Chemical Soil Background Study
for the
Santa Susana Field Laboratory

Background Study Update

Department of Toxic Substances Control
SSFL Project Team

July 2012
Chatsworth

Technical Roundtable Meeting
Introduction

Agenda:

Meeting's Main Goal

Statistics & Background Threshold Values (BTVs)

Conclusions & Recommendations
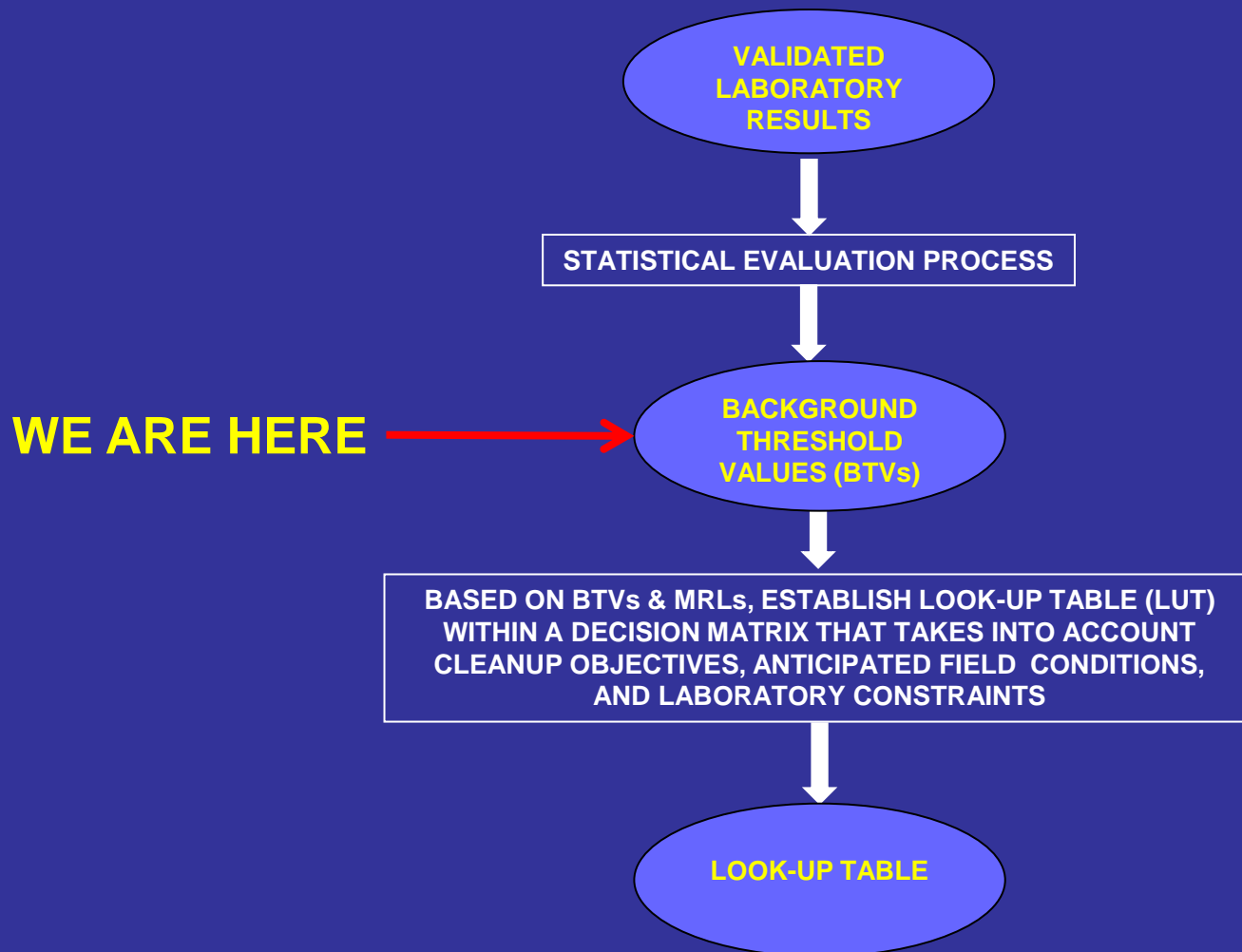
Group Discussion

Wrap-up

Technical Roundtable Meeting
Introduction

Meeting's Main Goal:

➢ **Understand Study's Data, Statistics, and Data Use(s)**

 ❖ **Briefly Revisit Data Sources**
 ❖ **Summarize Statistical Analyses & Results**
 ❖ **Discuss Example - Arsenic**

Technical Roundtable Meeting
Introduction

VALIDATED LABORATORY RESULTS

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STATISTICAL EVALUATION PROCESS

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WE ARE HERE → **BACKGROUND THRESHOLD VALUES (BTVs)**

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BASED ON BTVs & MRLs, ESTABLISH LOOK-UP TABLE (LUT) WITHIN A DECISION MATRIX THAT TAKES INTO ACCOUNT CLEANUP OBJECTIVES, ANTICIPATED FIELD CONDITIONS, AND LABORATORY CONSTRAINTS

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LOOK-UP TABLE

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Statistical Evaluation Process
BTVs In Remedial Strategies

Cleanup to Background Levels:

- DOE and NASA Administrative Orders on Consent (AOCs) require cleanup to either background levels or lab method reporting limits (MRLs).

