

APPENDIX A

**EVALUATION OF JUVENILE SWINE AS A MODEL
FOR GASTROINTESTINAL ABSORPTION
IN YOUNG CHILDREN**

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1.0 INTRODUCTION

Ideally, the reliability of an animal model as a predictor for toxicokinetic responses in humans would be based on a direct comparison of results in humans and the animal species under consideration. However, because intentional dosing of children with lead is not feasible, a direct comparison of lead absorption results in swine with that for children is not possible. Nevertheless, the relevance of the swine as an animal model for lead absorption can be evaluated by comparing a number of physiological attributes of the gastrointestinal system that are likely to be important in influencing the degree to which lead in ingested soil material is released from its soil or mineral matrix to form soluble compounds that can be absorbed into the body. Factors that may affect dissolution include gastric acidity and gastric holding time, which determine the exposure of the ingested material to the acidic environment of the stomach, where dissolution initially occurs. Morphological and physiological factors in the small intestine, where absorption of lead is thought to occur, may also affect RBA; however, these are likely to be less important for those soil materials for which solubility is the limiting factor for RBA.

Weis and LaVelle (1991) and Casteel et al. (1996) determined that gastric function in juvenile swine is sufficiently similar to that of human children so that juvenile swine could serve as a model for predicting RBA of soil-borne lead in children. This view is supported by several reviews on the comparative anatomy and physiology of the human and pig gastrointestinal systems (Dodds, 1982; Miller and Ullrey, 1987; Moughan et al., 1992; Pond and Houpt, 1978) and, in particular, the following pertinent observations.

2.0 GASTROINTESTINAL TRACT MORPHOLOGY AND HISTOLOGY

The anatomy of the neonatal digestive system in the pig and human are very similar (Moughan et al., 1992). The body-weight adjusted ratios of intestinal length to stomach volume in the child and piglet are comparable, as shown below:

Species	Stomach Volume (cm ³ /kg)	Small Intestine Length (cm/kg)	Large Intestine length (cm/kg)	Small intestine length/stomach volume	Large intestine length/stomach volume
Human	9.6	95.6	19.4	9.96	4.93
Swine	28.9	229.2	59.6	7.93	3.85

Source: Moughan et al., 1992.

Birth body weights of 3.4 (human) and 1.3 (pig) kg were assumed.

The histology of the small intestine, colon, and rectum in the piglet is similar to that of the human (Moughan et al., 1992). Small anatomical differences between humans and swine would

not be expected to markedly affect digestion in the neonate (Moughan et al., 1992). The piglet is considered to be a useful model of the anatomical development of the human neonatal digestive tract (Moughan et al., 1992; Miller and Ullrey, 1987).

3.0 GASTRIC HOLDING TIMES

Gastric emptying time in humans is highly variable (USEPA, 2001). The rate of emptying of stomach contents varies depending on the type of food, the volume of the meal, and its caloric content. High caloric substances such as fat empty more slowly than carbohydrates. The most important factor effecting liquid gastric emptying is the caloric content of the liquid meal. Upright positioning and ambulation have been described to speed gastric emptying. Other factors that are believed to affect gastric emptying include the osmolality, acidity, and chain length of fatty acids in the meal. Differences in emptying may also exist between males and females. These factors tend to make direct comparisons of data from different reports difficult. Nevertheless, the available data do not suggest any substantial differences in gastric holding times between children and juvenile swine.

In the 4-week old pig, gastric emptying following a meal was rapid, with 30 to 40% passing into the duodenum within 15 minutes and the remaining portion of gastric contents following about one hour later (Pond and Houpt, 1978). Gastric pH did not affect gastric emptying time in juvenile swine (Pond and Houpt, 1978). In an unpublished study by Casteel (personal communication), gastric emptying in juvenile swine was shown to be influenced by feeding intervals, both pre- and post-dosing. The investigators reported rapid clearance of the bolus (complete within 2 hours) after an overnight fast; however, feeding 4 hours prior to dosing slowed completion of gastric emptying to 4 hours. Feeding at two hours post-dosing accelerated the movement of the residual gastric contents, although most of the bolus had already cleared the stomach.

In humans, gastric emptying time in neonates and premature infants is typically about 87 minutes, but can be as long as 6 to 8 hours, with adult values (typically about 65 minutes) being reached at 6 to 8 months of age (FDA, 1998; Balis, 2000).

4.0 GASTRIC ACIDITY

Direct comparisons of gastric acidity as a function of age in humans and swine are not available. However, available information on gastric acid secretion does not suggest there are any major differences that would affect extrapolation of RBA values measured in juvenile swine to humans. Agunod et al. (1969) reported that gastric acid output (corrected for body weight) reached normal adult levels in swine at 2 to 3 months post partum. In humans, gastric pH is neutral at birth, but drops to 1 to 3 within hours of birth. Gastric acid secretion then declines on days 10 to 30, and does not approach adult values until approximately 3 months of age (FDA, 1998). Nagita et al. (1996) reported that the intragastric pH of infants was <4 for only half of the day, whereas baseline pH in normal adults is <2. The development of maximal acid secretion in the pig also has some similarities to that of humans (Xu and Cranwell, 1990). In both the pig and human, maximal acid secretion correlates with age and body weight with pentagastrin,

histamine, and histalog used as secretagogues (Xu and Cranwell, 1990). A limitation of the available pig data is that all of the studies measure the maturation of gastric acid output rather than intragastric pH, which Nagita et al. (1996) asserts is a preferable measure of gastric maturity. Temporal studies of the intragastric pH of juvenile swine are not available.

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APPENDIX B

DETAILED DESCRIPTION OF ANIMAL EXPOSURE

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DETAILED DESCRIPTION OF ANIMAL EXPOSURE

1.0 EXPERIMENTAL ANIMALS

All animals used in this program were young intact males of the Pig Improvement Corporation (PIC) genetically defined Line 26, and were purchased from Chinn Farms, Clarence, MO. The number of animals purchased for each study was typically 6 to 8 more than required by the protocol. These animals were usually purchased at age 4 to 5 weeks (weaning occurs at age 3 weeks), and they were then held under quarantine for one week to observe their health before beginning exposure to test materials. Any animals that appeared to be in poor health during this quarantine period were excluded. To minimize weight variations between animals and groups, extra animals that were most different in body weight on day -4 (either heavier or lighter) were also excluded from the study. The remaining animals were assigned to dose groups at random. When exposure began (day zero), the animals were about 5 to 6 weeks old and weighed an average of about 8 to 11 kg.

All animals were housed in individual lead-free stainless steel cages. Each animal was examined by a certified veterinary clinician (swine specialist) prior to being placed on study, and all animals were examined daily by an attending veterinarian while on study. Blood samples were collected for clinical chemistry and hematological analysis on days -4, 7, and 15 to assist in clinical health assessments. Any animal that became ill and could not be promptly restored to good health by appropriate treatment was promptly removed from the study.

2.0 DIET

Animals provided by the supplier were weaned onto standard pig chow purchased from MFA Inc., Columbia, MO. In order to minimize lead exposure from the diet, the animals were gradually transitioned from the MFA feed to a special low-lead feed (guaranteed less than 0.2 ppm lead, purchased from Zeigler Brothers, Inc., Gardners, PA) over the time interval from day -7 to -3, and this feed was then maintained for the duration of the study. The feed was nutritionally complete and met all requirements of the National Institutes of Health–National Research Council (NRC, 1988). The typical nutritional components and chemical analysis of the feed are presented in Table 2-1 of the main text. Periodic analysis of feed samples during this program indicated the mean lead level was less than the detection limit (0.05 ppm).

Each day every animal was given an amount of feed equal to 5% of the mean body weight of all animals on study. Feed was administered in two equal portions of 2.5% of the mean body weight at each feeding. Feed was provided at 11:00 AM and 5:00 PM daily. Drinking water was provided *ad libitum* via self-activated watering nozzles within each cage. Periodic analysis of samples from randomly selected drinking water nozzles indicated the mean lead concentration was less than 2 µg/L.

3.0 DOSING

The dose levels used in these studies were selected to be as low as possible in an effort to make measurements at the low end of the dose-response curve where saturation of biological systems is minimal. Based on experience from previous investigations, doses of lead acetate in the range of 25 to 675 µg Pb/kg-day were found to give clear and measurable increases in lead levels in all endpoints measured (blood, liver, kidney, bone), so doses in this range (usually 25 to 225 µg Pb/kg-day) were employed in most studies. The doses of test materials were usually set at the same level as lead acetate, except that one higher dose was often included in case the test materials were found to yield very low responses. Depending on the concentration of lead in the test material and the target dose level for lead, soil intake rates by the swine were in the range of 500 to 2500 mg/day.

Animals were exposed to lead acetate or a test material for 15 days, with the dose for each day being administered in two equal portions given at 9:00 AM and 3:00 PM (two hours before feeding). These exposure times were selected so that lead ingestion would occur at a time when the stomach was largely or entirely empty of food. This is because the presence of food in the stomach is known to reduce lead absorption (e.g., Chamberlain et al., 1978; Rabinowitz et al., 1980; Heard and Chamberlain, 1982; Blake et al., 1983; James et al., 1985). Dose calculations were based on measured group mean body weights and were adjusted every three days to account for animal growth.

For animals exposed by the oral route, dose material was placed in the center of a small portion (about 5 grams) of moistened feed. This “doughball” was administered to the animals by hand. Most animals consumed the dose promptly, but occasionally some animals delayed ingestion of the dose for up to two hours (the time the daily feed portion was provided). Random and intermittent delays of this sort are not considered to be a significant source of error. Occasionally, some animals did not consume some or all of the dose (usually because the dose dropped from their mouth while chewing). All missed doses were recorded and the time-weighted average dose calculation for each animal was adjusted downward accordingly.

For animals exposed by intravenous injection, doses were given via a vascular access port (VAP) attached to an indwelling venous catheter that had been surgically implanted according to standard operating procedures by a board-certified veterinary surgeon through the external jugular vein to the cranial vena cava about 3 to 5 days before exposure began.

4.0 REFERENCES

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APPENDIX B
ATTACHMENT 1
DETAILED STUDY DESIGNS

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EXPERIMENT 1A STUDY DESIGN

Pig Number	Group	Material Administered*	Dose (μg Pb/kg-day)
3 20	1	Control	0
2 22 23 24 27	2	PbAc	25
1 26 29 32 35	3	PbAc	75
9 14 17 31 34	4	PbAc (-2 hr)	225
7 12 19 30 33	5	PbAc (0 hr)	225
5 18 21 25 36	6	PbAc (+2 hr)	225
4 15 16	7A	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 2 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
206 226	1	Control	0
215 220 222 229 251	2	PbAc	25
209 228 244 248 258	3	PbAc	75
204 216 247 252 260	4	PbAc	225
201 207 221 238 259	5	Bingham Creek Residential	75
236 237 240 242 249	6	Bingham Creek Residential	225
224 234 235 243 257	7	Bingham Creek Residential	450
202 217 219 253 254	8	Bingham Creek Channel Soil	75
203 225 227 232 250	9	Bingham Creek Channel Soil	225
205 210 213 218 255	10	Bingham Creek Channel Soil	675
208 214 230 231 239 241 246 256	11	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 3 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
304 339	1	Control	0
309 312 324 337 340	2	PbAc	75
313 315 342 354 356	3	PbAc	225
305 311 318 321 331	4	Jasper County High Lead Smelter	75
316 317 330 352 353	5	Jasper County High Lead Smelter	225
319 341 344 345 348	6	Jasper County High Lead Smelter	625
325 329 338 343 351	7	Jasper County Low Lead Yard	75
302 326 328 332 346	8	Jasper County Low Lead Yard	225
306 333 334 335 349	9	Jasper County Low Lead Yard	625
307 320 322 347 350	10	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 4 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
417 430	1	Control	0
409 419 429 443 444	2	PbAc	75
408 410 426 449 455	3	PbAc	225
402 407 411 423 450	4	Murray Smelter Slag	75
420 431 432 440 446	5	Murray Smelter Slag	225
412 418 427 437 442	6	Murray Smelter Slag	625
404 406 416 428 454	7	Jasper County High Lead Mill	75
401 433 434 435 441	8	Jasper County High Lead Mill	225
403 405 413 448 453	9	Jasper County High Lead Mill	625
415 421 424 425 438 439 445 451	10	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 5 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
530 536	1	Control	0
514 518 519 520 524	2	PbAc	75
501 513 529 534 547	3	PbAc	225
503 523 532 549 555	4	Aspen Berm	75
509 512 539 540 550	5	Aspen Berm	225
510 516 525 537 542	6	Aspen Berm	675
502 507 517 522 528	7	Aspen Residential	75
505 506 521 553 554	8	Aspen Residential	225
526 535 541 545 548	9	Aspen Residential	675
504 508 515 538 543 544 546 551	10	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 6 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
614 638	1	Control	0
613 624 630 639 641	2	PbAc	75
616 644 651 653 654	3	PbAc	225
619 623 626 631 647	4	Midvale Slag	75
602 605 628 640 650	5	Midvale Slag	225
603 615 629 633 645	6	Midvale Slag	675
610 611 617 637 643	7	Butte Soil	75
601 609 618 621 635	8	Butte Soil	225
620 627 634 646 655	9	Butte Soil	675
604 606 607 612 625 632 642 648	10	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 7 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
706 714 718 735 743	1	Control	0
703 709 748 750 755	2	PbAc	25
711 715 716 747 752	3	PbAc	75
704 712 736 740 753	4	California Gulch Phase I Residential Soil	25
702 708 728 739 756	5	California Gulch Phase I Residential Soil	75
717 723 725 732 737	6	California Gulch Phase I Residential Soil	225
707 713 730 738 741	7	California Gulch Fe/Mn PbO	25
733 742 746 749 751	8	California Gulch Fe/Mn PbO	75
719 721 729 744 745	9	California Gulch Fe/Mn PbO	225
722 724 727 734 754	10	PbAc (IV)	100

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 8 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
808 810 836	1	PbAc (IV)	0
805 807 812 827 834	2	PbAc (IV)	25
813 815 825 845 853	3	PbAc (IV)	50
801 816 820 843 852	4	PbAc (IV)	100
809 830 841 848 855	5	Control	0
817 818 819 838 846	6	PbAc	25
804 840 842 844 849	7	PbAc	75
857 826 828 831 851	8	California Gulch AV Slag	25
806 814 823 847 854	9	California Gulch AV Slag	75
811 822 824 837 856	10	California Gulch AV Slag	225

