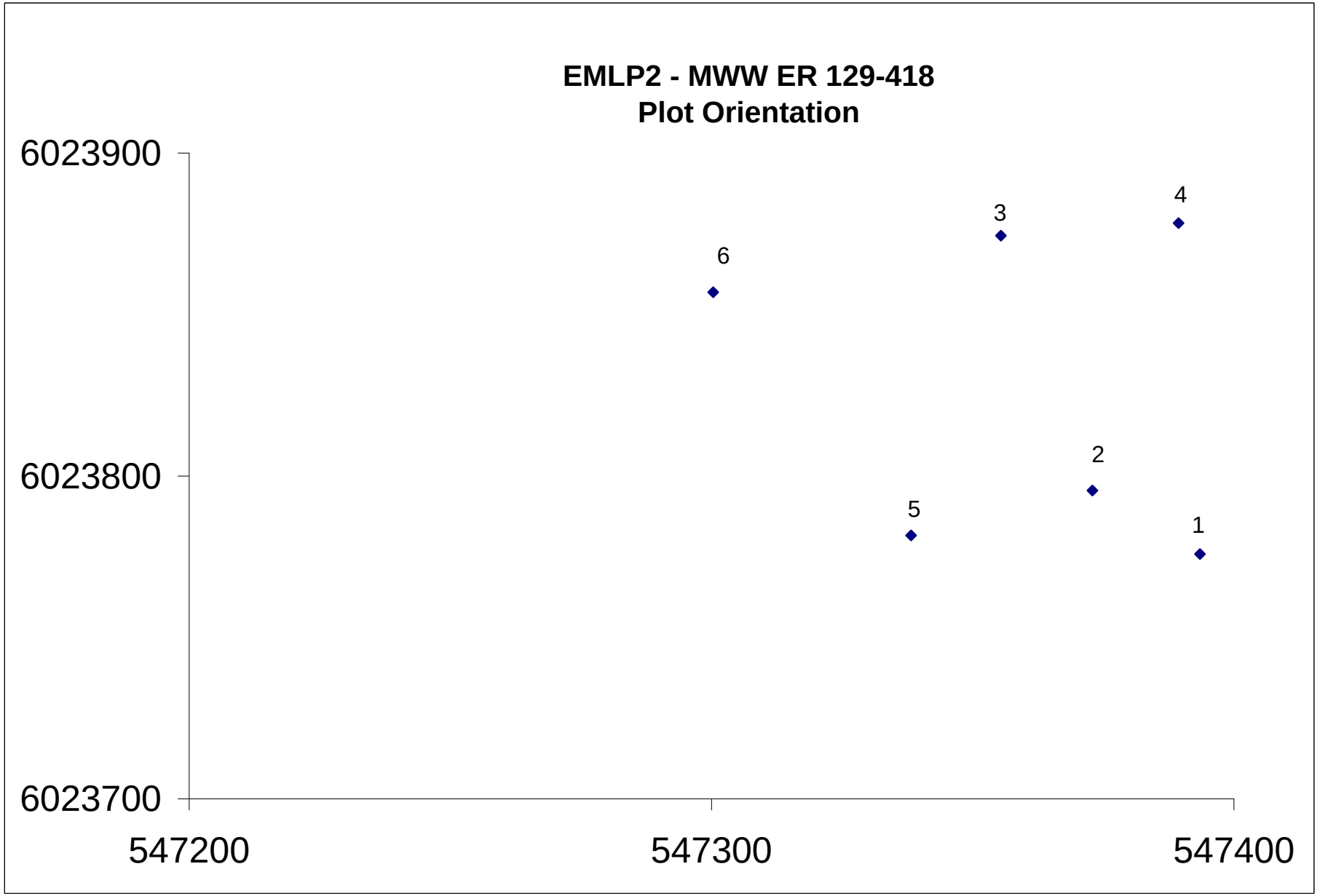

EMLP2 - HWP 2-008-0462
Plot Orientation
5958700
5958600
5958500
5958400
516800
516900
517000
517100
2
3
4
6
5
1