  - For SSFL on-site samples exceeding BTV-derived LUT values, resample and remediate if analytical results are reproducible.
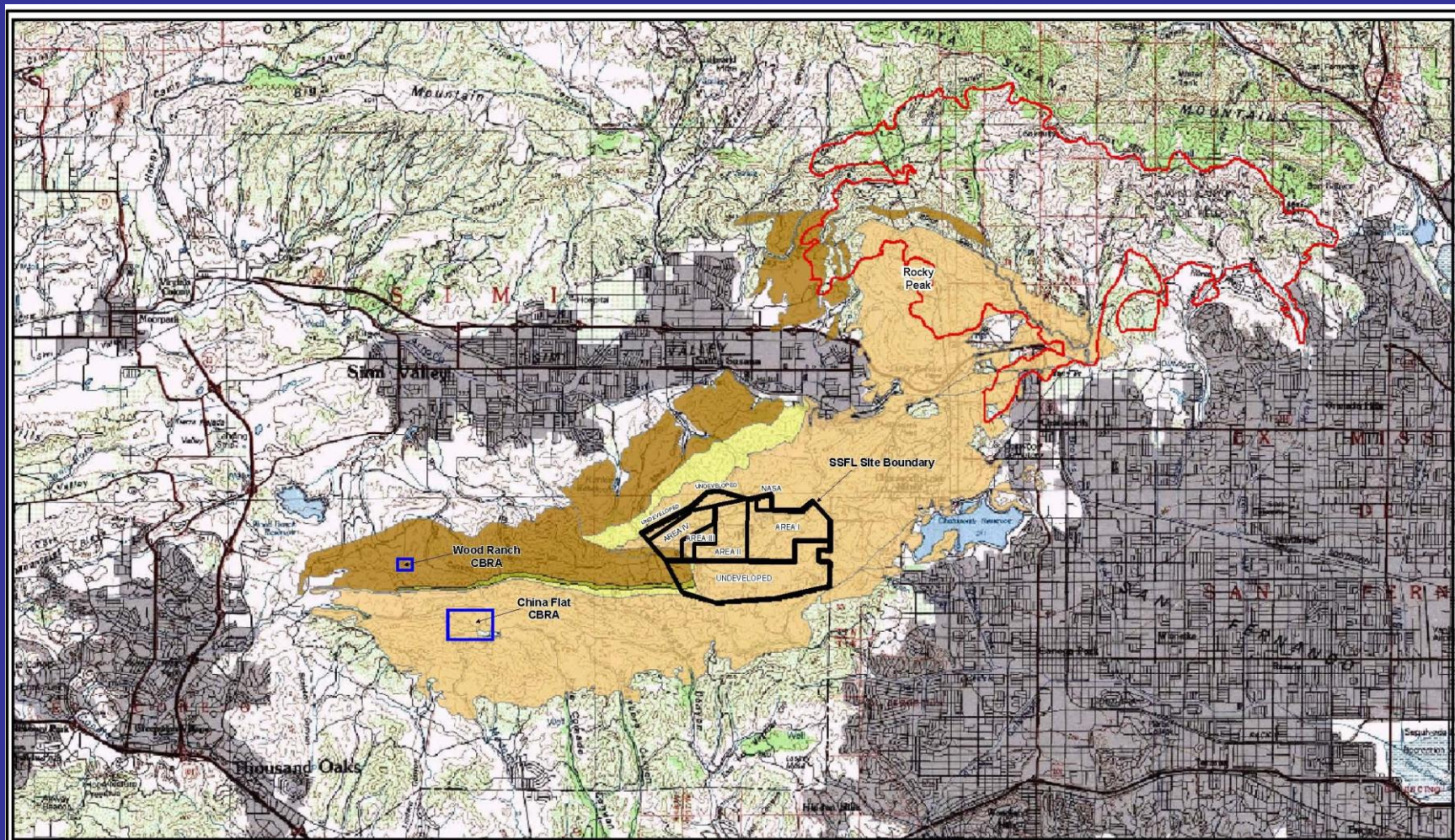
Chemical Soil Background Study Objectives:

- ➢ **Obtain data that represent BTVs.**

- ➢ **Provide results to be used in the process that develops the basis for determining the extent of soil contamination and ultimate cleanup decisions at SSFL.**
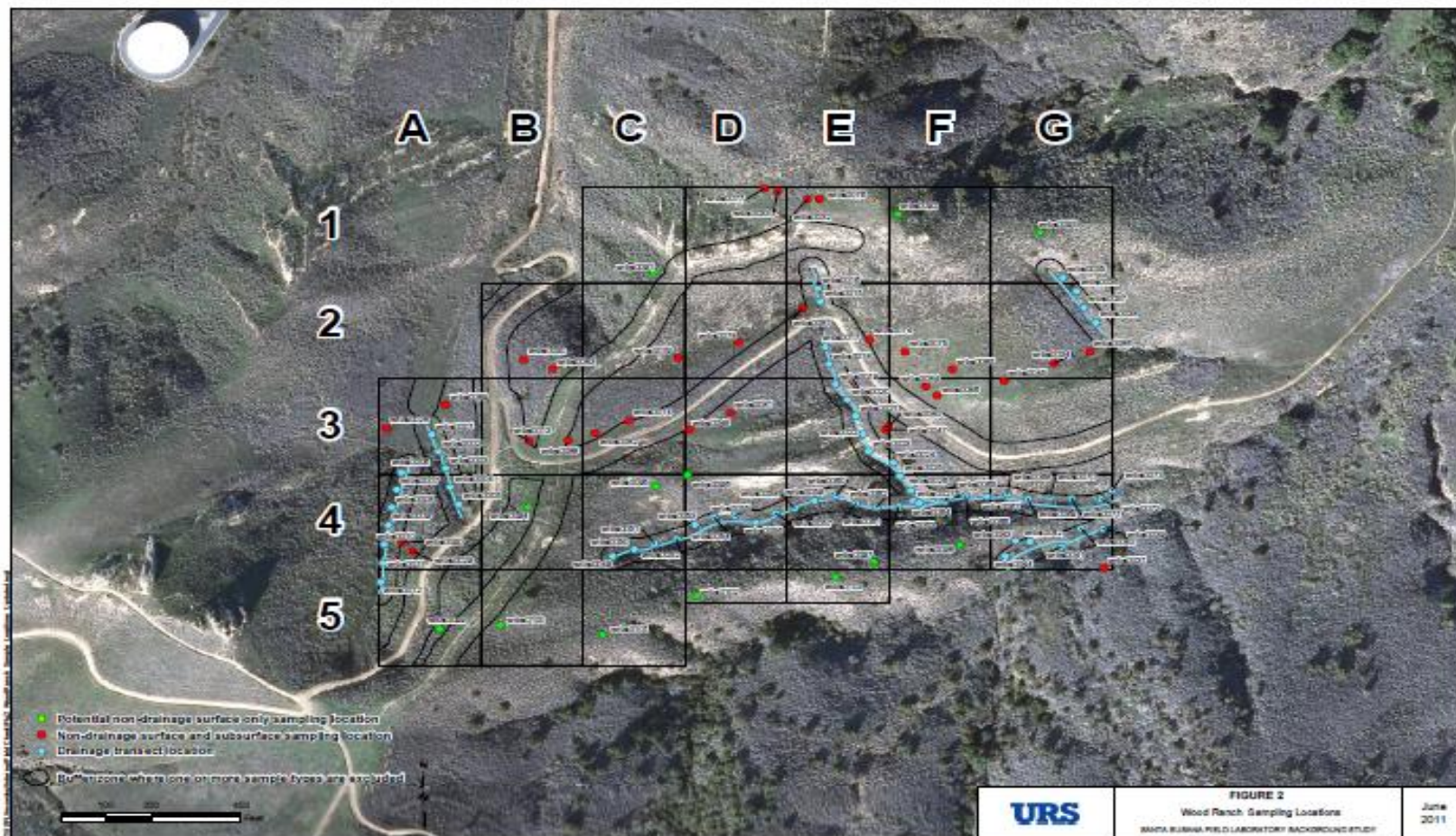
Chemical Soil Background Study
Wood Ranch Final Locations