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 9 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
907 912 919 930 942 943 953	1	PbAc (IV)	100
901 902 920 925 928	2	Control	0
905 909 927 931 940	3	PbAc	25
923 933 948 950 956	4	PbAc	75
911 929 934 947 954	5	Palmerton Location 2	25
903 910 938 951 955	6	Palmerton Location 2	75
906 908 916 918 922	7	Palmerton Location 2	225
913 914 932 937 946	8	Palmerton Location 4	25
924 926 944 949 957	9	Palmerton Location 4	75
917 921 939 941 945	10	Palmerton Location 4	225

*All materials administered orally unless designated IV (intravenously)

EXPERIMENT 11 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
1109 1124 1135 1139 1151	1	Control	0
1103 1104 1116 1117 1118	2	PbAc	25
1105 1123 1129 1130 1144	3	PbAc	75
1121 1136 1138 1146 1150	4	PbAc	225
1106 1112 1133 1142 1149	5	Murray Smelter Soil	75
1102 1122 1128 1143 1154	6	Murray Smelter Soil	225
1126 1137 1140 1141 1155	7	Murray Smelter Soil	675
1110 1115 1134 1148 1153	8	NIST Paint	75
1101 1108 1111 1132 1152	9	NIST Paint	225
1113 1119 1120 1125 1147	10	NIST Paint	675

*All materials administered orally

EXPERIMENT 12 STUDY DESIGN

Pig Number	Group	Material Administered*	Dose ($\mu\text{g Pb/kg-day}$)
1205 1228 1236	1	Control	0
1208 1213 1215 1217 1248	2	PbAc	25
1227 1240 1243 1244 1255	3	PbAc	75
1222 1225 1226 1241 1249	4	PbAc	225
1201 1233 1250 1251 1253	5	Galena-enriched Soil	75
1203 1209 1214 1231 1247	6	Galena-enriched Soil	225
1218 1229 1235 1237 1254	7	Galena-enriched Soil	675
1207 1223 1230 1245 1252	8	Palmerton Location 2 (reproducibility)	25
1202 1210 1212 1220 1232	9	Palmerton Location 2 (reproducibility)	75
1211 1216 1221 1239 1246	10	Palmerton Location 2 (reproducibility)	225
1204 1224 1238 1242	11	California Gulch Oregon Gulch Tailings	225

*All materials administered orally

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APPENDIX C

**DETAILED METHODS OF
SAMPLE COLLECTION AND ANALYSIS**

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APPENDIX C

DETAILED METHOD OF SAMPLE COLLECTION AND ANALYSIS

1.0 COLLECTION OF BIOLOGICAL SAMPLES

Blood

Samples of blood were collected from each animal three or four days before exposure began, on the first day of exposure (day 0), and on multiple days thereafter (usually days 1, 2, 3, 5, 7, 9, 12, and 15). All blood samples were collected by vena-puncture of the anterior vena cava, and samples were immediately placed in purple-top Vacutainer[®] tubes containing EDTA (ethylenediaminetetra-acetic acid) as anticoagulant. Blood samples were collected each sampling day beginning at 8:00 AM, approximately one hour before the first of the two daily exposures to lead on the sampling day and 17 hours after the last lead exposure the previous day. This blood collection time was selected because the rate of change in blood lead resulting from the preceding exposures is expected to be relatively small after this interval (LaVelle et al., 1991; Weis et al., 1993), so the exact timing of sample collection relative to last dosing is not likely to be critical.

Liver, Kidney, and Bone

Following collection of the final blood sample at 8:00 AM on day 15, all animals were humanely euthanized and samples of liver, kidney, and bone (the right femur) were removed and stored in plastic bags for lead analysis.

Samples of all biological samples collected were archived in order to allow for reanalysis and verification of lead levels, if needed, and possibly for future analysis for other metals (e.g., arsenic, cadmium). All animals were also subjected to detailed examination at necropsy by a certified veterinary pathologist in order to assess overall animal health.

2.0 PREPARATION OF BIOLOGICAL SAMPLES FOR ANALYSIS

Blood

One mL of whole blood was removed from the purple-top Vacutainer and added to 9.0 mL of “matrix modifier,” a solution recommended by the Centers for Disease Control and Prevention (CDCP) for analysis of blood samples for lead (CDC, 2001). The composition of matrix modifier is 0.2% (v/v) ultrapure nitric acid, 0.5% (v/v) Triton X-100, and 0.2% (w/v) dibasic ammonium phosphate in deionized and ultrafiltered water. Samples of the matrix modifier were routinely analyzed for lead to ensure the absence of lead contamination.

Liver and Kidney

One gram of soft tissue (liver or kidney) was placed in a screw-cap Teflon container with 2 mL of Optima grade concentrated (70%) nitric acid and heated in an oven to 90°C overnight. After cooling, the digestate was transferred to a clean 10 mL volumetric flask and diluted to volume with deionized and ultrafiltered water.

Bone

The right femur of each animal was removed, defleshed, and dried at 100°C overnight. The dried bones were then broken in half, placed in a muffle furnace and dry-ashed at 450°C for 48 hours. Following dry ashing, the bone was ground to a fine powder using a mortar and pestle, and 200 mg was removed and dissolved in 10.0 mL of 1:1 (v:v) Optima grade concentrated nitric acid/water. After the powdered bone was dissolved and mixed, 1.0 mL of the acid solution was removed and diluted to 10.0 mL by addition of 0.1% (w/v) lanthanum oxide (La₂O₃) in deionized and ultrafiltered water.

3.0 LEAD ANALYSIS

Samples of biological tissue (blood, liver, kidney, bone) and other materials (e.g., food, water, reagents and solutions) were arranged in a random sequence and provided to USEPA's analytical laboratory in a blind fashion (identified to the laboratory only by a chain of custody tag number). Each sample was analyzed for lead using a Perkin Elmer Model 5100 graphite furnace atomic absorption spectrophotometer. Internal quality assurance samples were run every tenth sample and the instrument was recalibrated every 15th sample. A blank, duplicate, and spiked sample were run every 20th sample. In addition, a series of quality assurance (QA) samples were prepared and submitted to the laboratory in blind fashion, including a variety of duplicates, blanks, and standards.

All results from the analytical laboratory were reported in units of µg Pb/L of prepared sample. The quantitation limit was defined as three-times the standard deviation of a set of seven replicates of a low-lead sample (typically about 2 to 5 µg/L). The standard deviation was usually about 0.3 µg/L, so the quantitation limit was usually about 0.9 to 1.0 µg/L (ppb). However, because different dilution factors were used for different sample types, the detection limit varies from sample type to sample type. For prepared blood samples (diluted 1/10), this corresponds to a quantitation limit of 10 µg/L (1 µg/dL). For soft tissues (liver and kidney, also diluted 1/10), this corresponds to a quantitation limit of 10 µg/kg (ppb) wet weight, and for bone (final dilution of 1/500) the corresponding quantitation limit is 0.5 µg/g (ppm) ashed weight.

4.0 REFERENCES

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APPENDIX D

DETAILED METHODS FOR DATA REDUCTION AND STATISTICAL ANALYSIS

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APPENDIX D

DETAILED METHODS FOR DATA REDUCTION AND STATISTICAL ANALYSIS

1.0 INTRODUCTION

The method used to estimate the RBA of lead in a particular test material compared to lead in a reference material (lead acetate) is based on the principal that equal absorbed doses of lead will produce equal biological responses. By definition:

$$Absorbed\ Dose_{ref} = Administered\ Dose_{ref} \cdot ABA_{ref}$$

$$Absorbed\ Dose_{test} = Administered\ Dose_{test} \cdot ABA_{test}$$

where *ref* and *test* indicate the reference and test material, respectively. When the responses are equal, then:

$$Administered\ Dose_{ref} \cdot ABA_{ref} = Administered\ Dose_{test} \cdot ABA_{test}$$

Thus:

$$RBA = \frac{ABA_{test}}{ABA_{ref}} = \frac{Administered\ Dose_{ref}}{Administered\ Dose_{test}}$$

That is, given the dose-response curve for some particular endpoint (e.g., the concentration of lead in blood or tissue) for both the reference material and the test material, RBA may be calculated as the ratio of administered doses that produce equal biological responses.

Note that, in this approach, the mathematical form of the dose-response model must be the same for both reference material and test material. This is because the shape of the dose-response curve is a function only of the pharmacokinetic response of the biological organism to an absorbed dose of lead, and the response per unit dose absorbed dose does not depend on whether the absorbed lead was derived from reference material or test material. Another way to envision this is to recognize that, if the unit of exposure were absorbed dose (rather than administered dose), the dose-response curves for reference material and test material would be identical. Note that, in this approach, RBA is a sample-specific constant and does not depend on administered dose.

Based on this, the general procedure for estimating the value of RBA from measured dose-response data for reference and test materials is as follows:

1. Plot the biological responses of individual animals exposed to a series of oral doses of reference material. Select an exposure-response model which can fit smoothly

through the observed data points. The model may be either linear or non-linear, depending on the response endpoint being used.

2. Plot the biological responses of individual animals exposed to a series of doses of test material. Fit the same exposure-response model as was used for the reference material. Note that the intercept term must be the same for both curves, but that other coefficients may be different.
3. To find the ratio of doses that produce equal responses, set the two exposure response curves equal to each other and solve for the ratio of doses expressed in terms of the model parameters.

For example, assume that the increase in lead in femur (*PbF*) is observed to be a linear function of administered dose. Assume that the best-fit exposure-response models derived from the experimental data for animals exposed to reference material and test material are as follows:

$$PbF_{ref} = 2 + 6 \cdot Dose_{ref}$$

$$PbF_{test} = 2 + 3 \cdot Dose_{test}$$

Setting the two equations equal yields:

$$2 + 6 \cdot Dose_{ref} = 2 + 3 \cdot Dose_{test}$$

Solving yields:

$$\frac{Dose_{ref}}{Dose_{test}} = \frac{3}{6} = 0.5$$

That is, the ratio of administered doses that produce equal responses is 0.5, so the RBA is 0.5 (50%).

An important assumption used in this approach is that administration of increasing doses of test material will cause increased biological responses. However, this may not occur in the case of a test material in which the form of lead has very low solubility. For example, the solubility of lead sulfide (galena) in water is less than 1 µg/L. Thus, if a dose of lead sulfide results in saturation of the gastric fluid, administration of more lead sulfide will not increase the concentration of bioavailable lead and, hence, little or no increase in response would be expected. An example of this is shown in Figure D-1. In this case, RBA cannot be defined as the ratio of doses that produce equal responses, since many different doses of lead sulfide all produce the same response. However, this is not a substantial difficulty, since the amount of lead that becomes bioavailable will be small (and hence the response will be close to control), and simple inspection of the data will demonstrate that the test material is not likely to be of health concern.

2.0 MEASUREMENT ENDPOINTS

2.1 Description of Measurement Endpoints

Four independent measurement endpoints were evaluated in each study, based on the concentration of lead observed in blood, liver, kidney, and bone (femur). For liver, kidney, and bone, the measurement endpoint was simply the concentration in the tissue at the time of sacrifice (day 15). For blood, the measurement endpoint used to quantify response was the area under the curve (AUC) for blood lead vs. time (days 0-15). The area under the blood lead vs. time curve for each animal was calculated by finding the area under the curve for each time step (i.e., the interval between successive blood collection days) using the trapezoidal rule:

$$AUC(d_i \text{ to } d_j) = 0.5 \cdot (r_i + r_j) \cdot (d_j - d_i)$$

where:

d = day number, where i and j are successive blood sampling events

r = response (blood lead value) on day i (r_i) or day j (r_j)

The areas of the trapezoids for each time step were then summed to yield the final AUC for each animal.

2.2 Responses Below Quantitation Limit

In some cases, most or all of the responses in a group of animals were below the quantitation limit for the endpoint being measured. For example, this was normally the case for blood lead values in unexposed animals (both on day -4 and day 0 and in control animals), and also occurred during the early days in the study for animals given test materials with low bioavailability. In these cases, all animals which yielded responses below the quantitation limit were evaluated as if they had responded at one-half the quantitation limit. This approach was used because an assumed value of one-half the detection limit minimizes the potential bias in the assumption.

2.3 Assessment of Blood Lead Outliers

Occasionally blood lead values were obtained that were clearly different than expected. A value was considered to be an outlier if it was clearly different from other values within the same dose group on the same day, and/or if the value was clearly different from the time trend established by preceding and following time points in the same animal. A total of 21 such cases occurred out of a total of 4,284 blood lead data points (0.5%). These values were excluded in the calculation of AUC, and the missing value was replaced by a value interpolated from the preceding and following values from the same animal.

3.0 DERIVATION OF STATISTICAL DOSE-RESPONSE MODELS

The techniques used to derive statistical models of the dose-response data and to estimate RBA are based on the methods recommended by Finney (1978). All model fitting was performed using JMP™ version 3.2.2, a commercial software package developed by SAS®. Details are provided below.

3.1 Use of Simultaneous Regression

As noted by Finney (1978), when the data to be analyzed consist of two dose-response curves (the reference material and the test material), it is obvious that both curves must have the same intercept, since there is no difference between the curves when the dose is zero. This requirement is achieved by combining the two dose response equations into one and solving for the parameters simultaneously. For example, if the dose response model is linear, the approach is as follows:

Separate Models:

$$\mu_r(i) = a + b_r \cdot x_r(i)$$

$$\mu_t(i) = a + b_t \cdot x_t(i)$$

Combined Model

$$\mu(i) = a + b_r \cdot x_r(i) + b_t \cdot x_t(i)$$

where $\mu(i)$ indicates the expected mean response of animals exposed at dose $x(i)$, and the subscripts r and t refer to reference and test material, respectively. The coefficients of this combined model are derived using multivariate regression, with the understanding that the combined data set is restricted to cases in which one (or both) of x_r and x_t are zero (Finney, 1978). The same approach may be extended for use when there are three data sets (reference material, test material 1, test material 2) that are all derived from a single study and must therefore all have the same intercept.

3.2 Use of Weighted Regression

Regression analysis based on ordinary least squares assumes that the variance of the responses is independent of the dose and/or the response (Draper and Smith, 1998). In these studies, this assumption is generally not satisfied. Figure D-2 provides two example data sets that show a clear increase in the variability of the responses as a function of increasing dose. This is referred to as heteroscedasticity. Most other data sets from this study display a similar tendency toward increasing variance in response as a function of increasing dose.