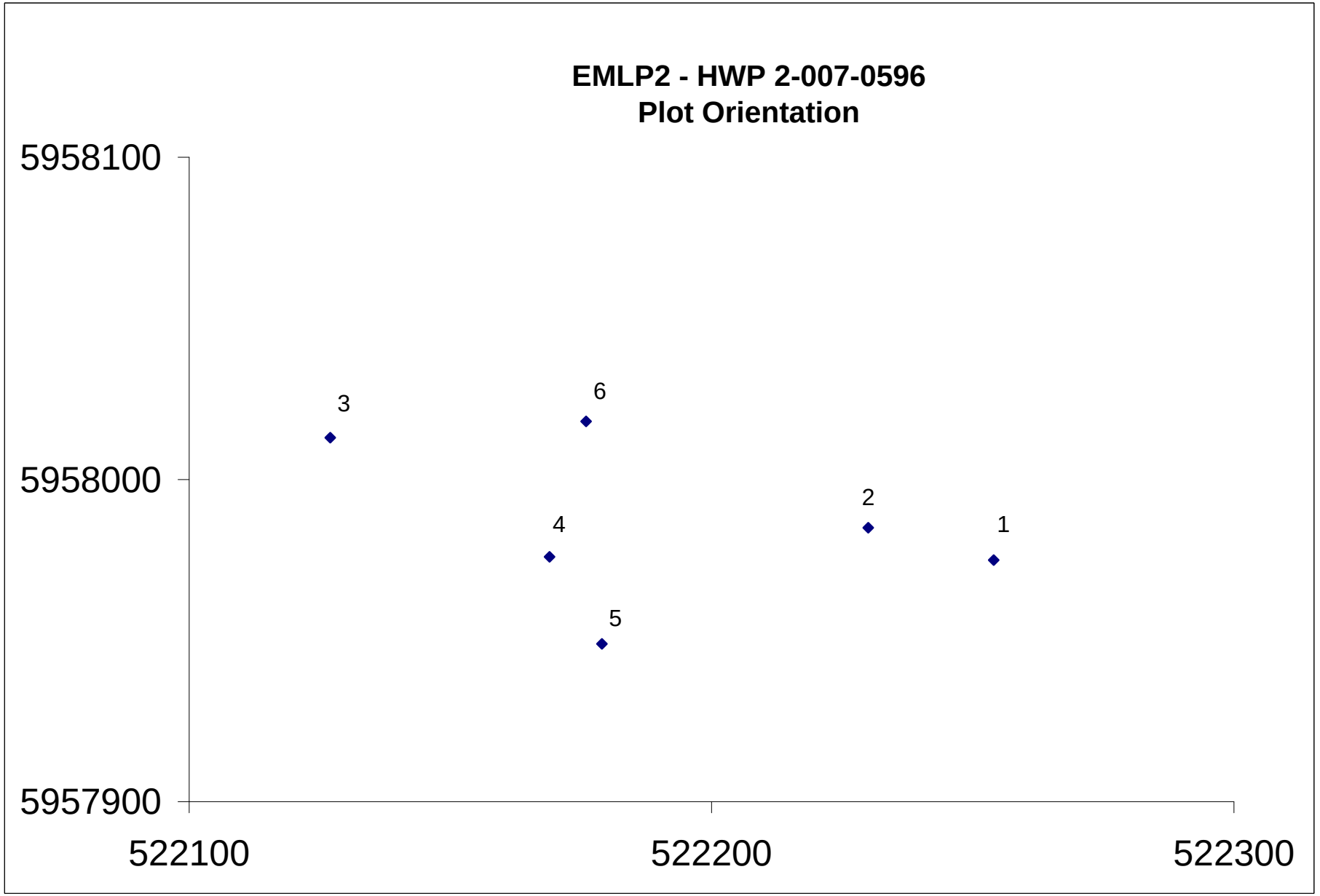

EMLP2 - HWP 2-009-0048
Plot Orientation
5955100
5955000
5954900
5954800
5954700
5954600
506500
506600
506700
506800
506900
507000
507100
1
2
3
4
5
6

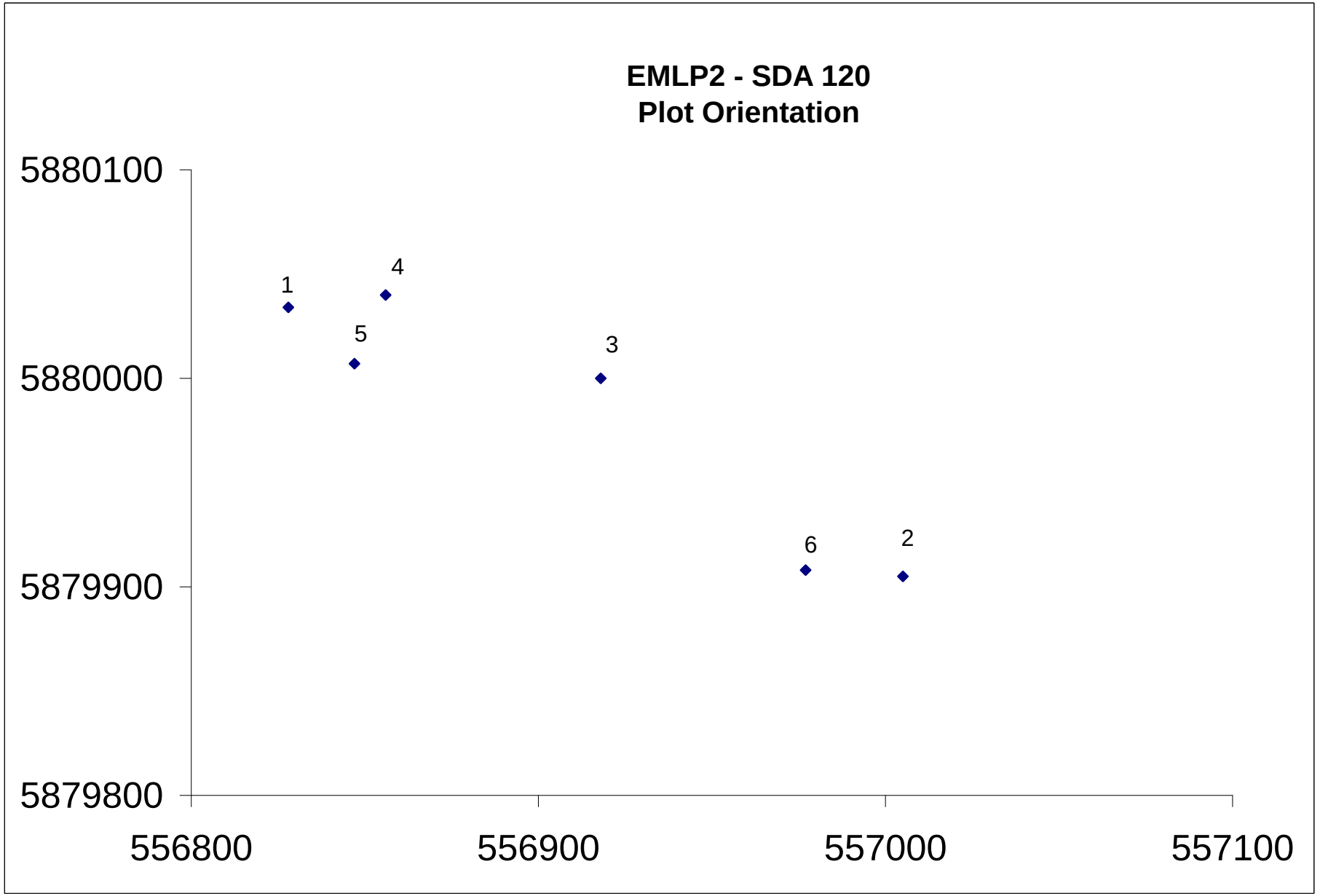

EMLP2 - HWP 2-008-0443
Plot Orientation
5961200
5961100
5961000
5960900
518400
518500
1
2
3
4
5
6