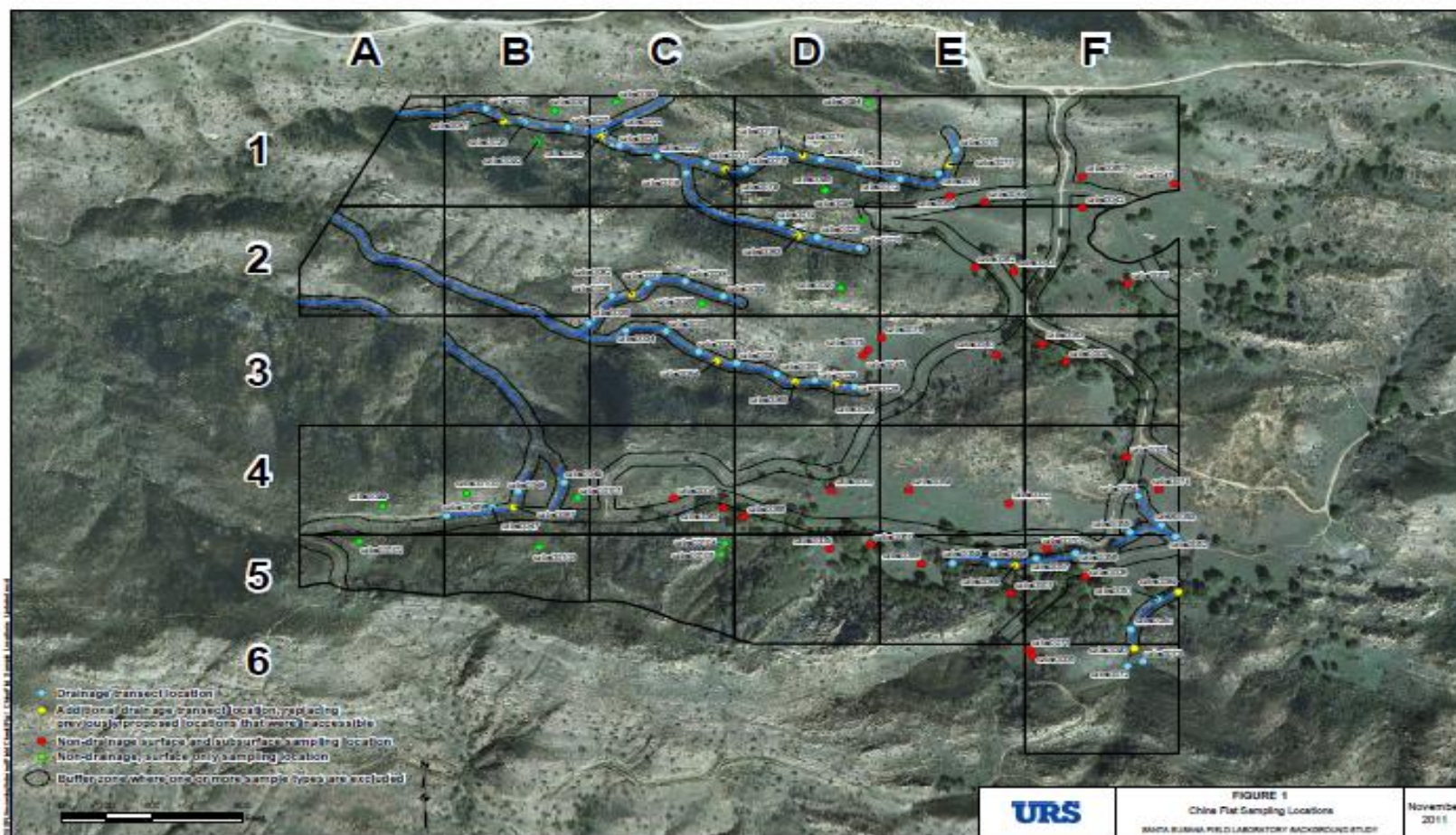**Total Sampling Locations = 103 (Santa Susana Fm.)**

Chemical Soil Background Study
China Flat Final Sample Locations

Total Sampling Locations = 105 (Chatsworth Fm.)

Chemical Soil Background Study
Samples & Results

Primary soil samples = 268

Chemical analytes = 111

Total number of individual chemical analytical results = 24,678

✓ Data Are Valid & Useable For The Intended Purposes.

Reference:
Department of Toxic Substances Control. 2011. *Sampling and Analysis Plan, Chemical Soil Background Study, Santa Susana Field Laboratory, Ventura County, California*, May.

"Organic" typically means the compound contains carbon (e.g., oils, proteins, etc.). In our study, it includes dioxins, herbicides and pesticides, poly-aromatic hydrocarbons, phthalates, and alcohols.

"Inorganic" involves metals. In our study, it also includes perchlorate.

Statistical Evaluation Process

BTV Derivation

Chemical Soil Background Study
Strata and Samples

Stratum ID	Sample Population (Stratum)	Depth	Number of Samples Proposed	Number of Samples Analyzed
STRATA FOR INORGANIC ANALYTES				
1	Chatsworth Non-Drainage	Surface & Subsurface	60 (30 Surface; 30 Subsurface)	75 (45 Surface; 30 Subsurface)
2	Chatsworth Drainage	Surface	60 Surface	60 Surface
3	Santa Susana Non-Drainage	Surface & Subsurface	60 (30 Surface; 30 Subsurface)	73 (43 Surface; 30 Subsurface)
4	Santa Susana Drainage	Surface	60 Surface	60 Surface
STRATA FOR ORGANIC ANALYTES				
5	Combined Formation - Non-Drainage	Surface	60 (30 Chatsworth; 30 Santa Susana)	88 (45 Chatsworth; 43 Santa Susana)
6	Combined Formation - Drainage	Surface	60 (30 Chatsworth; 30 Santa Susana)	60 (30 Chatsworth; 30 Santa Susana)