One method for dealing with heteroscedasticity is through the use of weighted least squares regression (Draper and Smith, 1998). In this approach, each observation in a group of animals is assigned a weight that is inversely proportional to the variance of the response in that group:

$$w_i = \frac{1}{\sigma_i^2}$$

where:

w_i = weight assigned to all data points in dose group i

σ_i^2 = variance of responses in animals in dose group i

When the distributions of responses at each dose level are normal, weighted regression is equivalent to the maximum likelihood method. There are several options available for estimating the value of σ_i^2 :

Option 1: Utilize the observed variance (s_i^2) in the responses of animals in dose group i .

Option 2: Establish a variance model of the form $\sigma_i^2 = \alpha\mu_i^\rho$, where μ_i is the predicted mean response for dose group i . Simultaneously fit the data to derive values of α and ρ along with the other coefficients of the dose-response model using the data from a particular study. This approach is identical to the non-constant variance approach used by USEPA's BMDS (USEPA 1995, 2000a).

Option 3A: Establish an "external" variance model based on an analysis of the relationship between variance and mean response using observations combined from all studies and dose groups. Use that model to predict the expected variance in dose group i as a function of the predicted mean response for that dose group.

Option 3B: Establish an "external" variance model based on an analysis of the relationship between variance and mean response using observations combined from all studies and dose groups. Use that model to predict the expected variance in dose group i as a function of the observed mean response level for that dose group.

In this study, all four options were investigated for possible use. The advantages and disadvantages of each are discussed below.

Option 1 (use of group-specific sample variances) is the simplest approach, and does not require any assumptions or extrapolations. If the number of animals in each dose group was large enough to provide reliable estimates of the true variance for the dose group, this would be the preferred method. However, sample variance in a dose group is a random variable and, because the sample variance is based on only five observations (five animals per dose group), it can vary widely (especially when true variance is large). Therefore, weights assigned using this approach may occasionally be substantially higher or lower than the data actually warrant. For

example, this approach yielded poor results in cases where two adjacent groups (usually the control and the low dose group) had very low variance. In this situation, the weights for those groups were so high that the model fit was constrained to pass through them with very little deviation and other dose groups exerted very little influence. Figure D-3 shows an example of this. Because this outcome was judged to be inappropriate, Option 1 was not used.

Option 2 (using a non-constant variance model derived from the within-study data only) utilizes the entire data set from a single study to estimate expected variance as a function of dose, and so is less vulnerable to random variations in group-specific sample variances than Method 1. Despite this advantage, however, this approach requires that two additional parameters (α and ρ) be derived along with the other model parameters. This tends to over-parameterize the model and, when this option was tested (using the Solver tool in Microsoft® Excel), the fits were often not stable (i.e., different results were obtained with different starting guesses). On this basis, Option 2 was not employed.

Option 3 (both Options 3A and 3B) requires development of an external variance model based on the consolidated data from all studies. Figure D-4 shows the log-variance in response plotted as a function of the log-mean response in the group¹. One panel is presented for each of the four different endpoints. As seen, log-variance increases as an approximately linear function of log-mean response for all four endpoints:

$$\ln(s^2_i) = k_1 + k_2 \cdot \ln(\bar{y}_i)$$

Values of k_1 and k_2 are derived from the data for each endpoint using ordinary least squares minimization, and the resulting values are shown in the figures. Note that this variance model is of the same basic form as used in Option 2:

$$s^2_i = \exp(k_1) \cdot (\bar{y}_i)^{k_2}$$

In Option 3A, the weights for each response are assigned based on the predicted mean response at each dose level within that model. For example, assuming a linear model:

$$\mu_x(i) = a + b_1 \cdot x_1(i) + b_2 \cdot x_2(i)$$

$$\sigma^2_i = \exp[k_1 + k_2 \cdot \ln(\mu_x(i))]$$

In Option 3B, the same approach is used, except that the observed mean response rather than the predicted mean response is used to estimate σ^2_i :

$$\sigma^2_i = \exp[k_1 + k_2 \cdot \ln(\mu_x(i))]$$

¹ In this analysis, some dose groups were excluded if the estimate of variance and/or mean response was judged to be unreliable, based on the following two criteria: a) the number of animals in the dose group was ≤ 2 or b) the fraction of responses below the detection limit was more than 20%. For the blood lead AUC endpoint (where the raw data consist of multiple blood lead values as a function of time), this corresponds to an AUC less than about 15 $\mu\text{g}/\text{dL}$ -days.

In testing both options, it was found that Options 3A and 3B gave similar results in most cases. However, Option 3A (in which weights are not pre-assigned but are optimized during the fitting procedure) tended to be very sensitive to starting guesses, often failing to find solutions even when the starting guesses were good, and sometimes yielding different results depending on the starting guesses. In addition, this approach uses the expected mean response rather than the observed mean response to estimate the variance, which tends to diminish the role of the measured data in defining the best fit curve. In contrast, Option 3B was less prone to unstable solutions, and is based more directly on the data.

Based on a consideration of the advantages and disadvantages of each approach, Option 3B was selected for use in this project. This is mainly because it has relatively less vulnerability than Option A to random variations in observed variances in a dose group (which results in assignment of weights that are either too high or too low), and also because it could be implemented with relatively few difficulties. It should be noted, however, that Option 3B is somewhat vulnerable to poor fits when one particular dose group in a data set lies well below the expected smooth fit through the other dose groups. In this case, the variance assigned to the group (based on the observed mean response) is lower than typical for that dose level (and hence the weights assigned to the data are higher than usual), tending to force the line through that data set at the expense of the other data sets.

3.3 Choice of Model Forms

As noted above, the main objective of the curve-fitting effort is to find a mathematical model that fits both the reference and test group dose-response data sets smoothly. Note that there is no requirement that the model have a mechanistic basis or that the coefficients have a biological meaning. As discussed by Finney (1978), it is generally not appropriate to choose the form of the dose-response model based on only one experiment, but to make the choice based on the weight of observations across many different studies. Because simple inspection of the data suggest that, over the range of doses tested in these studies, some dose-response curves (mainly those for liver, kidney, and bone) appear to be approximately linear, while others (mainly those for blood lead AUC) appear to be nonlinear (tending to plateau as dose increases), the linear model and three alternative non-linear models were evaluated:

$$1) \text{ Linear: } y = a + b_r \cdot x_r + b_t \cdot x_t$$

$$RBA = \frac{b_t}{b_r}$$

$$2) \text{ Exponential: } y = a + b \cdot (1 - \exp(-c_r \cdot x_r)) + b \cdot (1 - \exp(-c_t \cdot x_t)) =$$

$$RBA = \frac{c_t}{c_r}$$

$$3) \text{ Michaelis-Menton: } y = a + b \cdot \left(\frac{x_r}{c_r + x_r} + \frac{x_t}{c_t + x_t} \right)$$

$$RBA = \frac{c_r}{c_t}$$

$$4) \text{ Power: } y = a + b_r \cdot x_r^c + b_t \cdot x_t^c$$

$$RBA = \left(\frac{b_t}{b_r} \right)^{1/c}$$

Appendix E presents the detailed results for every data set fit to each of the four different models investigated. Goodness-of-fit was assessed using the F test statistic and the adjusted coefficient of multiple determination ($Adj R^2$), calculated as follows (Draper and Smith, 1998):

$$F = \frac{MSE_{fit}}{MSE_{error}}$$

$$Adj R^2 = 1 - \frac{MSE_{error}}{MSE_{total}}$$

where:

$$MSE_{fit} = \sum w_i \cdot \frac{(\mu_i - \bar{y}^*)^2}{p-1}$$

$$MSE_{error} = \sum w_i \cdot \frac{(\mu_i - y_i)^2}{n-p}$$

$$MSE_{total} = \sum w_i \cdot \frac{(y_i - \bar{y}^*)^2}{n-1}$$

and:

$$\bar{y}^* = \frac{\sum (w_i \cdot y_i)}{\sum w_i}$$

p = number of parameters in model

n = number of observations (animals)

F is distributed as an F distribution with $(p-1)$ and $(n-p)$ degrees of freedom. Models with p values larger than 0.05 were not considered to be acceptable. Of the models that were acceptable

($p < 0.05$), the preferred model was identified based on Akaike's Information Criterion (AIC) (USEPA, 2000a and 2000b), which is calculated as:

$$AIC = -2 \cdot L + 2 \cdot p$$

where:

L = Log-likelihood function

p = number of parameters in the model

At the k th dose, the sample log-likelihood function is:

$$L_k = -\frac{N_k}{2} \cdot \ln(2\pi\sigma_k^2) - \frac{1}{2\sigma_k^2} \cdot \sum_{j=1}^{N_k} [y_{k,j} - f(x_k)]^2$$

(Nelson, 1982). The overall log-likelihood is the sum across all dose groups (g):

$$L = \sum_{k=1}^g L_k$$

so that

$$L = -\sum_{k=1}^g \frac{N_k}{2} \cdot \ln(2\pi\sigma_k^2) - \sum_{k=1}^g \frac{1}{2\sigma_k^2} \cdot \sum_{j=1}^{N_k} [y_{k,j} - f(x_k)]^2$$

The detailed results are presented in Appendix E, and the findings are summarized in Table D-1. Inspection of this table reveals the following main conclusions:

- For liver, kidney, and bone, the linear model generally gave the best fit, although this varied somewhat by endpoint (7/10 for kidney, 6/10 for bone, 4/10 for liver). In cases where the linear model was not the best fit, the RBA value given by the linear model was usually close to that given by whatever other model did provide the best fit, with an average absolute difference of 12% (6% if one data set [study 9] was excluded). On this basis, the linear model was selected for application to all dose-response data sets for liver, kidney, and bone.
- For the blood lead AUC endpoint, the linear model usually gave the worst fit, and on this basis it was rejected as a candidate for the AUC endpoint. In general, each of the three nonlinear models (exponential, Michaelis-Menton, and power) all tended to give similar results in terms of RBA value (the standard deviation in RBA for a particular test material averaged across the three models was usually less than 3%), and differences in the AIC were usually small. On this basis, it was concluded that any of these three models would be acceptable. The power model was not selected because it does not tend toward a plateau, while data from early blood lead pilot

studies (using higher doses than commonly used in the Phase II studies) suggest that the blood lead endpoint does tend to do so. Of the remaining two models (exponential and Michaelis-Menton), the exponential model was selected mainly because it yielded the best fit more often than the Michaelis-Menton model (4 out of 10 vs. 2 out of 10), and because the exponential model had been used in previous analyses of the data. Thus, the exponential model was selected for application to all dose-response data sets for the blood AUC endpoint, except in one special case noted below in section 4.5.

3.4 Assessment of Endpoint Outliers

In biological assays, it is not uncommon to note the occurrence of individual measured responses that appear atypical compared to the responses from other animals in the same dose group. For the purposes of this program, endpoint responses that yielded standardized weighted residuals greater than 3.5 or less than -3.5 were considered to be potential outliers (Canavos, 1984). When such data points were encountered in a data set, the RBA was calculated both with and without the potential outlier(s) excluded, and the result with the outlier excluded was used as the preferred estimate.

3.5 Treatment of Problematic Data Sets

Although the data reduction approach described above works well in most cases, a few data sets yielded atypical results. In particular, fitting the blood lead data set from Experiment 7 proved difficult. In this study, the blood lead AUC data set did not yield a solution in JMP for the exponential model, even though solutions could be obtained in Excel using minimization of weighted squared errors. However, the solutions tended to be unstable. This difficulty in modeling the data appears to be due to the fact that the data have relatively less curvature than most blood lead AUC data sets. Because of this lack of curvature, it is not possible to estimate the exponential plateau value (b) with confidence, which in turns makes it difficult to estimate the other parameters of the exponential model.

Several alternative solutions were evaluated, including a) using the model fits from one of the other nonlinear models, b) using the fit for the linear model, and c) fitting the data to the exponential model using a defined value for the plateau based on results from other data sets. The results (i.e., the RBA values based on the blood lead AUC endpoint) were generally similar for all three of these approaches:

Model	RBA of TM1	RBA of TM2
Power	0.65	0.83
Linear	0.69	0.90
Michaelis-Menton	0.69 ± 0.01*	0.90 ± 0.01*
Exponential fit	0.70 ± 0.02*	0.93 ± 0.04*
Exponential fit (parameter $b = 126.4$)**	0.75	1.04
Exponential fit (parameter $b = 169.1$)***	0.74	1.01

*Solution was unstable; values represent the mean and standard deviation of five different fitting results.

**Parameter b set to the mean of the estimates obtained for all other blood AUC data sets using the exponential model.

***Parameter b set to the maximum of the estimates obtained for all other blood AUC data sets using the exponential model.

All estimates are based on all data (outliers not excluded).

Based on these results, it was concluded that the results from the linear fit were representative of the range of values derived by other alternatives, so the JMP fit for the linear model was used for this data set.

3.6 Characterization of Uncertainty Bounds

Each RBA value is calculated as the ratio of a model coefficient for the reference data set and for the test data set:

$$RBA_{linear\ endpoints} = \frac{b_t}{b_r}$$

$$RBA_{blood\ AUC} = \frac{c_t}{c_r}$$

However, there is uncertainty in the estimates of the model coefficients in both the numerator and denominator and, hence, there is uncertainty in the ratio. As described by Finney (1978), the fiducial limits (uncertainty range) about the ratio R of two model coefficients may be calculated using Fieller's Theorem:

$$LB, UB = \frac{R - g \pm \frac{covar_{r,t}}{var_r} \pm \frac{t}{b_r} \cdot \sqrt{W}}{1 - g}$$

$$W = var_t - 2 \cdot R \cdot covar_{t,r} + R^2 \cdot var_r = \left(\frac{covar_{r,t}^2}{var_r} \right)$$

$$g = \frac{t^2}{b_r^2} \cdot var_r$$

where:

R = ratio (b_t / b_r for linear model, c_t / c_r for exponential model)

var_r = variance in the coefficient for the reference material

$covar_{r,t}$ = covariance in the coefficients for the reference and test materials

b_r = coefficient for the reference material (c_r in the case of the exponential model)

t = t statistic for alpha (0.05) and $(n-p)$ degrees of freedom

When g is small (<0.05), the variance of the ratio is approximated as (Finney 1978):

$$var_R = \frac{var_t - 2 \cdot R \cdot covar_{r,t} + R^2 \cdot var_r}{b_r^2}$$

3.7 Combination of RBA Estimates Across Endpoints

As discussed above, each study of RBA utilized four different endpoints to estimate absorption of lead, including blood AUC, liver, kidney, and bone. Consequently, each study yielded four independent estimates of RBA for each test material. Thus, the final RBA estimate for a test material involves combining the four end-point specific RBA values into a single value (point estimate), and estimating the uncertainty around that point estimate. The methods used to achieve these goals are described below.