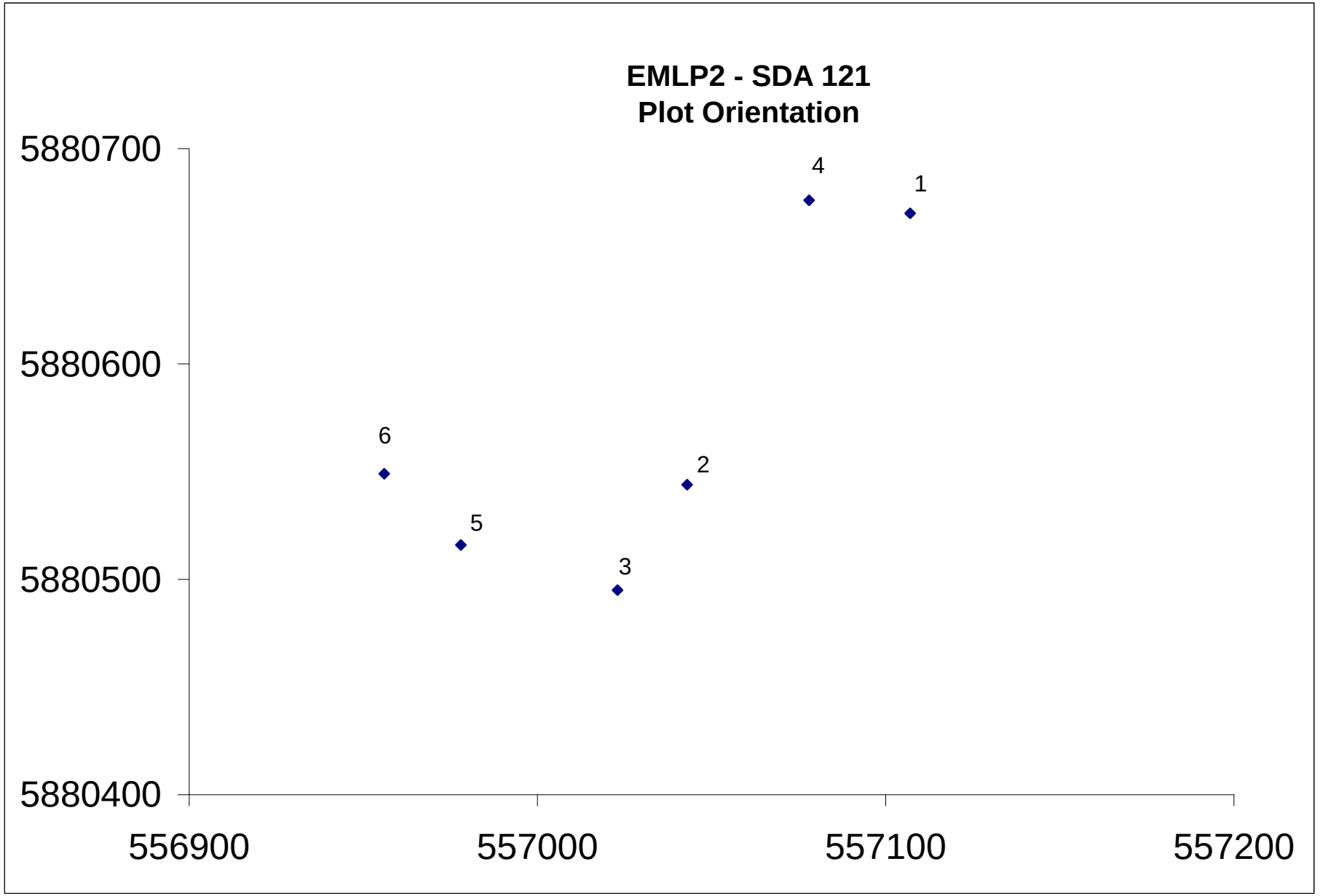

EMLP2 - WCG 65070046
Plot Orientation
6086800
6086700
311900
312000
312100
1
2
3
4
5
6

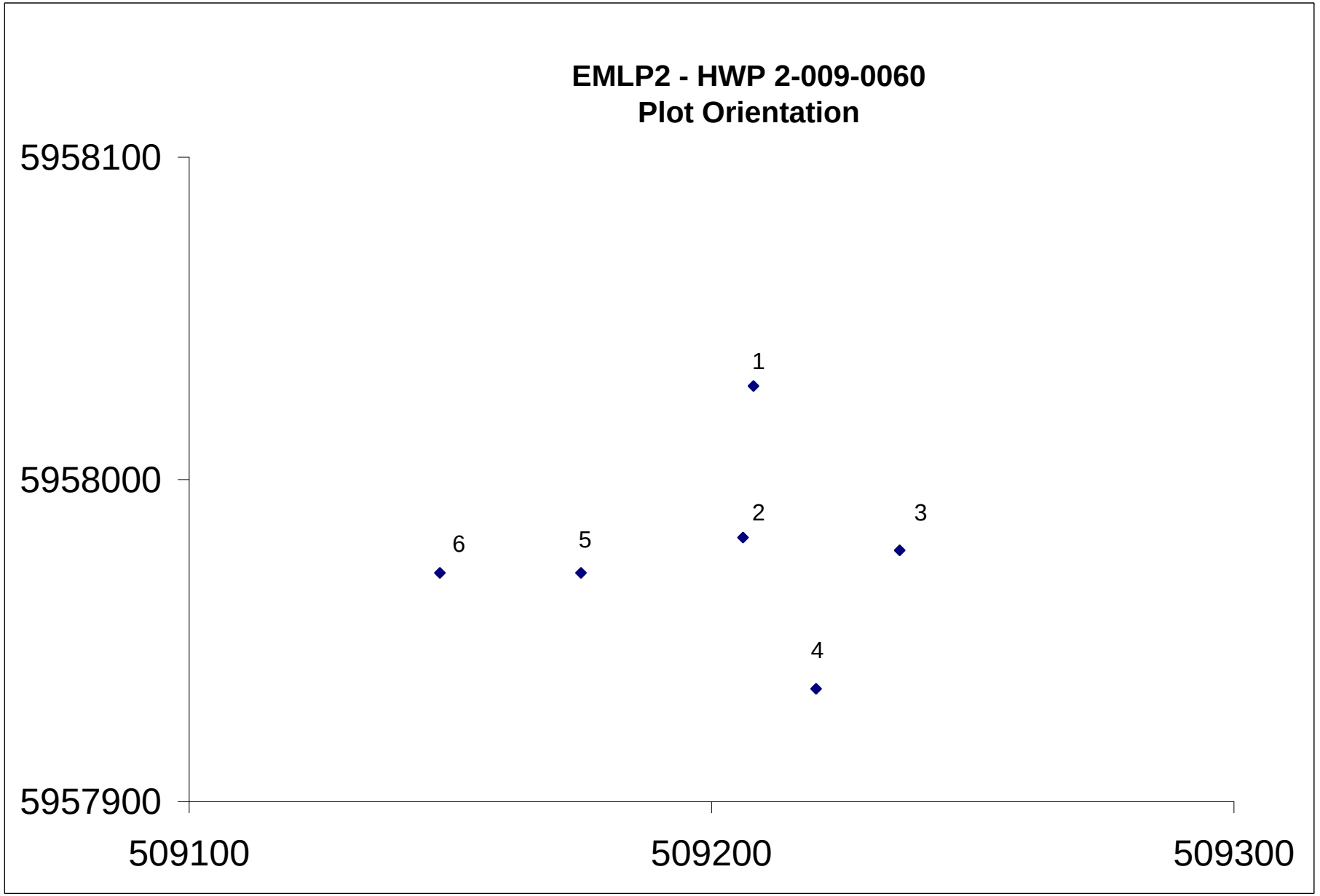

EMLP2 - CFG S19904
Plot Orientation
6033100
6033000
6032900
433900
434000
434100
434200
1
2
3
4
5
6