Statistical Evaluation Process
Dataset Definitions

I. "Initial" Datasets

For each analyte, "initial" datasets assembled from validated results for each of the six geomorphological groups or "strata."
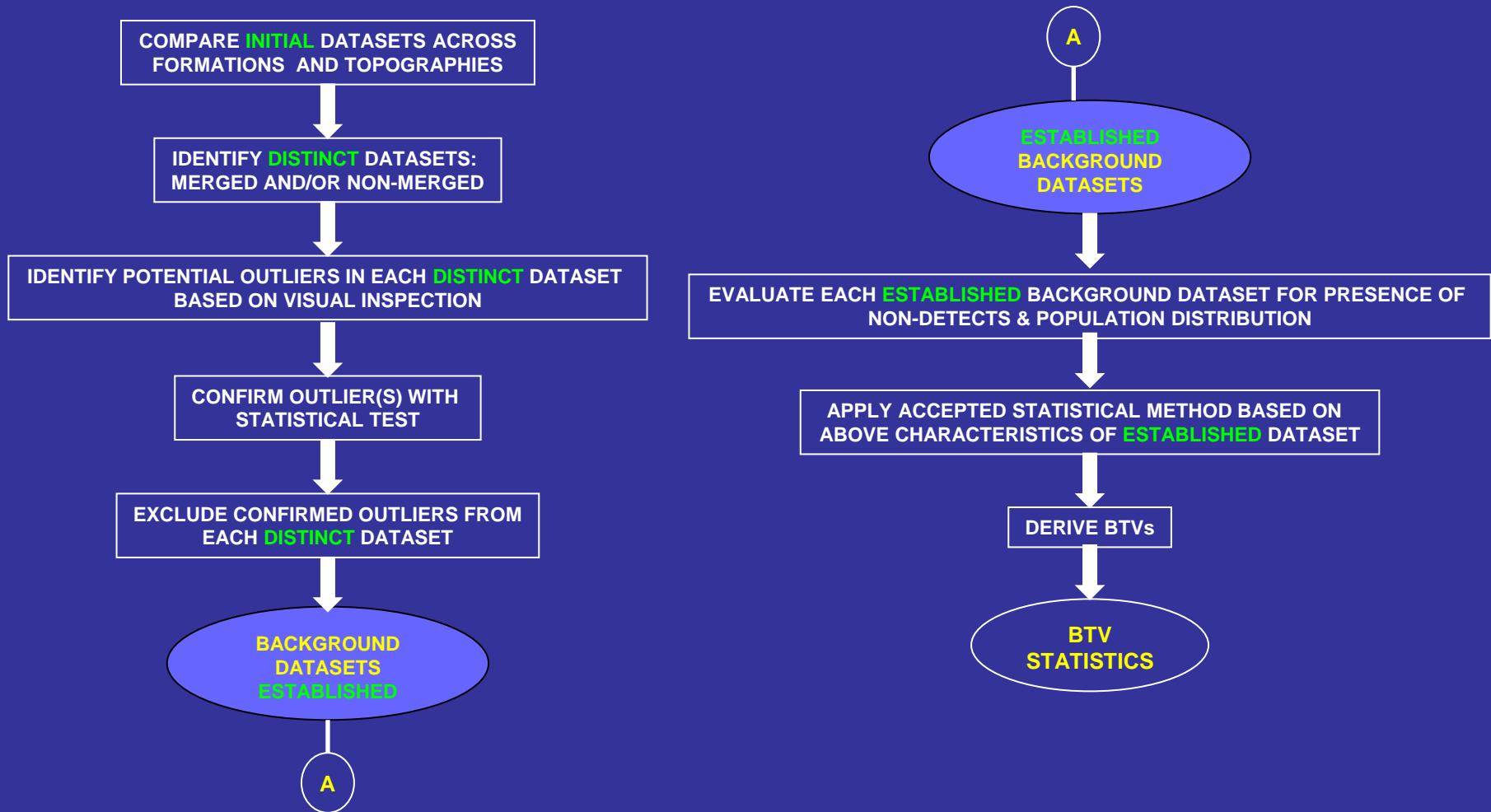
II. "Distinct" Datasets

"Initial" datasets, with no statistically significant differences, were merged and remainder retained as individual datasets. Resulted in one or more "distinct" datasets identified for each analyte.

III. "Established" Datasets

Potential outliers (if any) identified, confirmed outliers (if any) excluded from the "distinct" dataset. Resulted in one or more "established" datasets for each analyte. Statistics computed separately for each "established" dataset.

Statistical Evaluation Process
Establish Datasets & Derive BTVs

COMPARE INITIAL DATASETS ACROSS FORMATIONS AND TOPOGRAPHIES

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IDENTIFY DISTINCT DATASETS: MERGED AND/OR NON-MERGED

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IDENTIFY POTENTIAL OUTLIERS IN EACH DISTINCT DATASET BASED ON VISUAL INSPECTION

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CONFIRM OUTLIER(S) WITH STATISTICAL TEST

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EXCLUDE CONFIRMED OUTLIERS FROM EACH DISTINCT DATASET

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BACKGROUND DATASETS ESTABLISHED

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ESTABLISHED BACKGROUND DATASETS

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EVALUATE EACH ESTABLISHED BACKGROUND DATASET FOR PRESENCE OF NON-DETECTS & POPULATION DISTRIBUTION

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APPLY ACCEPTED STATISTICAL METHOD BASED ON ABOVE CHARACTERISTICS OF ESTABLISHED DATASET

↓

DERIVE BTVs

↓

BTV STATISTICS

Statistical Evaluation Process
Candidate BTV Statistics

Four statistics were considered as candidates for BTVs, representing inorganic and organic analytes:

- **95th Upper Percentile**
- **95% Upper Prediction Limit (UPL95)**
- **95%-95% Upper Tolerance Limit (UTL95-95)**
- **95% Upper Simultaneous Limit (USL95)**

Statistical Evaluation Process
"False Positive" versus "False Negative"

I. When A Clean Sample Is Judged "Contaminated" (False Positive)

Incorrectly concluding that a clean sample is contaminated.

II. When A Contaminated Sample Is Judged "Clean" (False Negative)

Incorrectly concluding that a contaminated sample is clean.

Statistical Evaluation Process
Candidate BTV Statistics

#1 95th Upper Percentile

- **Does not take into account the variability of <u>future SSFL on-site observations</u>. As a result, many future observations (e.g., on-site "clean" observations) may exceed the 95th Upper Percentile, resulting in a large number of false positives.**

Statistical Evaluation Process
Candidate BTV Statistics

#2 95% Upper Prediction Limit (UPL95)

- **Recommended only when a small number of future comparisons need to be made.**

- **When many observations (as at SSFL) are compared, the use of the UPL95 may result in a large number of false positives.**

Statistical Evaluation Process
Candidate BTV Statistics

#3 95% Upper Tolerance Limit w/ 95% Coverage (UTL95-95)

- About 5% of "clean" observations would be expected to exceed UTL95-95, resulting in a **significant number of false positives, but fewer false negatives (compared to USL95).**

#4 <u>95% Upper Simultaneous Limit (USL95)</u>

- **USL95 is based on an *established* background dataset and represents an estimate such that <u>*all*</u> "clean" observations are less than or equal to USL95, with 95% confidence.**

- **USL may be used when many and/or an unknown number of future on-site observations need to be compared with BTV.**

- **USL95 Reduces false positives, but increases false negatives (compared to UTL95-95).**

Statistical Evaluation Process
Statistical "Ground Rules"

- "J"-flagged data are included as detected values.