Derivation of the Point Estimate

The basic strategy for deriving a point estimate of RBA for a test material is to calculate a confidence-weighted average of the four endpoint-specific RBA values. If all four endpoints are considered to be equally reliable, the weighting factors are all equal (i.e., the point estimate is the simple average). If reliability is considered to differ from endpoint to endpoint, then weights are assigned in proportion to the reliability:

$$RBA_{point\ estimate} = \frac{\sum (RBA_i \cdot w_i)}{\sum w_i}$$

Because each endpoint-specific RBA value is calculated as the ratio of the parameters of the dose-response curves fitted to the experimental data for reference material and test material, the reliability of an endpoint-specific RBA is inherently related to the quality of the data that define the dose-response curve for that endpoint. For endpoints that tend to have low within-group variability and generate data that fit the dose-response model well, the uncertainty around

the model parameters will tend to be small and hence the uncertainty around the RBA value will also tend to be small. Conversely, if the underlying dose-response data for an endpoint are highly variable and the dose-response model does not fit the data well, there will tend to be high uncertainty in the model parameters and hence in the RBA estimate. Thus, a good indicator of relative reliability between the four different endpoints is the relative magnitude of the uncertainty (standard error) around RBA estimates based on each endpoint.

Figure D-5 plots the standard error in each RBA estimate as a function of the RBA value for each of the four different endpoints. As seen, uncertainty in RBA increases as a function of the estimated value of RBA in all four cases. This is expected because of the heteroscedasticity in the underlying dose-response data. Although RBA values based on blood AUC and femur tend to yield estimates with slightly lower standard errors than RBA values based on liver or kidney, the magnitude of the standard errors tends to be generally similar for all four endpoints, and the difference between the four regression lines is not statistically significant ($p = 0.699$). Based on this, each endpoint-specific RBA value was judged to have approximately equal validity, and the point estimate was calculated as the simple average across all four endpoint-specific RBA values.

Estimation of Uncertainty Bounds Around the Point Estimate

The uncertainty bounds around each point estimate were estimated using Monte Carlo simulation. For each test material, values for RBA were drawn from the uncertainty distributions for each endpoint with equal frequency. Each endpoint-specific uncertainty distribution was assumed to be normal, with the mean equal to the best estimate of RBA and the standard deviation estimated from Fieller's Theorem (see Section 4.6 above). The uncertainty in the point estimate was characterized as the range from the 5th to the 95th percentile of the average across endpoints.

4.0 RELATION BETWEEN RBA AND IVBA

4.1 Choice of Model Form

As discussed in Section 3.3.2 of the main text, one of the important objectives of this program was to characterize the degree to which measures of *in vitro* bioaccessibility (IVBA) correlate with and can be used to predict *in vivo* measurements of RBA. This objective was approached by plotting the point estimate of *in vivo* RBA vs. the corresponding IVBA value for each of the 19 different test materials and fitting several different mathematical models to the data. Because the measurement error in RBA is heteroscedastic (tending to increase as RBA increases), all of the model fitting was performed by minimizing the sum of the weighted squared errors between observed and predicted RBA, as described above (Section 4.2). The weighting factor assigned to each RBA point estimate was the inverse of the variance derived from Monte Carlo simulation, as described in Section 4.7 and shown in Table D-2. Goodness of fit was assessed using the AIC, as described in Section 4.3. The fitting results are shown in Figure D-6 (Panels A to D), and are summarized below:

Model	a	b	c	R ²	AIC
Linear: $RBA = a + b \cdot IVBA$	-0.028	0.878	--	0.924	-30.46
Power: $RBA = a + b \cdot IVBA^c$	-0.003	0.978	1.293	0.931	-29.92
2-Parameter Exponential: $RBA = a + b \cdot \exp(IVBA)$	-0.634	0.619	--	0.936	-33.02
3-Parameter Exponential: $RBA = a + b \cdot \exp(c \cdot IVBA)$	-0.476	0.464	1.225	0.936	-31.11

As seen, all of the models fit the data reasonably well, with the two exponential models fitting somewhat better than the linear model. However, the improved fit of the exponential models is due mainly to the fact that the two data points that occur in the central part of the x-range (IVBA = 0.378 and 0.470) lie below the best fit linear line, and these two data points tend to pull the central part of the curve down slightly when a non-linear model is used. If these two data points were absent, or if a third data point were present that were above the linear fit, the quality of the fits would be approximately equal for linear and non-linear models. Based on the judgment that two data points are not sufficient evidence to conclude that a non-linear fit is preferable to a linear model, the linear model is selected as the interim recommended model. As more data become available in the future, the relationship between IVBA and RBA will be reassessed and the model will be revised if needed.

Figure D-7 shows a graph of the best fit linear model through the data, along with the 95% prediction interval, calculated using SAS[®]. As noted above, the best fit equation is:

$$RBA = 0.878 \cdot IVBA - 0.028$$

4.2 Adjusting for Measurement Error in Both IVBA and RBA

In most cases, linear and non-linear regression techniques assume that there are no measurement errors in the independent variable (IVBA). However, as noted in Section 3 of the main text, IVBA is derived by experimental measurement and, hence, there is some degree of measurement error in each IVBA value. In this situation, use of weighted linear regression (which accounts only for the measurement errors in RBA) may yield a fit that is biased, with the magnitude of the error depending on the relative magnitude of the measurement errors in IVBA compared to RBA. In order to investigate whether this was an important adjustment, the data were fit by minimizing the chi-square merit function for a linear model (Cheng and Van Ness 1999):

$$X^2 = \sum \frac{(RBA_i - a - b \cdot IVBA_i)^2}{(Sy_i^2 + b^2 \cdot Sx_i^2)}$$

where:

a = Intercept of the linear equation

b = Slope of the linear equation

Sy_i^2 = Variance of RBA estimate i

Sx_i^2 = Variance of IVBA estimate i

As above, the value of Sy_i^2 was derived from the Monte Carlo simulation used to derive the point estimate for each RBA value, and the value of Sx_i^2 was the variance of the three independent measurements of IVBA (see Table D-2). Based on this approach, the best fit equation is:

$$RBA = 0.884 \cdot IVBA - 0.028$$

As seen, this fit is very similar to the weighted linear regression fit above, with the same intercept and a slightly greater slope. This relatively small effect of adjusting for measurement error in IVBA is expected, because measurement errors in IVBA tend to be substantially smaller (average coefficient of variation = 6%) than those in RBA (average coefficient of variation = 33%) (see Table D-2). Because the difference in results is so small for this data set, the fit based on weighted linear regression is selected as the preferred model at this time, because of its relative simplicity. This decision may be re-evaluated in the future as additional data become available.

5.0 REFERENCES

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APPENDIX D

TABLE D-1. MODEL COMPARISONS

Endpoint	Experiment	LINEAR						EXPONENTIAL						MICHAELIS-MENTON						POWER						Lowest AIC
		AIC	p	Adj R ²	RBA1	RBA2	RBA3	AIC	p	Adj R ²	RBA1	RBA2	RBA3	AIC	p	Adj R ²	RBA1	RBA2	RBA3	AIC	p	Adj R ²	RBA1	RBA2	RBA3	
Blood AUC	2	412.4014	< 0.001	0.779	0.38	0.31	--	393.6549	< 0.001	0.827	0.34	0.30	--	391.8262	< 0.001	0.831	0.33	0.30	--	386.1163	< 0.001	0.846	0.34	0.30	--	POWER
Blood AUC	3	428.5143	< 0.001	0.818	0.53	0.63	--	377.8492	< 0.001	0.896	0.65	0.94	--	376.0574	< 0.001	0.899	0.65	0.94	--	374.4287	< 0.001	0.902	0.62	0.85	--	POWER
Blood AUC	4	455.6739	< 0.001	0.787	0.34	0.48	--	382.9415	< 0.001	0.896	0.47	0.84	--	379.6654	< 0.001	0.901	0.47	0.84	--	374.2627	< 0.001	0.909	0.40	0.73	--	POWER
Blood AUC	5	385.03	< 0.001	0.864	0.50	0.55	--	345.1702	< 0.001	0.933	0.69	0.72	--	344.7351	< 0.001	0.934	0.68	0.73	--	344.9323	< 0.001	0.934	0.61	0.68	--	MM
Blood AUC	6	333.5853	< 0.001	0.820	0.28	0.30	--	311.8304	< 0.001	0.888	0.21	0.19	--	312.3221	< 0.001	0.886	0.21	0.19	--	316.066	< 0.001	0.875	0.24	0.23	--	EXP
Blood AUC	7	394.3537	< 0.001	0.692	0.69	0.90	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	394.2826	< 0.001	0.689	0.65	0.83	--	POWER
Blood AUC	8	377.1965	< 0.001	0.822	0.26	--	--	337.9125	< 0.001	0.898	0.26	--	--	336.9394	< 0.001	0.900	0.26	--	--	344.3656	< 0.001	0.885	0.20	--	--	MM
Blood AUC	9	328.7634	< 0.001	0.862	0.62	0.54	--	312.2198	< 0.001	0.909	0.82	0.62	--	312.6794	< 0.001	0.908	0.80	0.62	--	316.1967	< 0.001	0.899	0.73	0.60	--	EXP
Blood AUC	11	436.4331	< 0.001	0.857	0.49	0.60	--	390.4143	< 0.001	0.922	0.70	0.86	--	391.3314	< 0.001	0.921	0.70	0.86	--	402.3932	< 0.001	0.905	0.66	0.83	--	EXP
Blood AUC	12	375.1354	< 0.001	0.906	0.01	0.78	0.09	370.3802	< 0.001	0.910	0.01	0.71	0.07	370.7599	< 0.001	0.910	0.01	0.72	0.07	374.8385	< 0.001	0.905	0.01	0.74	0.07	EXP
Liver	2	543.2988	< 0.001	0.567	0.35	0.25	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	543.0502	< 0.001	0.574	0.39	0.26	--	POWER
Liver	3	562.2981	< 0.001	0.782	0.56	1.20	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	561.4696	< 0.001	0.786	0.60	1.08	--	POWER
Liver	4	558.5529	< 0.001	0.564	0.51	0.86	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	555.8161	< 0.001	0.586	0.39	0.74	--	POWER
Liver	5	674.4086	0.003	0.268	0.93	1.13	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	675.8198	0.007	0.249	0.87	1.02	--	LIN
Liver	6	468.3743	< 0.001	0.622	0.13	0.14	--	470.3592	< 0.001	0.612	0.13	0.14	--	470.3592	< 0.001	0.612	0.13	0.14	--	470.2987	< 0.001	0.613	0.13	0.13	--	LIN
Liver	7	503.4618	< 0.001	0.679	0.54	0.71	--	505.44	< 0.001	0.671	0.54	0.72	--	NS	NS	NS	NS	NS	--	505.3976	< 0.001	0.672	0.54	0.72	--	LIN
Liver	8	629.6988	< 0.001	0.452	0.18	--	--	NS	NS	NS	NS	--	--	NS	NS	NS	NS	--	--	630.6132	< 0.001	0.441	0.18	--	--	LIN
Liver	9	484.9237	< 0.001	0.727	0.60	0.53	--	470.6533	< 0.001	0.777	1.11	0.65	--	471.6336	< 0.001	0.774	1.07	0.65	--	475.7101	< 0.001	0.760	0.89	0.62	--	EXP
Liver	11	561.4438	< 0.001	0.757	0.58	0.73	--	561.5909	< 0.001	0.757	0.66	0.71	--	561.5427	< 0.001	0.757	0.65	0.71	--	560.9762	< 0.001	0.759	0.63	0.73	--	POWER
Liver	12	506.975	< 0.001	0.716	0.02	1.25	0.11	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	493.7966	< 0.001	0.746	0.02	0.98	0.12	POWER
Kidney	2	530.2226	< 0.001	0.687	0.22	0.27	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	532.2104	< 0.001	0.679	0.22	0.27	--	LIN
Kidney	3	533.5968	< 0.001	0.834	0.58	0.91	--	534.2703	< 0.001	0.833	0.58	0.97	--	534.219	< 0.001	0.834	0.58	0.97	--	534.0045	< 0.001	0.834	0.56	0.95	--	LIN
Kidney	4	550.1067	< 0.001	0.715	0.31	0.70	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	551.8207	< 0.001	0.709	0.30	0.68	--	LIN
Kidney	5	547.8196	< 0.001	0.529	0.73	0.78	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	548.0081	< 0.001	0.527	0.64	0.74	--	LIN
Kidney	6	500.2596	< 0.001	0.552	0.12	0.16	--	501.6143	< 0.001	0.543	0.11	0.14	--	501.6373	< 0.001	0.543	0.11	0.14	--	501.9909	< 0.001	0.541	0.12	0.14	--	LIN
Kidney	7	501.5953	< 0.001	0.657	0.51	0.86	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	503.5096	< 0.001	0.649	0.51	0.85	--	LIN
Kidney	8	586.5547	< 0.001	0.573	0.14	--	--	585.9632	< 0.001	0.571	0.14	--	--	585.9527	< 0.001	0.571	0.14	--	--	581.2902	< 0.001	0.587	0.13	--	--	POWER
Kidney	9	535.8631	< 0.001	0.579	0.51	0.41	--	511.6407	< 0.001	0.661	1.62	0.52	--	513.5473	< 0.001	0.655	1.63	0.55	--	518.7502	< 0.001	0.636	1.36	0.56	--	EXP
Kidney	11	576.6481	< 0.001	0.725	0.36	0.55	--	578.6496	< 0.001	0.718	0.53	0.47	--	578.7016	< 0.001	0.717	0.48	0.48	--	578.2471	< 0.001	0.720	0.39	0.52	--	LIN
Kidney	12	868.9066	< 0.001	0.329	0.01	0.47	0.04	870.0698	< 0.001	0.315	0.01	0.34	0.03	870.32	< 0.001	0.315	0.01	0.36	0.03	864.5181	< 0.001	0.326	0.01	0.73	0.08	POWER
Femur	2	180.5215	< 0.001	0.863	0.24	0.26	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	182.5211	< 0.001	0.859	0.24	0.26	--	LIN
Femur	3	187.2204	< 0.001	0.863	0.65	0.75	--	186.1918	< 0.001	0.870	0.70	0.81	--	186.1445	< 0.001	0.870	0.70	0.81	--	186.099	< 0.001	0.870	0.68	0.79	--	POWER
Femur	4	196.1178	< 0.001	0.886	0.31	0.89	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	195.6032	< 0.001	0.888	0.32	0.96	--	POWER
Femur	5	221.1807	< 0.001	0.856	0.67	0.73	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	222.5578	< 0.001	0.854	0.65	0.72	--	LIN
Femur	6	227.7994	< 0.001	0.465	0.11	0.10	--	229.7051	< 0.001	0.451	0.11	0.10	--	229.7112	< 0.001	0.451	0.11	0.10	--	229.612	< 0.001	0.451	0.11	0.11	--	LIN
Femur	7	216.3481	< 0.001	0.615	0.53	0.80	--	216.5913	< 0.001	0.611	0.56	0.95	--	NS	NS	NS	NS	NS	--	216.3737	< 0.001	0.612	0.56	0.93	--	LIN
Femur	8	193.9091	< 0.001	0.830	0.20	--	--	195.1797	< 0.001	0.828	0.20	--	--	195.1037	< 0.001	0.828	0.20	--	--	185.5952	< 0.001	0.850	0.18	--	--	POWER
Femur	9	118.6208	< 0.001	0.855	0.47	0.40	--	112.175	< 0.001	0.884	0.50	0.43	--	111.9654	< 0.001	0.885	0.50	0.43	--	111.1541	< 0.001	0.888	0.48	0.41	--	POWER
Femur	11	198.2084	< 0.001	0.871	0.39	0.74	--	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	--	200.0238	< 0.001	0.869	0.38	0.73	--	LIN
Femur	12	137.1663	< 0.001	0.865	0.01	0.95	0.01	139.1501	< 0.001	0.856	0.01	0.95	0.01	139.1506	< 0.001	0.856	0.01	0.95	0.01	139.1826	< 0.001	0.861	0.01	0.95	0.01	LIN

-- = The respective test material does not exist for this study.
NS = No solution; the software could not find a solution, or the solution was unstable and/or had unrealistic parameter estimates.
NA = Not applicable; the preferred model has the best fit, or no solution was found for the preferred model.