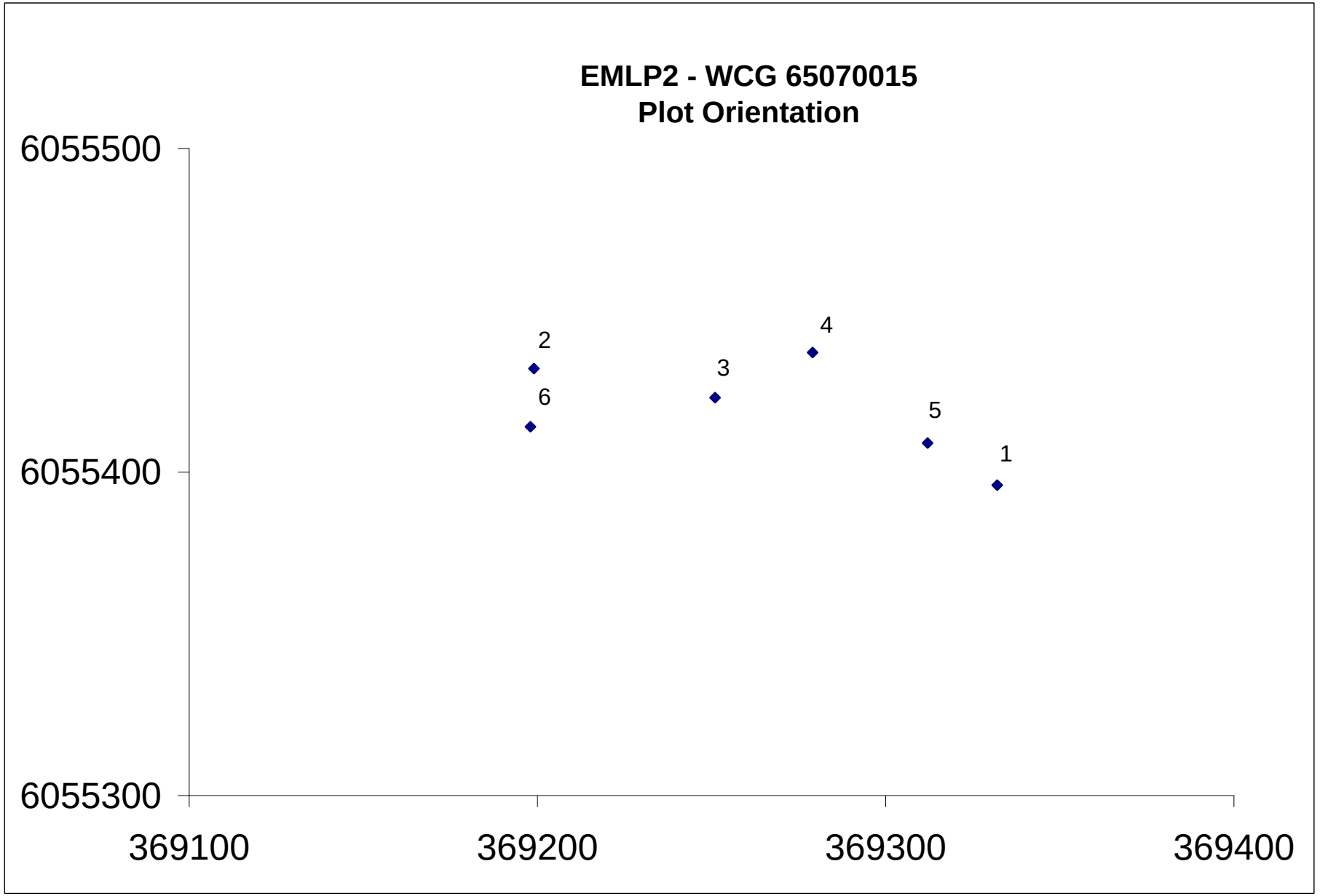

EMLP2 - MWW ER 129-418
Plot Orientation
6023900
6023800
6023700
547200
547300
547400
6
3
4
2
5
1