- A minimum of five (5) detected values was necessary to conduct the statistical calculations and derive BTVs.

- For datasets with less than five (5) detected values, BTV derivation is "non-statistical" - MRL recommended as BTV (or ND for datasets with all non-detects).

- Outliers specifically excluded from statistical calculations and BTV derivations - excluding outliers acts to control the number of false negatives.

Statistical Evaluation Process
Box & Whisker Plot

- Graphical representation of population median and range of observations
- Used to visually compare two or more datasets
- Potential outliers confirmed by statistical test

Example – Arsenic

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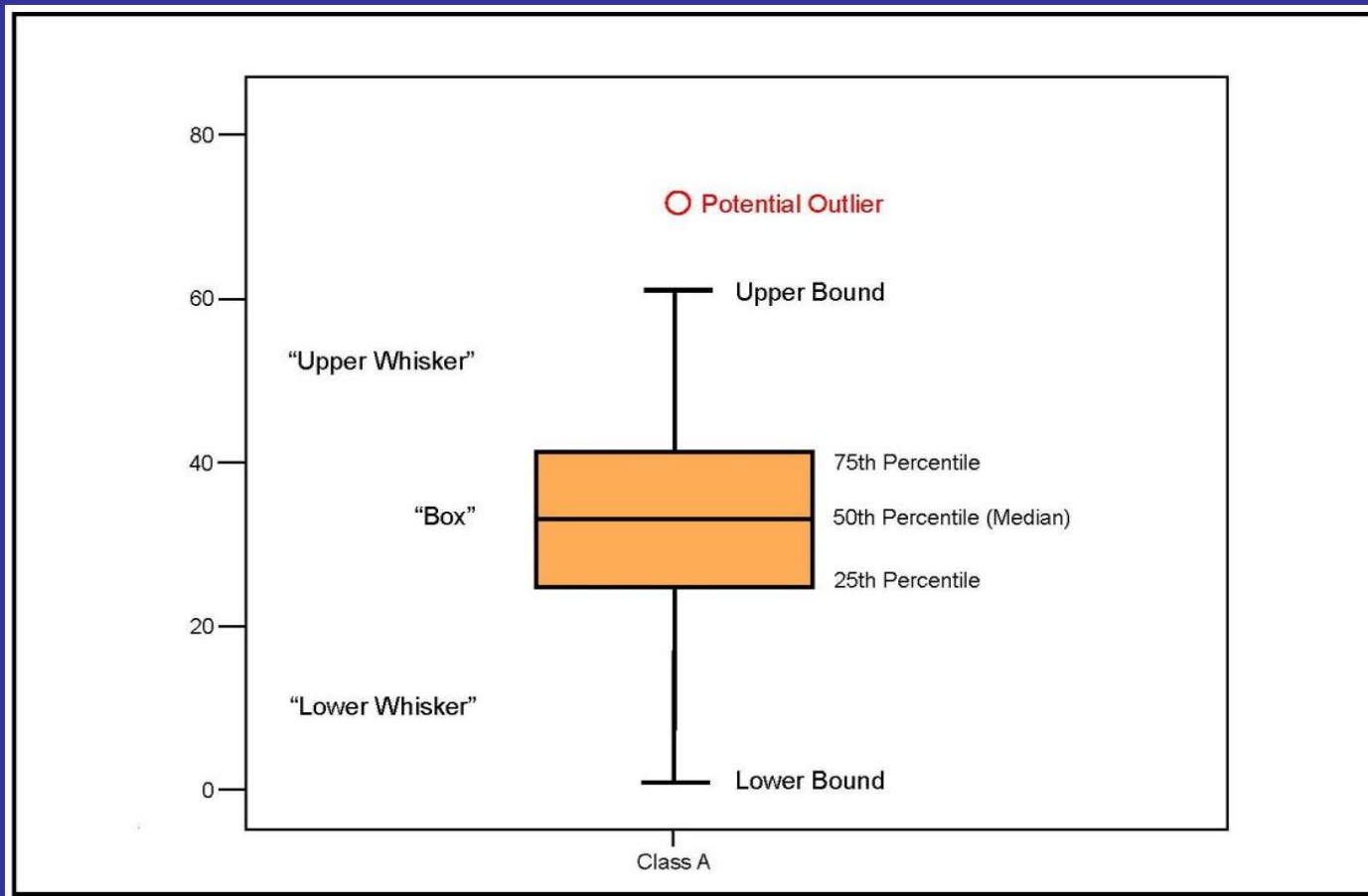
Box Plot - Arsenic (Metal)
Four *Initial* Datasets

1 additional detection at 183 mg/kg

Box Plots for Arsenic Concentration (mg/kg)