APPENDIX D

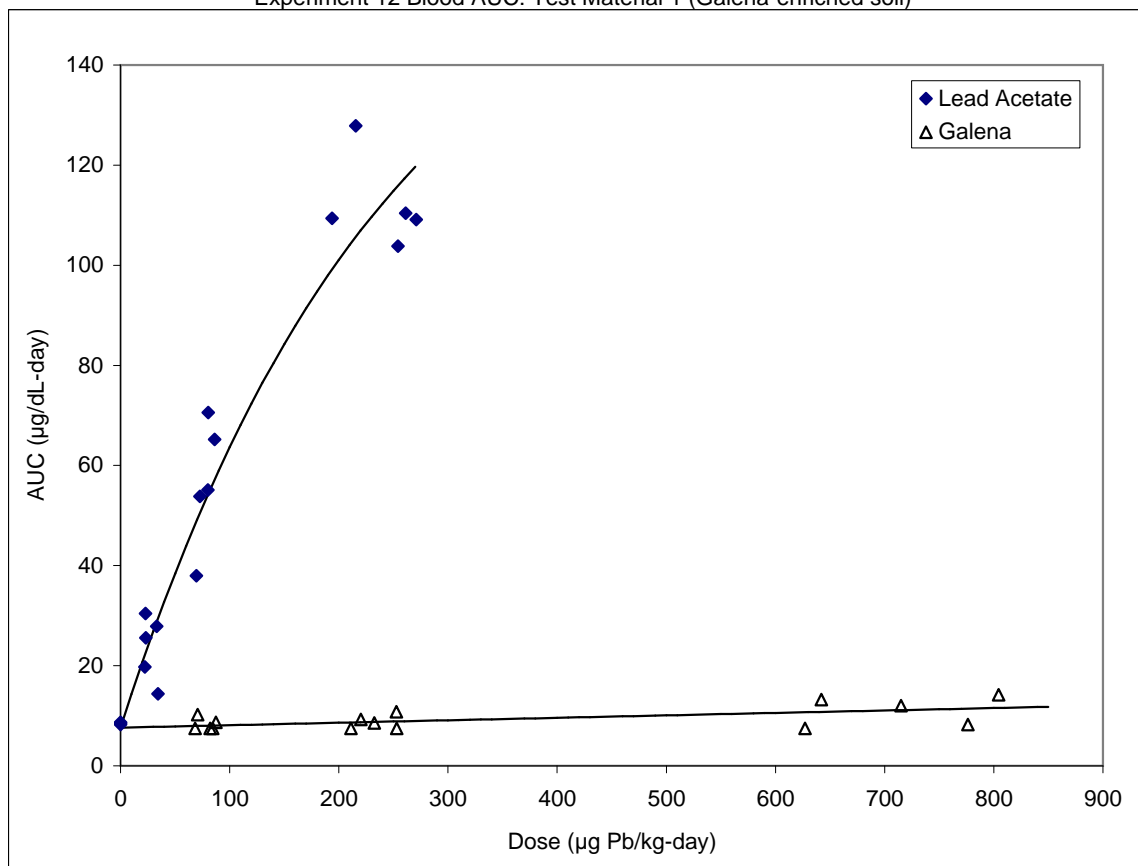
TABLE D-2. DATA FOR WEIGHTED REGRESSION OF RBA vs. IVBA

Sample	RBA				IVBA			
	Best Estimate	Standard Deviation	Variance		Best Estimate	Standard Deviation	Variance	
Galena-enriched Soil	0.011	0.009	82%	8.12E-05	0.045	0.012	26%	1.40E-04
California Gulch AV Slag	0.199	0.065	33%	4.26E-03	0.094	0.016	17%	2.64E-04
California Gulch Oregon Gulch Tailings	0.061	0.047	78%	2.24E-03	0.112	0.009	8%	7.73E-05
Midvale Slag	0.141	0.050	35%	2.49E-03	0.174	0.009	5%	8.93E-05
Butte Soil	0.144	0.049	34%	2.39E-03	0.223	0.006	2%	3.03E-05
Bingham Creek Channel Soil	0.266	0.053	20%	2.78E-03	0.378	0.007	2%	5.01E-05
Bingham Creek Residential	0.268	0.068	25%	4.58E-03	0.470	0.012	3%	1.45E-04
Palmerton Location 2	0.602	0.184	31%	3.38E-02	0.636	0.004	1%	1.29E-05
Murray Smelter Slag	0.401	0.132	33%	1.73E-02	0.643	0.073	11%	5.39E-03
Aspen Berm	0.740	0.182	25%	3.31E-02	0.649	0.016	2%	2.45E-04
California Gulch Phase I Residential Soil	0.723	0.212	29%	4.50E-02	0.651	0.015	2%	2.20E-04
Jasper County High Lead Smelter	0.609	0.108	18%	1.16E-02	0.693	0.055	8%	3.04E-03
Palmerton Location 4	0.493	0.136	28%	1.85E-02	0.697	0.027	4%	7.51E-04
Aspen Residential	0.749	0.164	22%	2.68E-02	0.714	0.020	3%	3.83E-04
NIST Paint (SRM 2589)	0.719	0.165	23%	2.72E-02	0.725	0.020	3%	4.12E-04
Murray Smelter Soil	0.508	0.164	32%	2.69E-02	0.747	0.068	9%	4.64E-03
Jasper County Low Lead Yard	0.900	0.178	20%	3.18E-02	0.790	0.056	7%	3.13E-03
Jasper County High Lead Mill	0.823	0.192	23%	3.68E-02	0.853	0.002	0%	2.97E-06
California Gulch Fe/Mn PbO	1.049	0.299	28%	8.93E-02	0.872	0.005	1%	2.37E-05

APPENDIX D

FIGURE D-1. DOSE-RESPONSE CURVE FOR GALENA

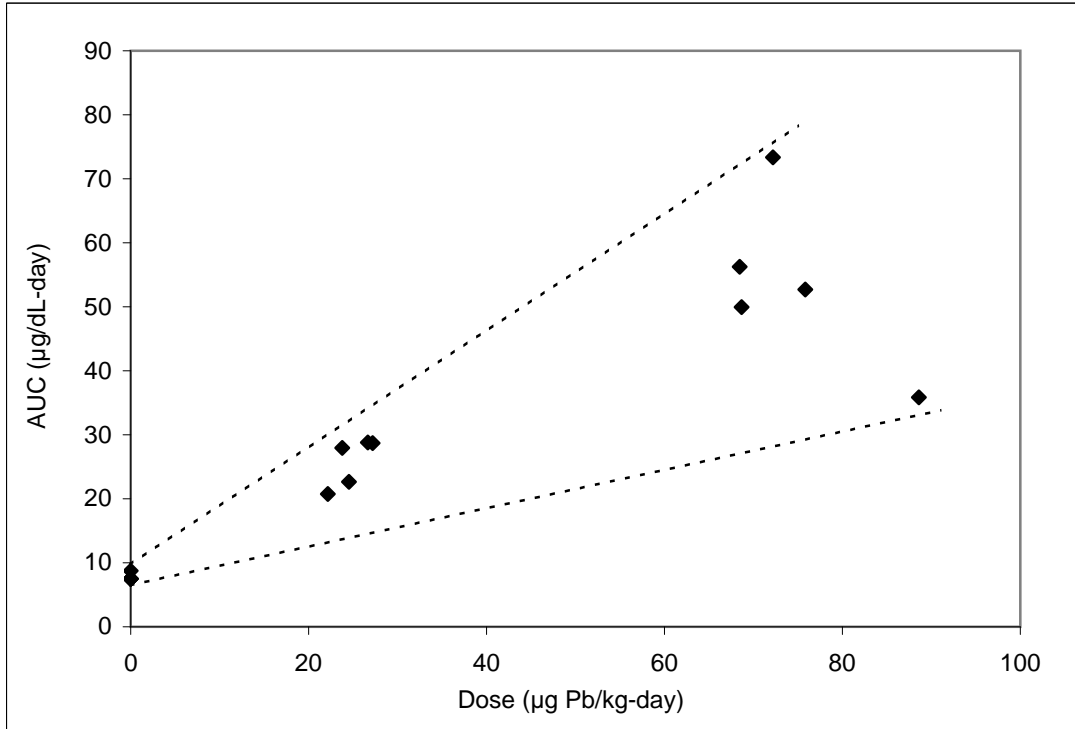
Experiment 12 Blood AUC: Test Material 1 (Galena-enriched soil)



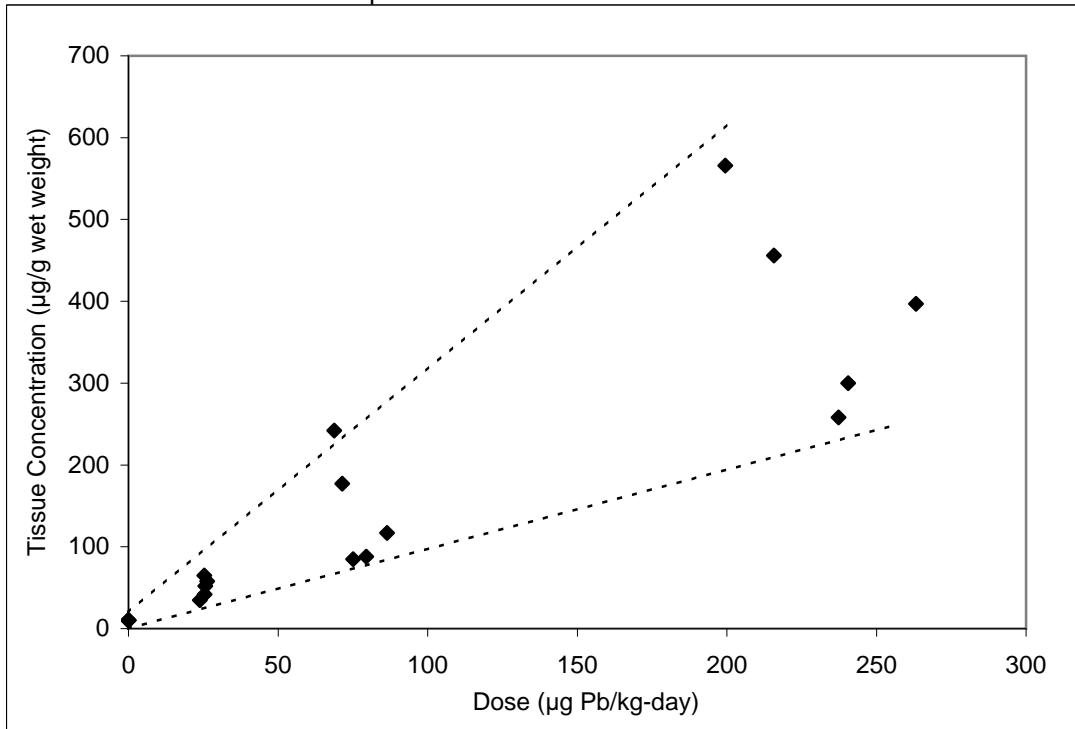
APPENDIX D

FIGURE D-2. EXAMPLES OF HETEROSCEDASTICITY

Experiment 9 Blood AUC: Lead Acetate



Experiment 7 Liver: Test Material 2



APPENDIX D

**FIGURE D-3. EXAMPLE OF POOR FIT DUE TO LOW VARIANCE
IN SOME DOSE GROUPS**

Option 1, Linear Fit: Experiment 12 Liver, Lead Acetate

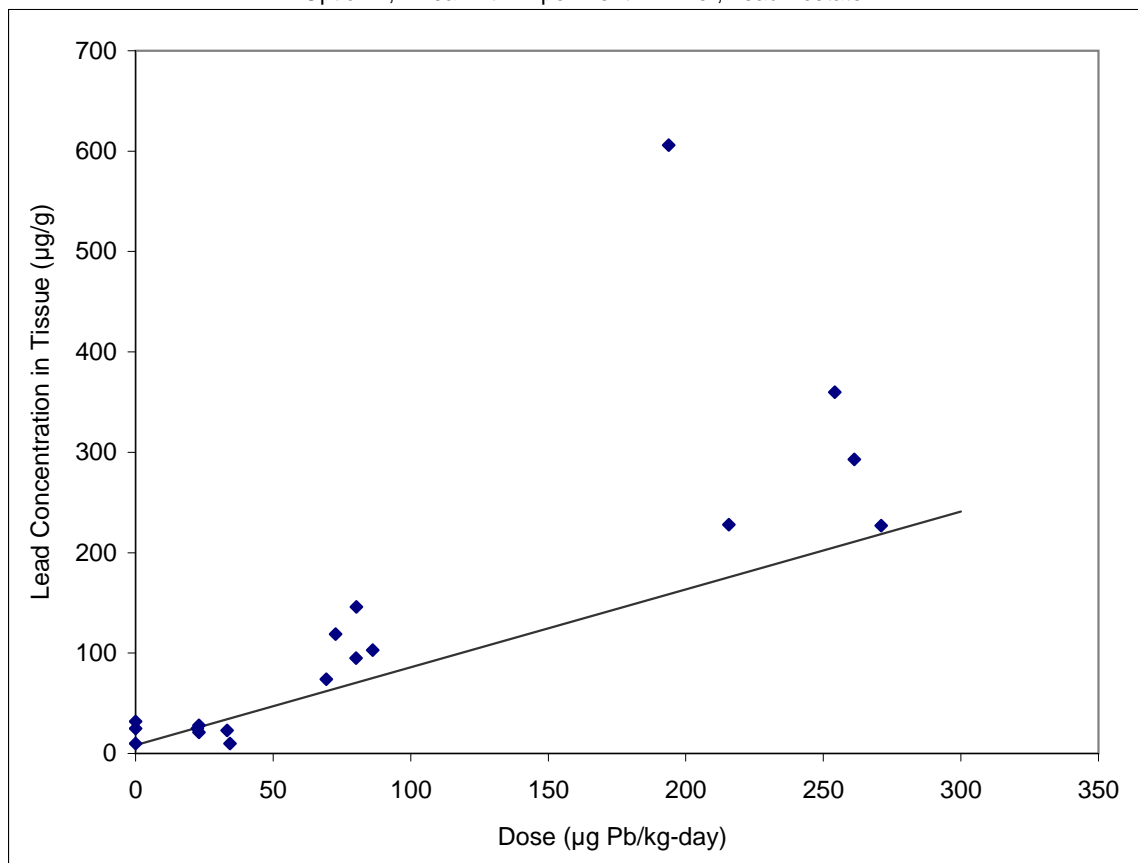


FIGURE D-4. VARIANCE MODELS

All Phase II Lead Studies. Data Quality Exclusion Rules Enforced.