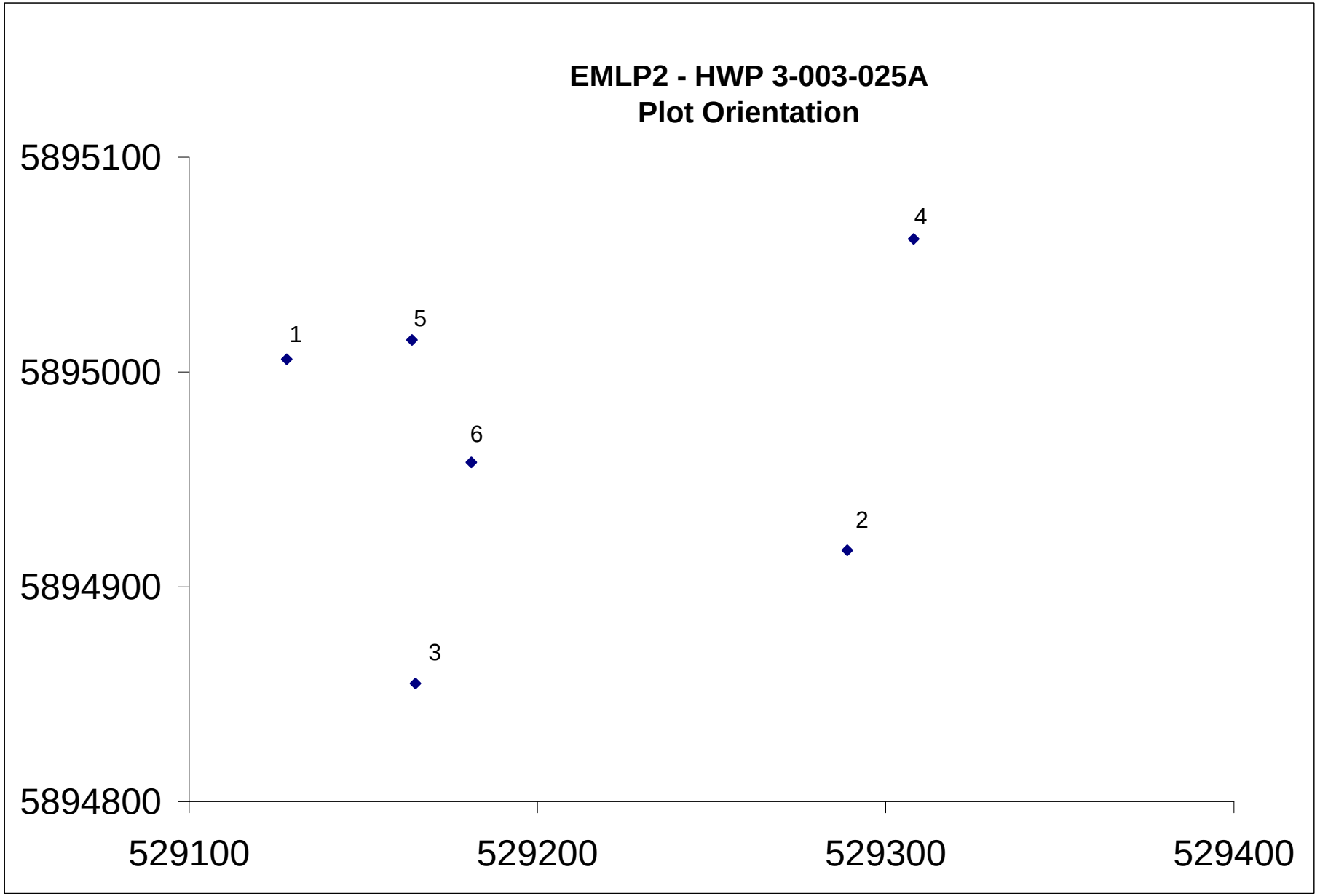

EMLP2 - HWP 2-007-0596
Plot Orientation
5958100
5958000
5957900
522100
522200
522300
3
6
2
4
1
5

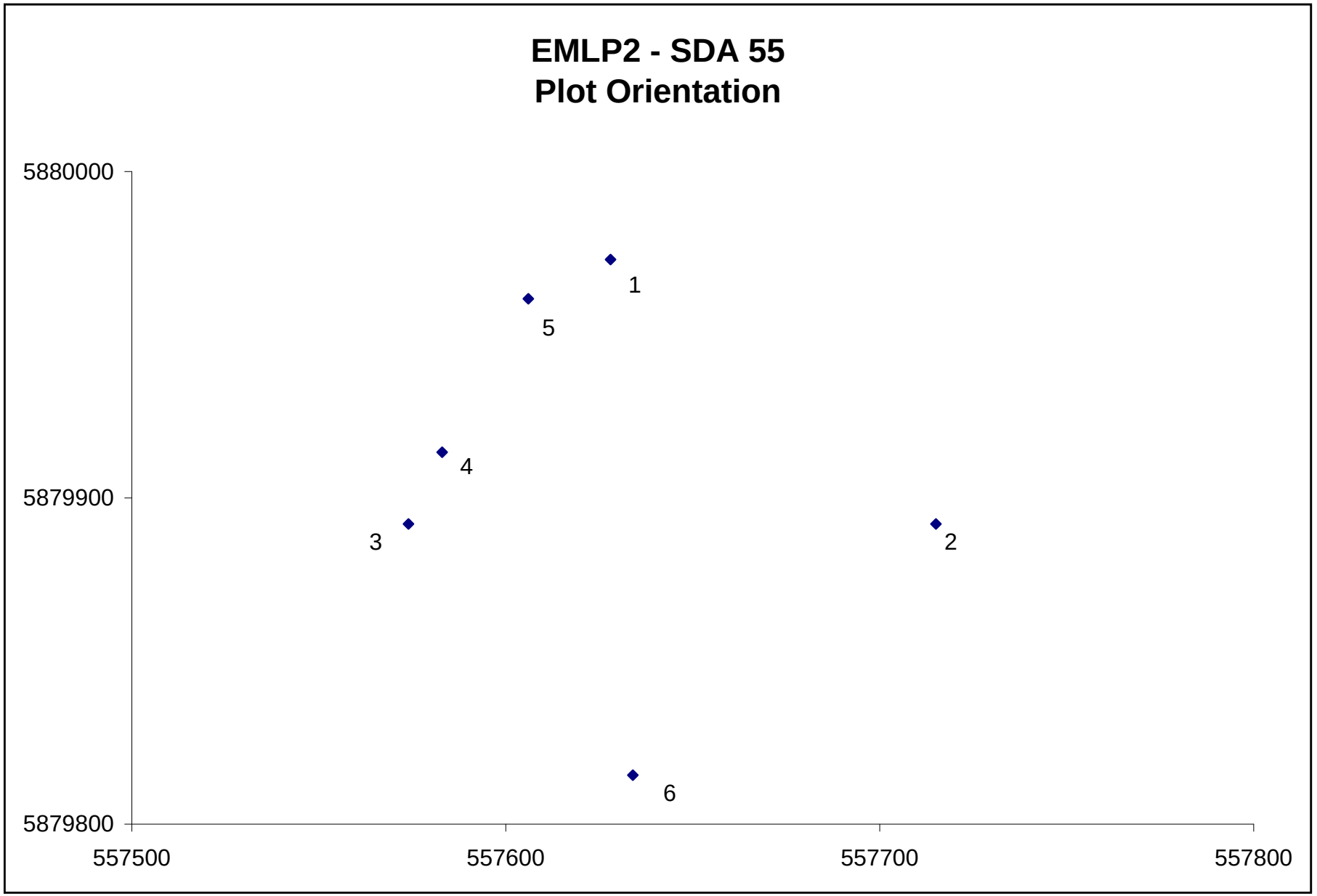

EMLP2 - SDA 120
Plot Orientation
5880100
5880000
5879900
5879800
556800
556900
557000
557100
1
4
5
3
6
2