Observed Data

| Chatsworth / Drainage | Chatsworth / Non-Drainage | Santa Susana / Drainage | Santa Susana / Non-Drainage |
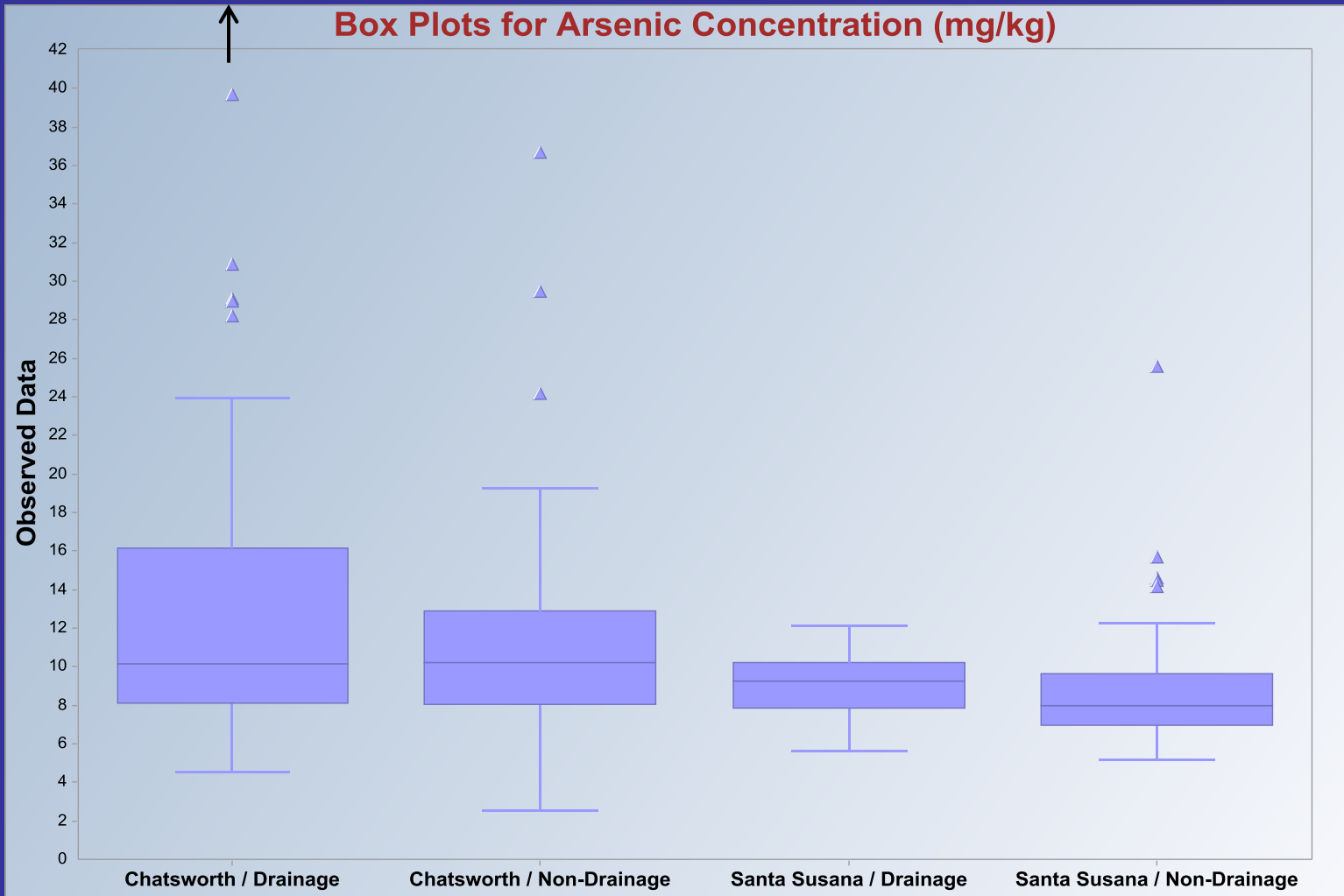
n = No. of Samples   n = 60   n = 75   n = 60   n = 73

Box Plot for Arsenic Conc (mg/kg)
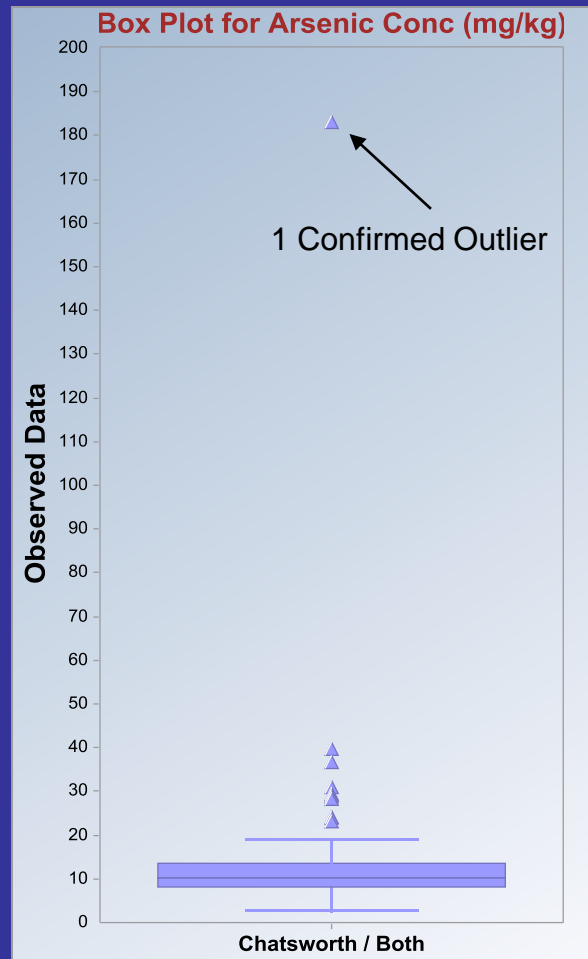
1 Confirmed Outlier