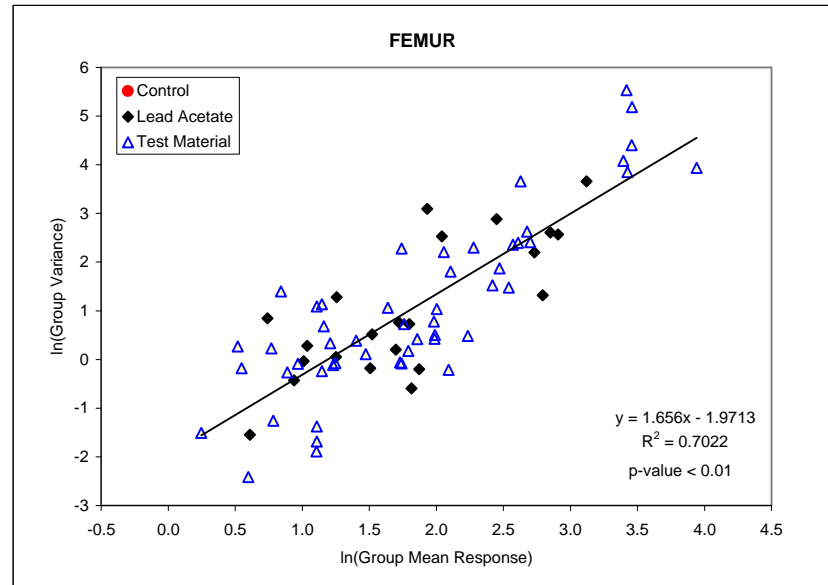
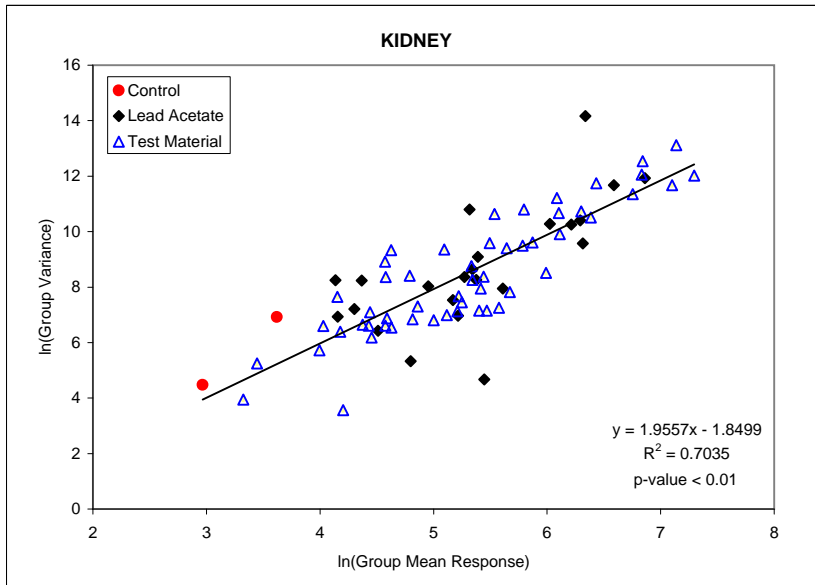
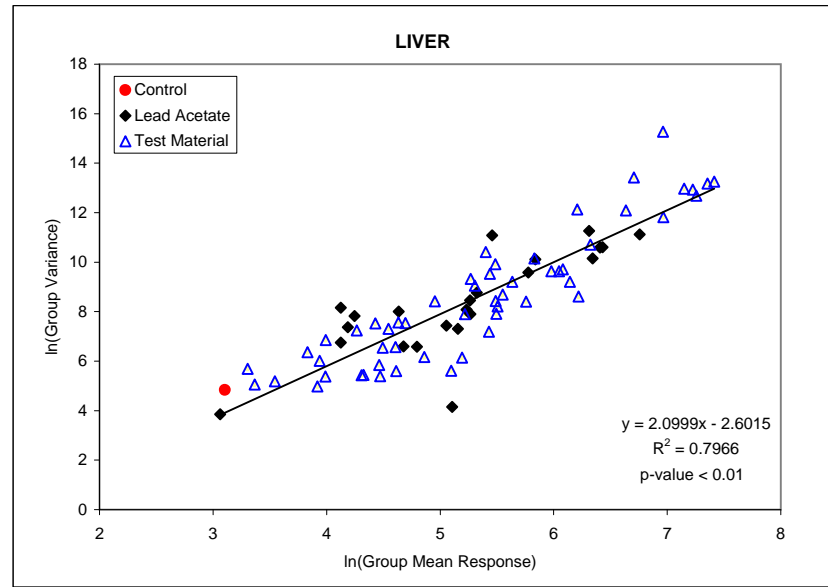
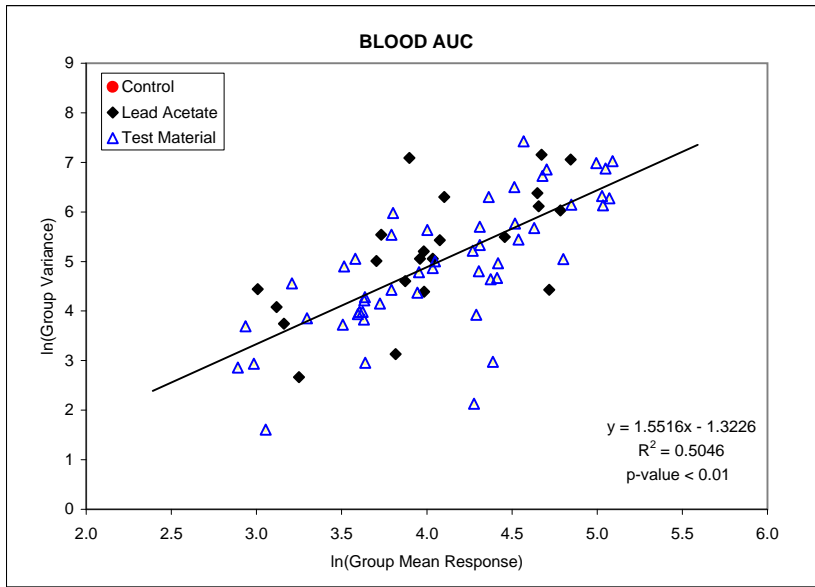
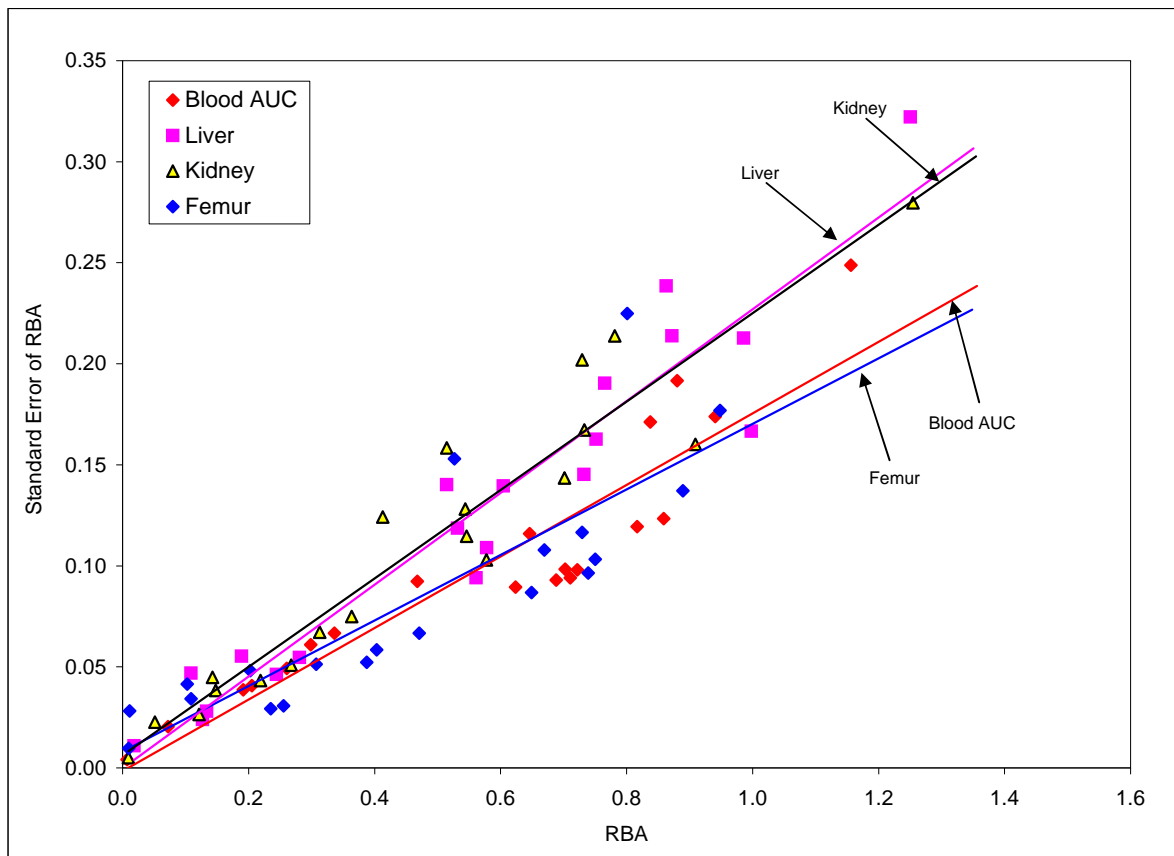


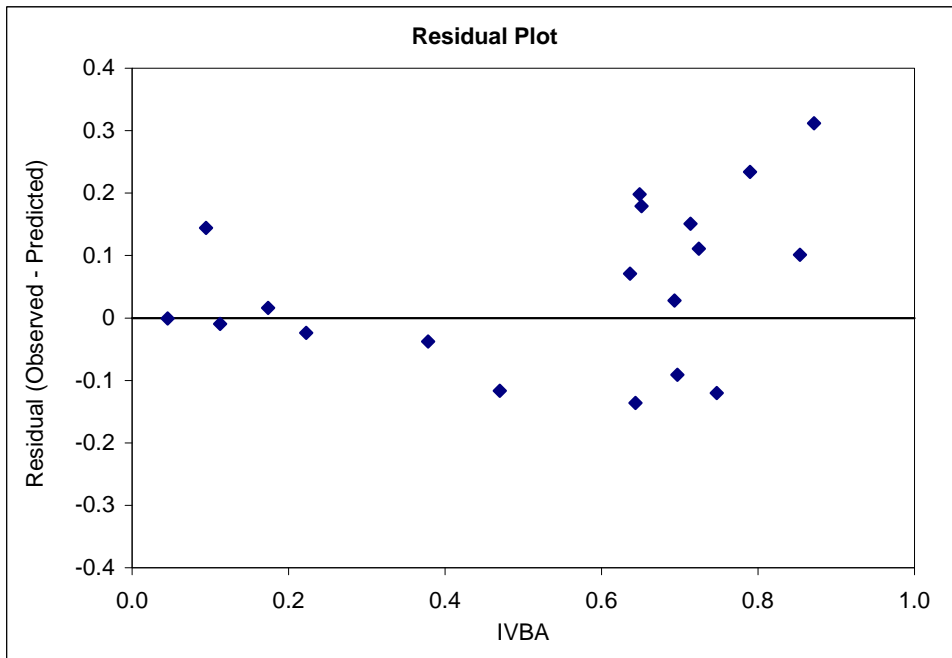
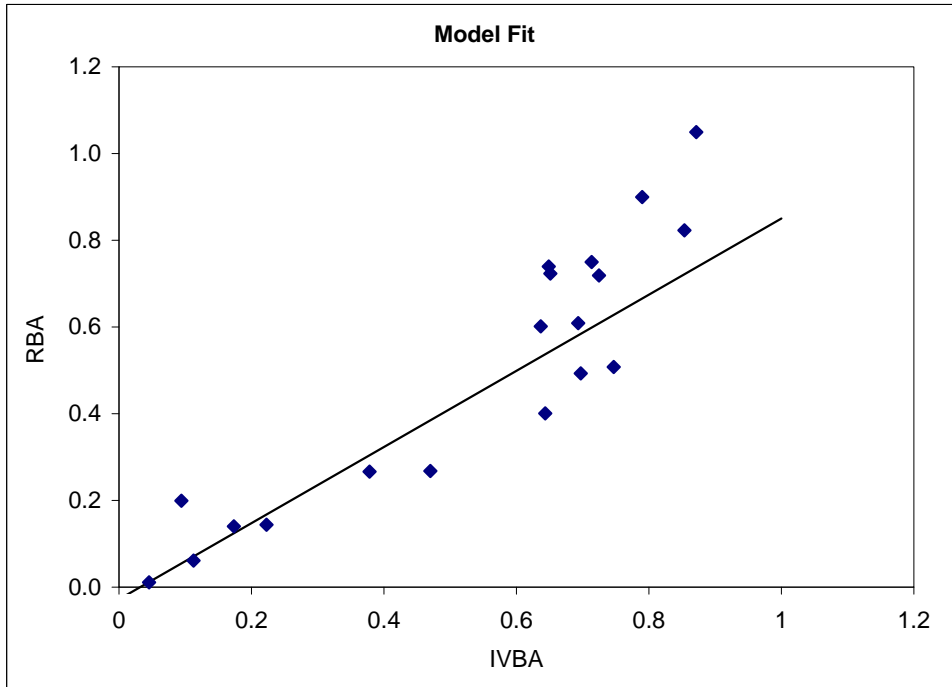
FIGURE D-5. EVALUATION OF RELATIVE PRECISION OF MEASUREMENT ENDPOINTS