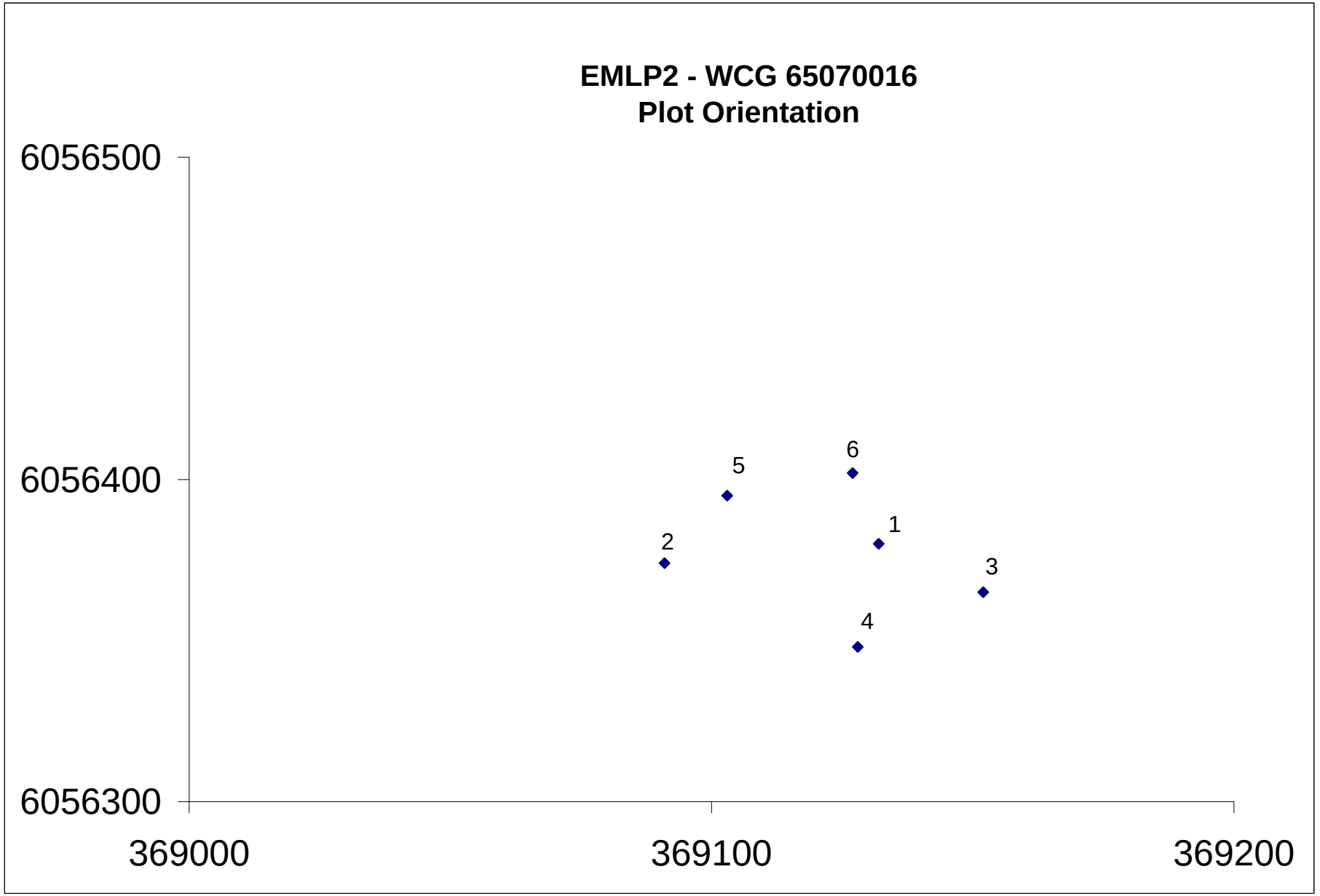

EMLP2 - SDA 121
Plot Orientation
5880700
5880600
5880500
5880400
556900
557000
557100
557200
1
2
3
4
5
6

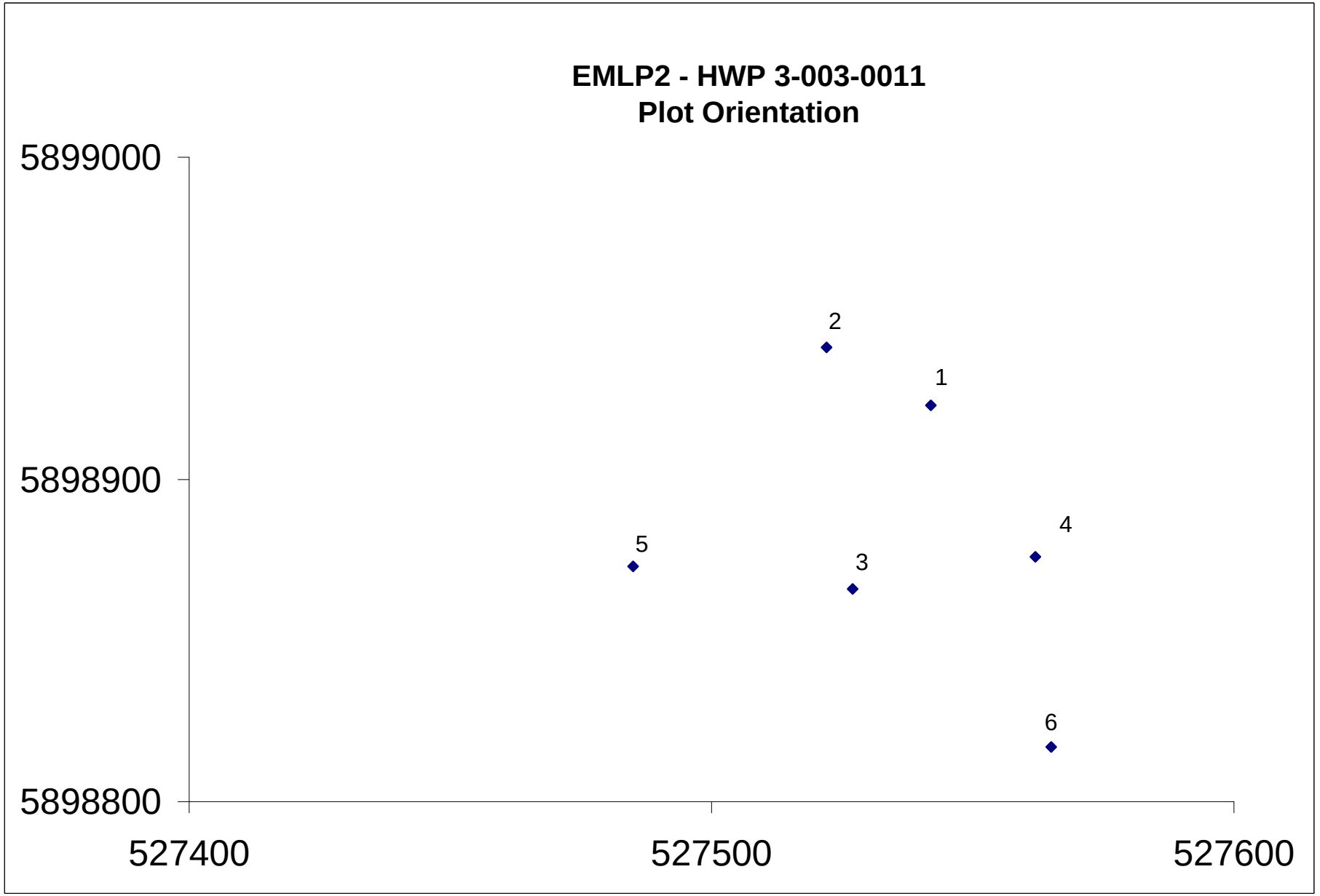

EMLP2 - HWP 2-009-0060
Plot Orientation
5958100
5958000
5957900
509100
509200
509300
1
2
3
4
5
6