Observed Data

Chatsworth / Both

n = No. of Samples
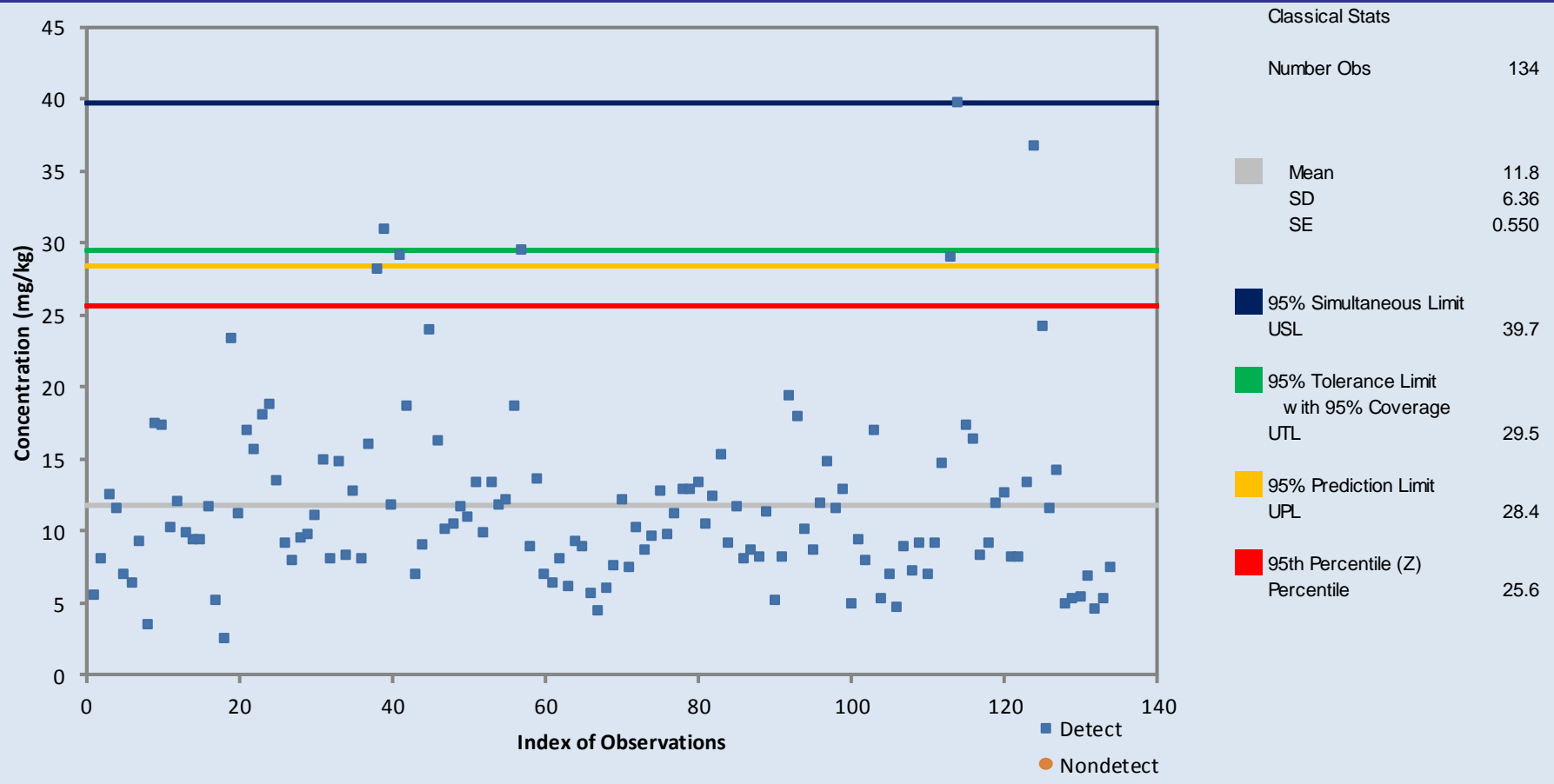
n = 135

26
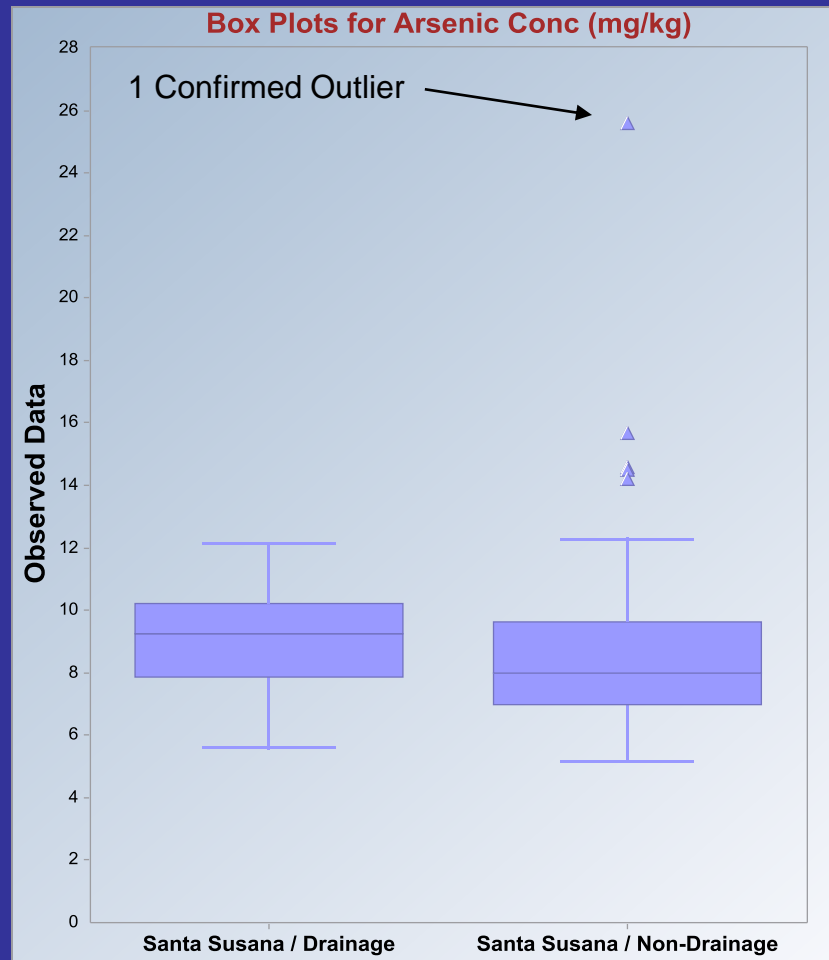
n = No. of Samples

n = 60   n = 73

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Scatter Plot - Arsenic
Chatsworth Formation; Both Topographies
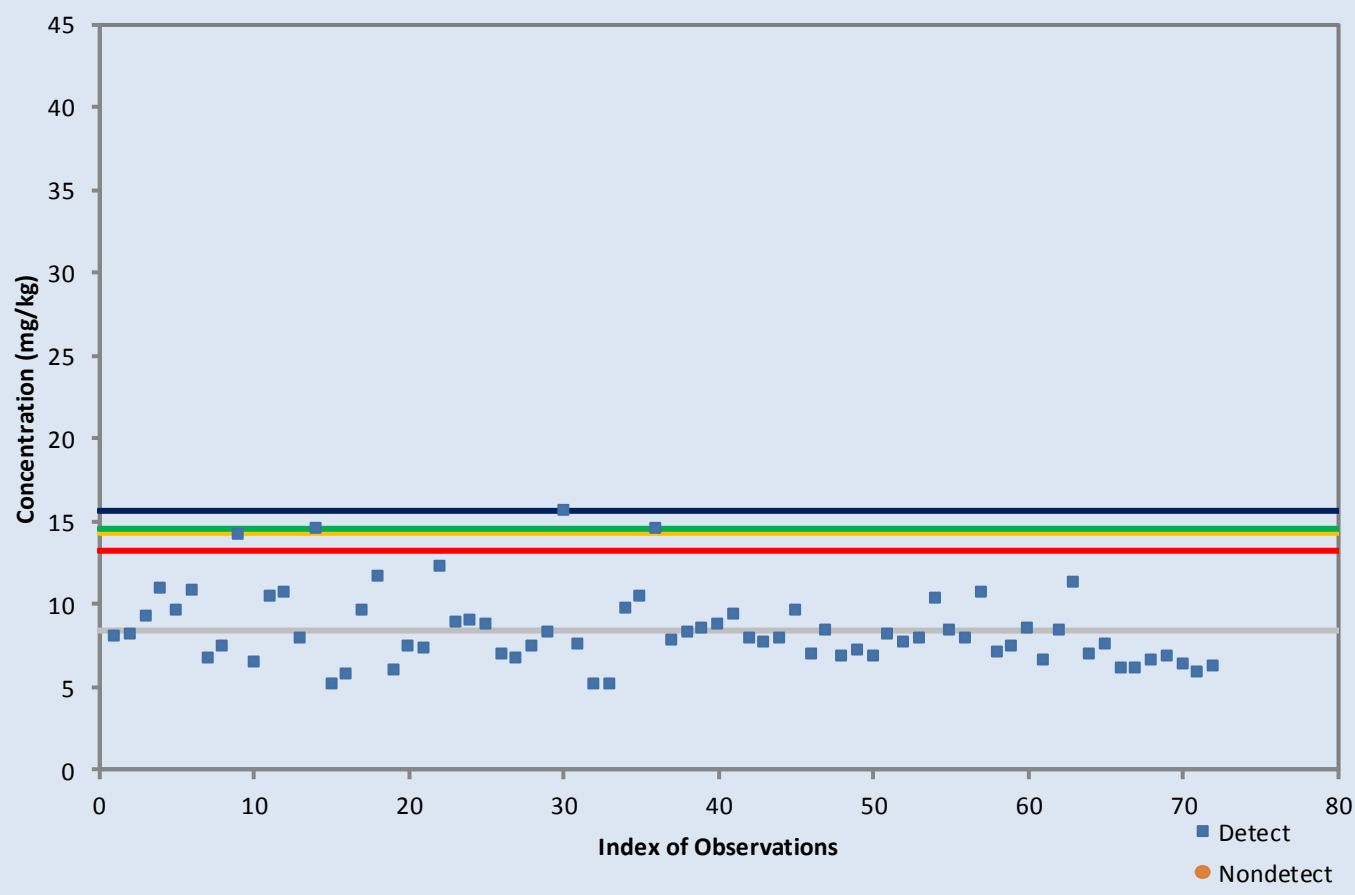First *Established* Dataset ("Nonparametric")