Endpoint	Slope	Intercept	R ²
Blood AUC	0.177	-0.002	0.867
Liver	0.227	0.000	0.916
Kidney	0.219	0.006	0.914
Femur	0.162	0.008	0.732

Comparison of Regression Lines	
F	0.638
Fcrit(0.05)	2.227
p	0.699

FIGURE D-6. FIT OF DIFFERENT MODELS TO IVBA-RBA DATA
Panel A: Linear Model ($y = a + b \cdot x$)



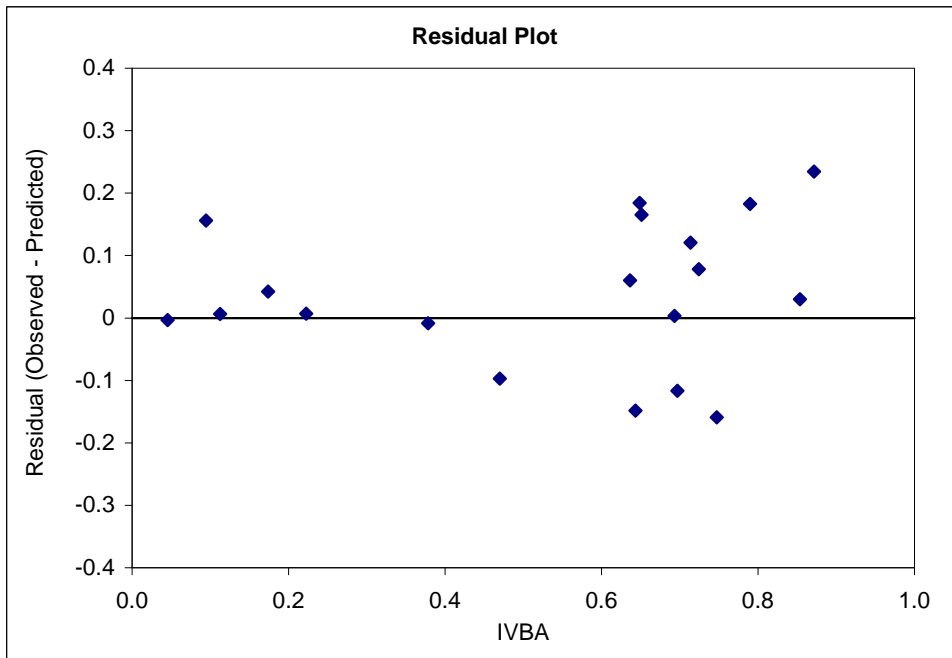
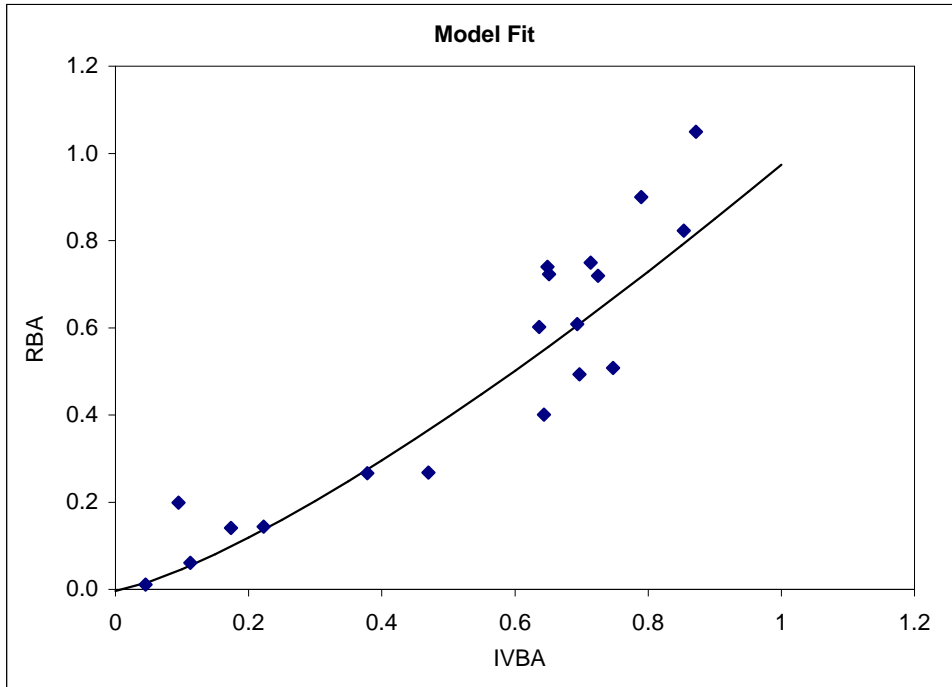
Parameter Estimates

a	-0.0281
b	0.8782

Fit Statistics

r^2	0.9243
Adj r^2	0.9199
AIC	-30.46

FIGURE D-6, Continued. FIT OF DIFFERENT MODELS TO IVBA-RBA DATA
Panel B: Power Model ($y = a + b \cdot x^c$)



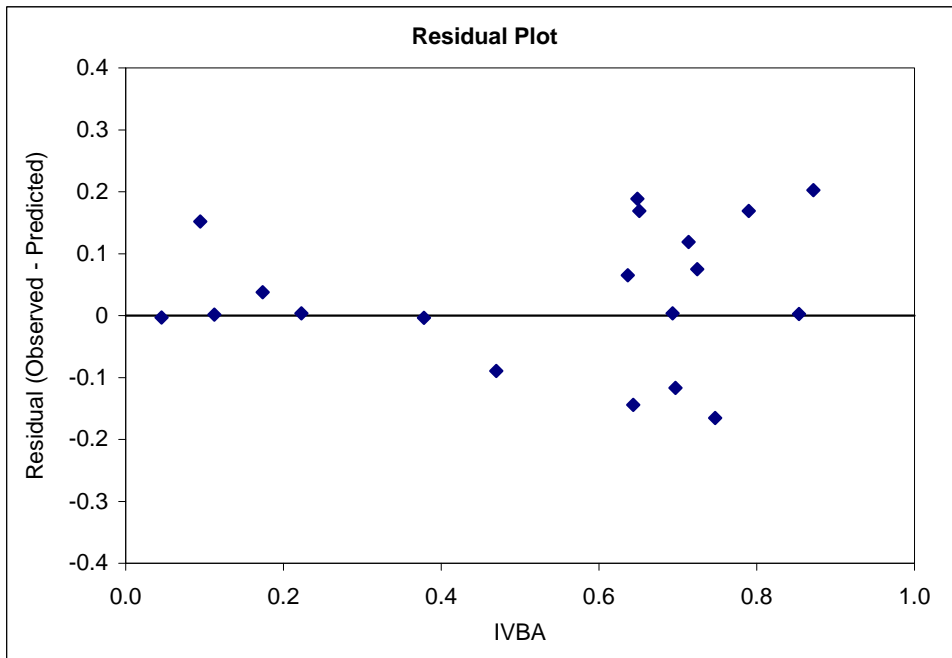
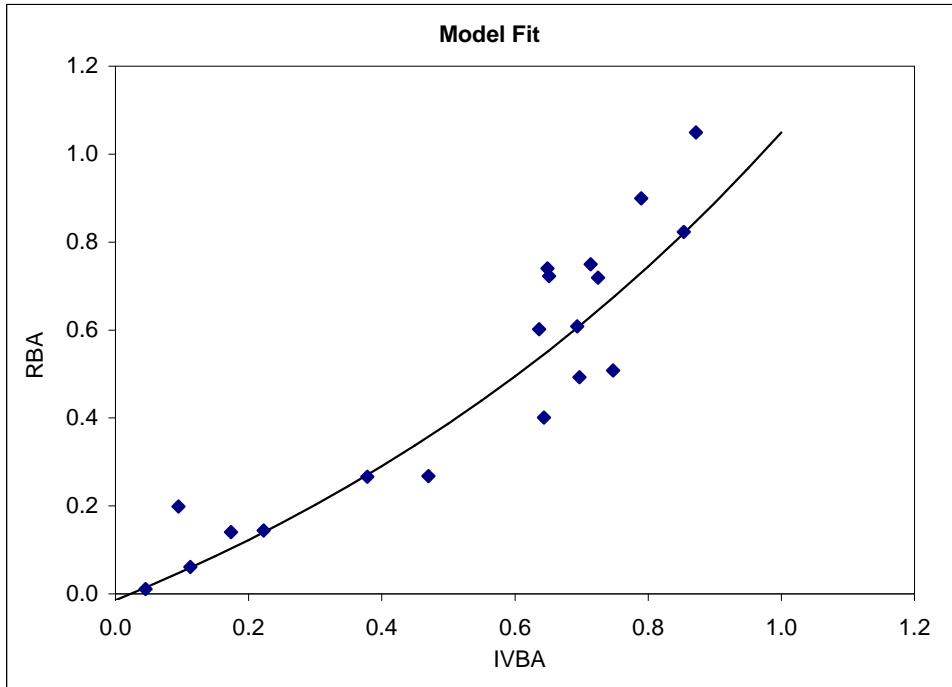
Parameter Estimates

a	-0.0033
b	0.9775
c	1.2933

Fit Statistics

R ²	0.9307
Adj R ²	0.9220
AIC	-29.92

FIGURE D-6, Continued. FIT OF DIFFERENT MODELS TO IVBA-RBA DATA
Panel C: 2-Parameter Exponential Model ($y = a + b \cdot \exp(x)$)



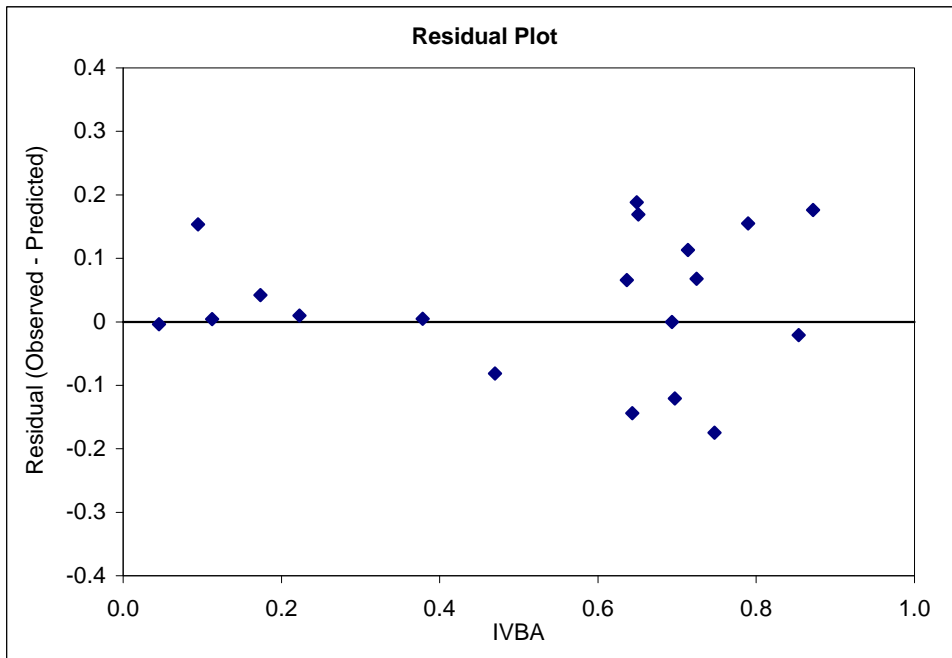
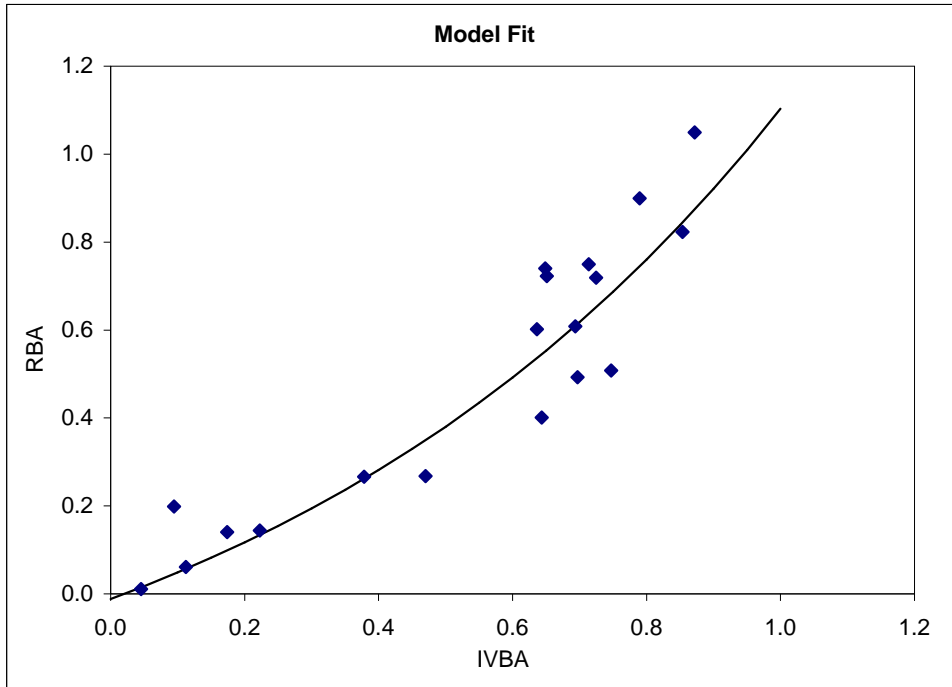
Parameter Estimates

a	-0.6339
b	0.6193

Fit Statistics

R ²	0.9355
Adj R ²	0.9317
AIC	-33.02

FIGURE D-6, Continued. FIT OF DIFFERENT MODELS TO IVBA-RBA DATA
Panel D: 3-Parameter Exponential Model ($y = a + b \cdot \exp(c \cdot x)$)