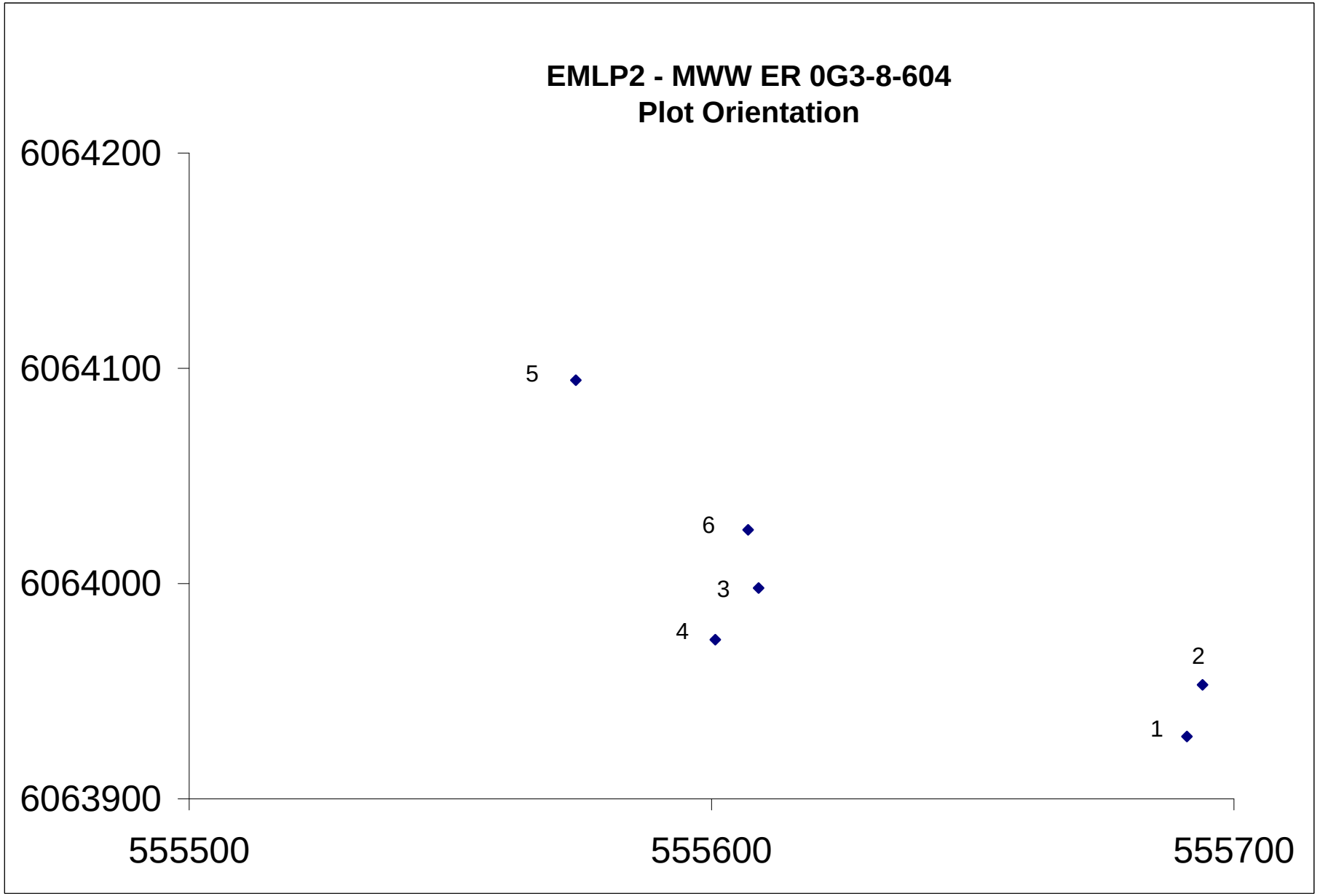

EMLP2 - WCG 65070015
Plot Orientation
6055500
6055400
6055300
369100
369200
369300
369400
2
3
4
6
5
1