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Scatter Plot - Arsenic
Santa Susana Formation; Non-Drainage
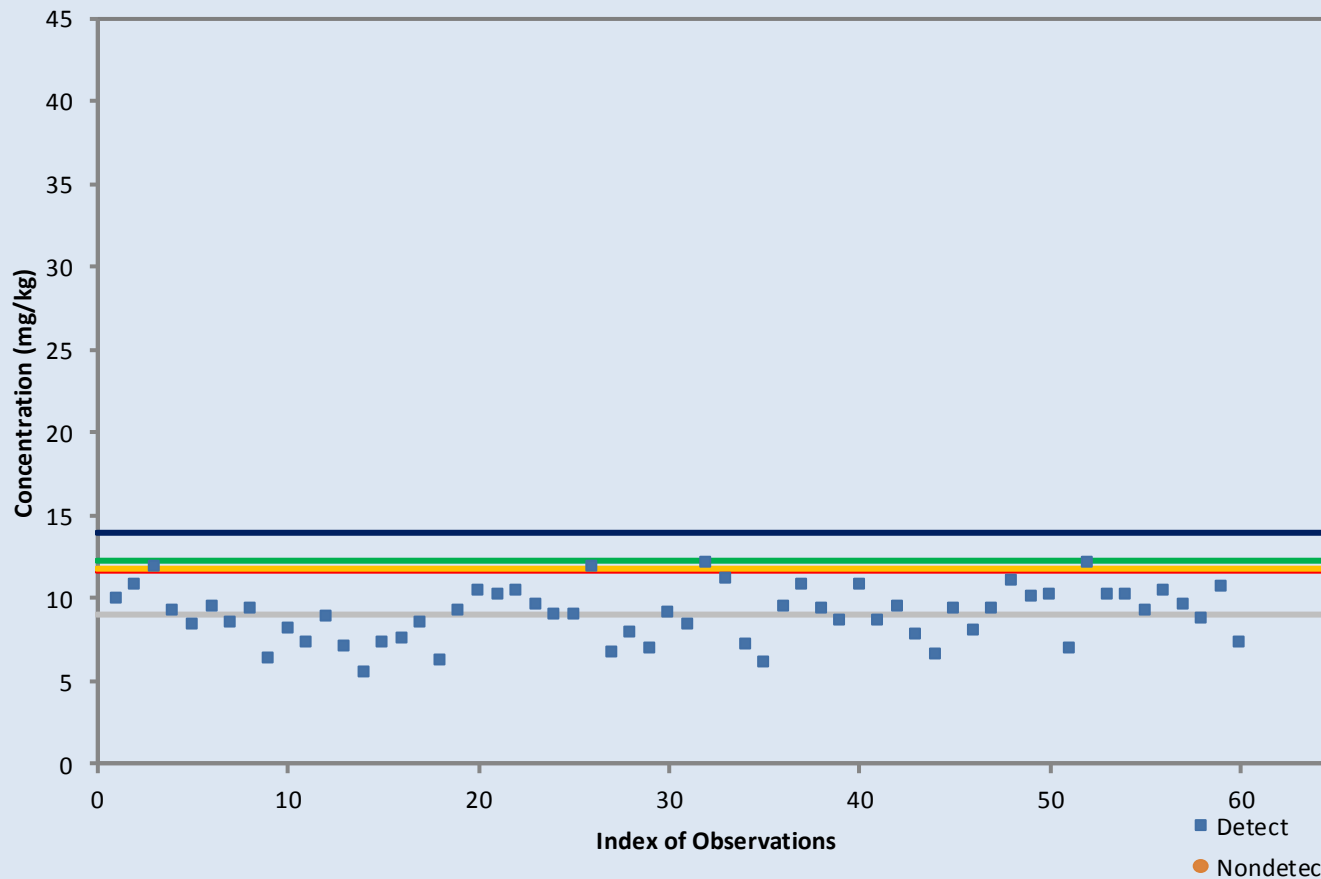# Second *Established* Dataset ("Nonparametric")

Scatter Plot - Arsenic
Santa Susana Formation; Drainage
Third *Established* Dataset ("Normal")

Statistical Summary
Arsenic

Analyte Class	Analyte	Unit	Formation	Topography	Background Threshold Values (BTVs)			
					95th Percentile	UPL95	UTL95-95	USL95
METAL	Arsenic	mg/kg	Chatsworth	Both	25.6	28.4	29.5	39.7
			Santa Susana	Non-Drainage	13.2	14.3	14.6	15.7
			Santa Susana	Drainage	11.7	11.8	12.3	13.9

Conclusion & Recommendations

Chemical Soil Background Study
Conclusion & Recommendations

- **The background data represent true background.**

- **Under the AOC process, the USL95 statistic is recommended for deriving BTVs:**
  - **A very large number of analyte-by-analyte and sample-by-sample comparisons will be made.**

  - **For a given dataset, USL95 reduces false positives, when compared to UTL95 and when properly applied.**

- **Use finalized BTVs as basis for preparing the Look-Up Tables.**

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Table Handout

Summary Statistical Evaluation

Group Discussion

Technical Roundtable Meeting

Study Report

Public Review & Comments

Follow-Up Meeting

Chemical Soil Background Study
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Technical Roundtable Meeting

Group Discussion & Wrap-Up