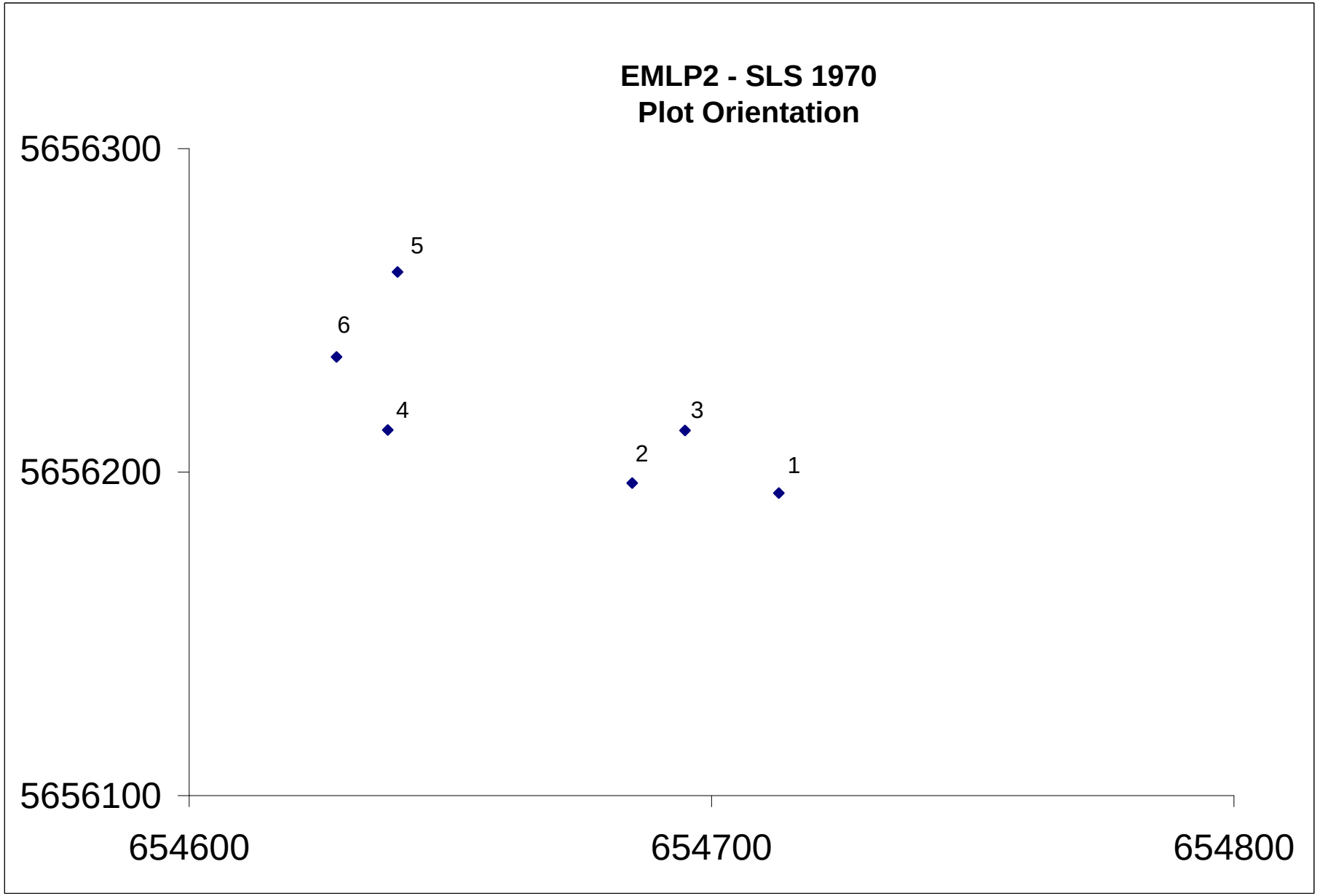

EMLP2 - HWP 3-003-025A
Plot Orientation
5895100
5895000
5894900
5894800
529100
529200
529300
529400
1
2
3
4
5
6

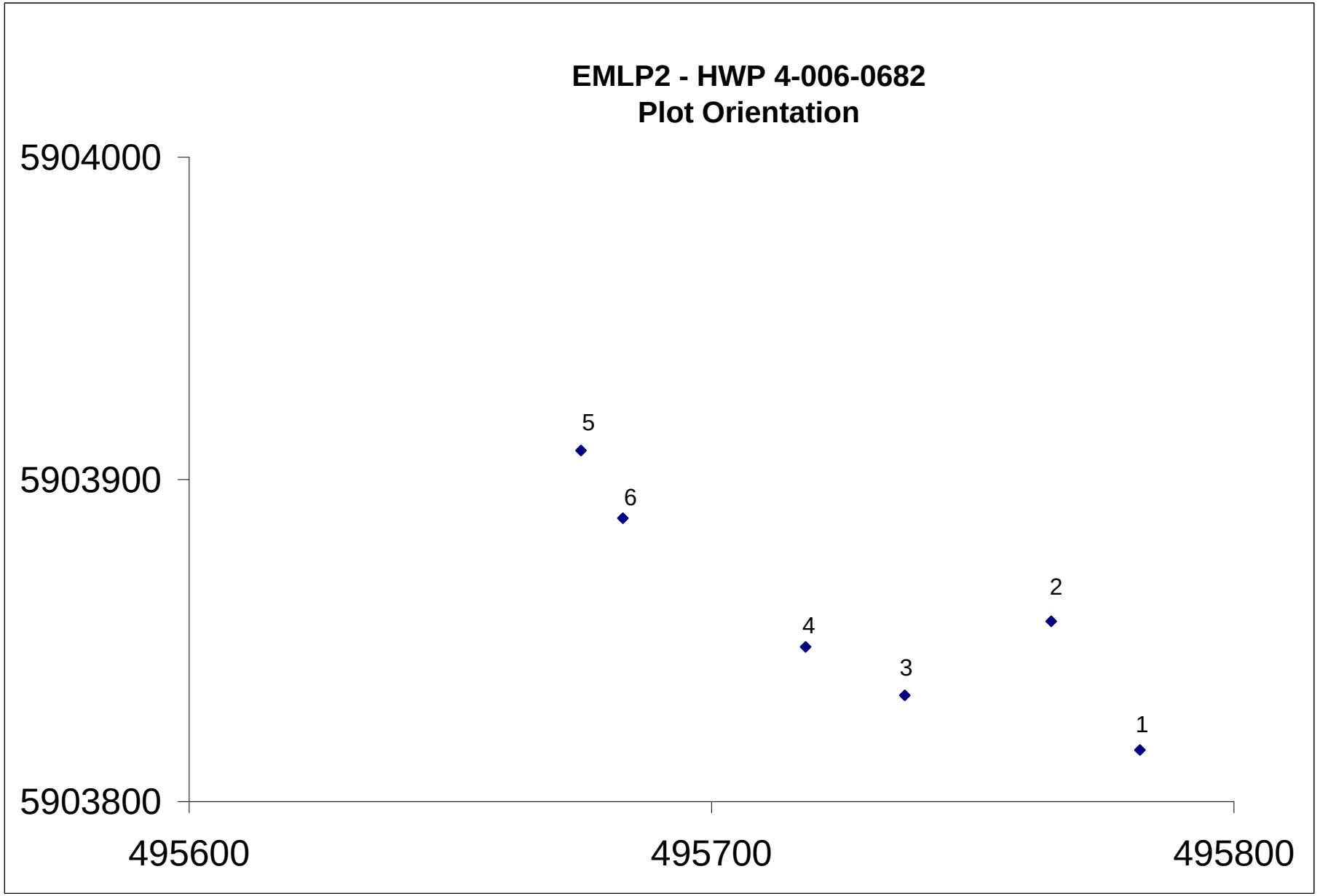

EMLP2 - SDA 55
Plot Orientation
5880000
5879900
5879800
557500
557600
557700
557800
1
5
4
3
2
6


EMLP2 - WCG 65070016
Plot Orientation
6056500
6056400
6056300
369000
369100
369200
1
2
3
4
5
6


EMLP2 - HWP 3-003-0011
Plot Orientation
5899000
5898900
5898800
527400
527500
527600
1
2
3
4
5
6


EMLP2 - MWW ER 0G3-8-604
Plot Orientation
6064200
6064100
6064000
6063900
555500
555600
555700
5
6
3
4
2
1


EMLP2 - SLS 1970
Plot Orientation
5656300
5656200
5656100
654600
654700
654800
5
6
4
3
2
1


EMLP2 - HWP 4-006-0682
Plot Orientation
5904000
5903900
5903800
495600
495700
495800
5
6
4
2
3
1