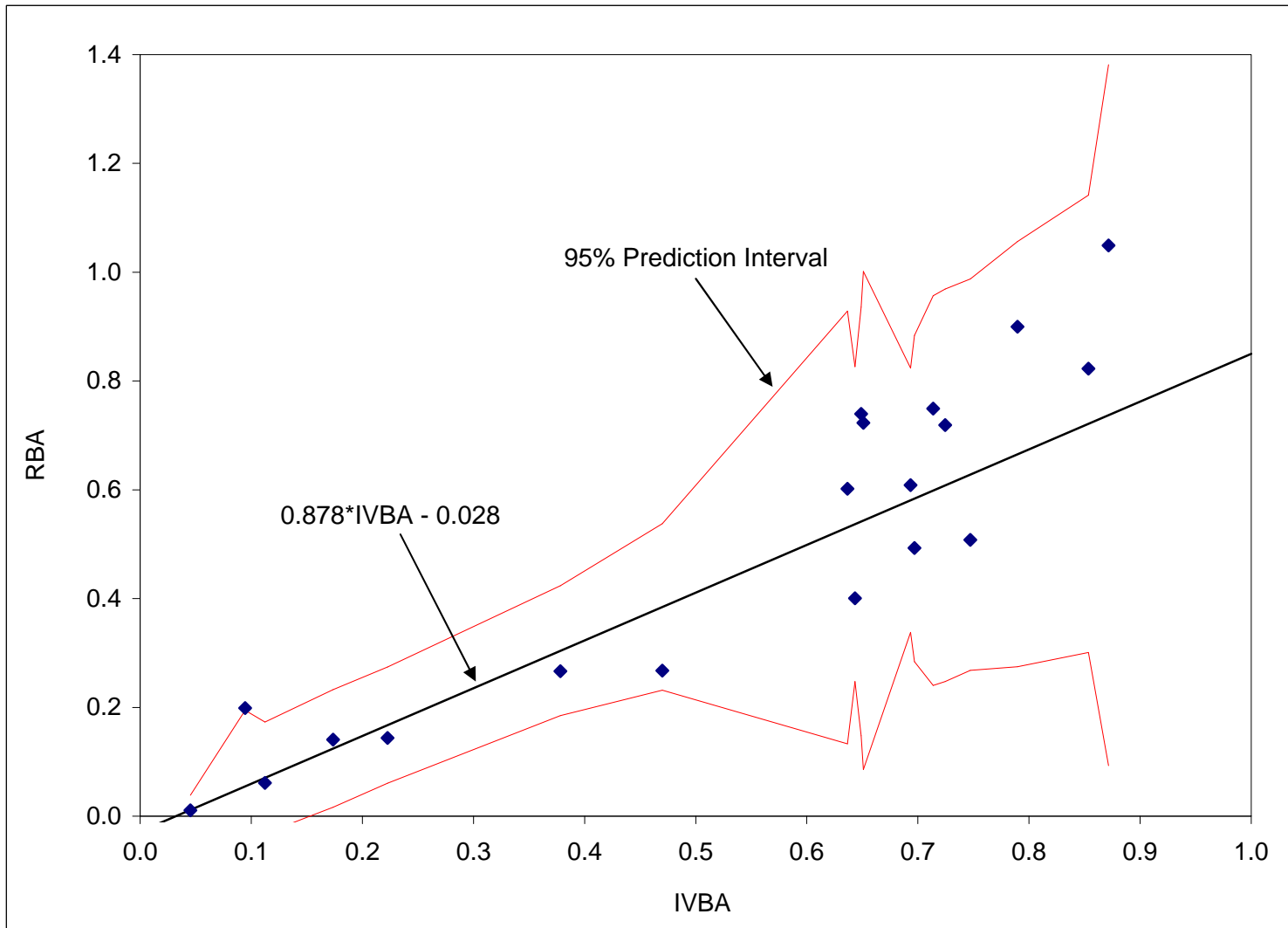
Parameter Estimates

a	-0.4756
b	0.4639
c	1.2245

Fit Statistics

R ²	0.9359
Adj R ²	0.9279
AIC	-31.11

FIGURE D-7. PREDICTION INTERVAL FOR RBA BASED ON MEASURED IVBA



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APPENDIX E

**DETAILED DOSE-RESPONSE DATA AND
MODEL FITTING RESULTS**

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APPENDIX E

EXPERIMENT 1a **Effects of Food**

Test Material 1: Lead Acetate, simultaneous with feeding

Test Material 2: Lead Acetate, 2 hours after feeding

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

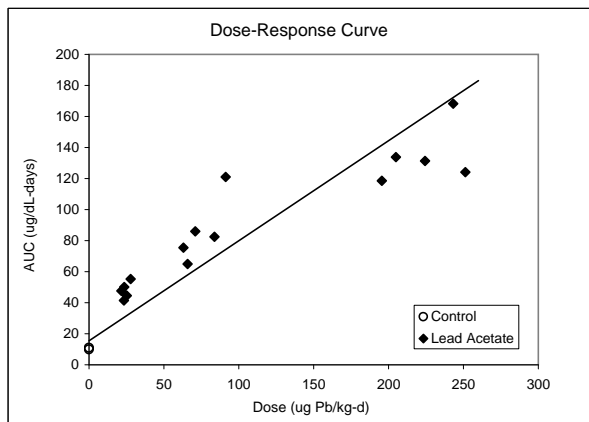
APPENDIX E

Figure 1a - All Data

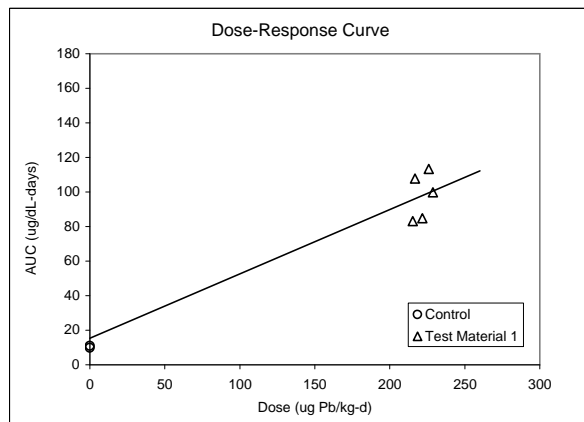
Phase II Experiment 1a: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

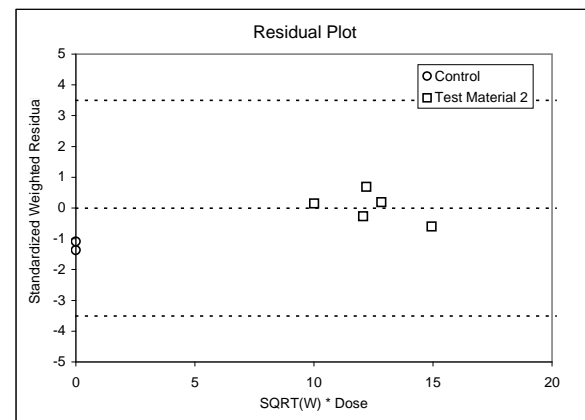
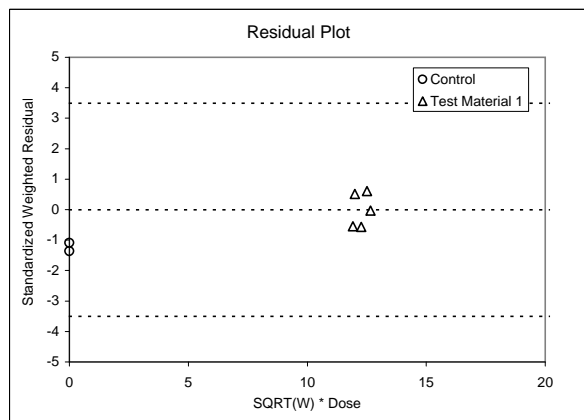
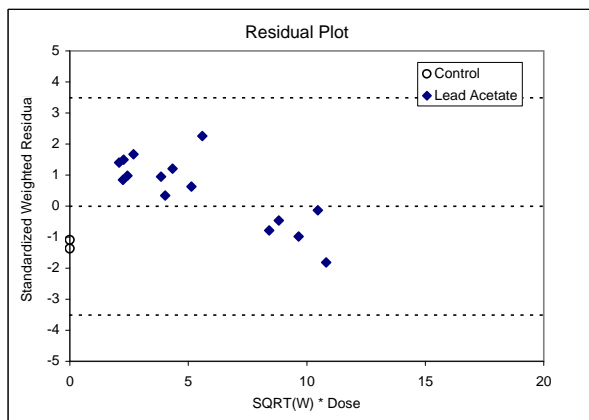
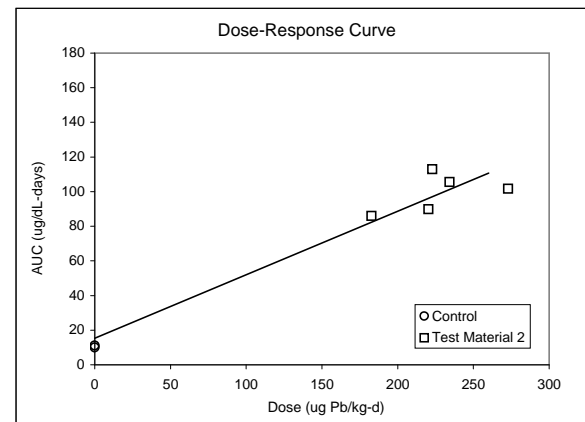
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.54E+01	2.81E+00
b1	6.45E-01	5.97E-02
b2	3.72E-01	5.15E-02
b3	3.66E-01	5.04E-02
Covariance (c1,c2)	0.0887	--
Covariance (c1,c3)	0.0872	--
Degrees of Freedom	23	--

Goodness of Fit

Statistic	Estimate
F	64.226
p	< 0.001
Adjusted R ²	0.8795
AIC	246.105

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.58	0.57
Lower bound	0.43	0.42
Upper bound	0.75	0.74
Standard Error	0.092	0.090

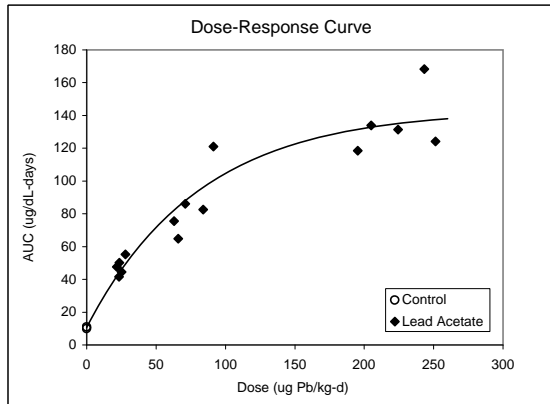
APPENDIX E

Figure 1b - All Data

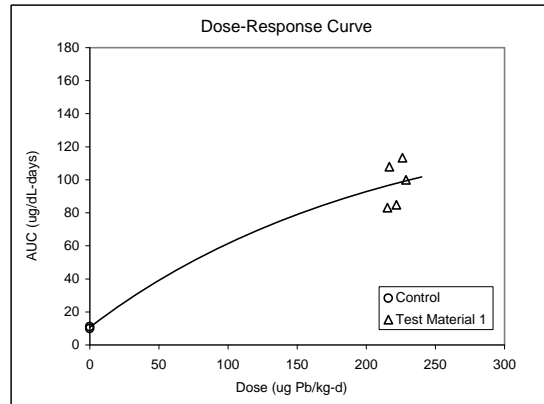
Phase II Experiment 1a: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

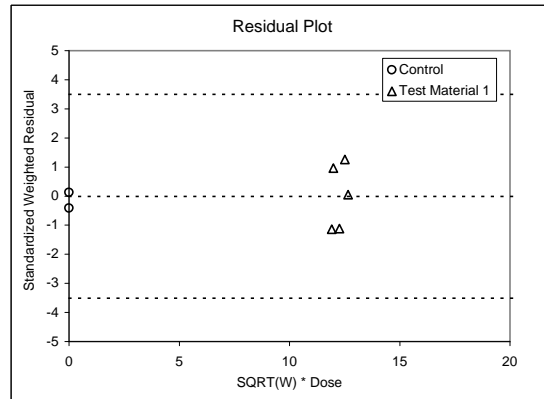
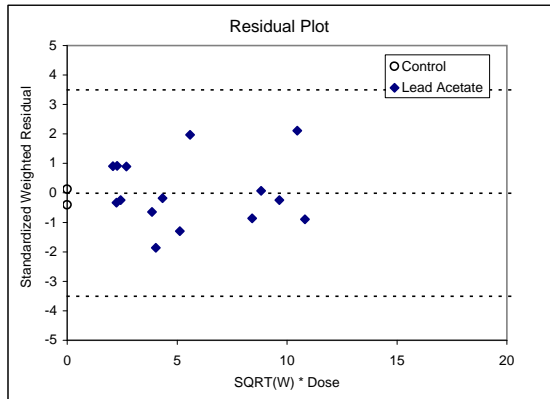
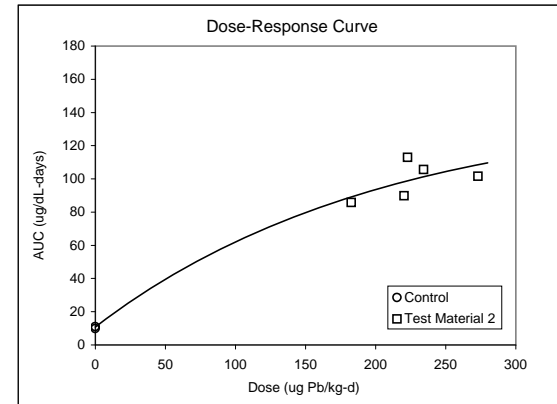
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.07E+01	1.55E+00
b	1.33E+02	1.04E+01
c1	1.23E-02	1.88E-03
c2	4.81E-03	8.84E-04
c3	4.88E-03	9.19E-04
Covariance (c1,c2)	0.6771	--
Covariance (c1,c3)	0.6779	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	202.312
p	< 0.001
Adjusted R ²	0.9687
AIC	215.723

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.39	0.40
Lower bound	0.30	0.30
Upper bound	0.49	0.50
Standard Error	0.054*	0.056*

* $g \geq 0.05$, estimate is uncertain

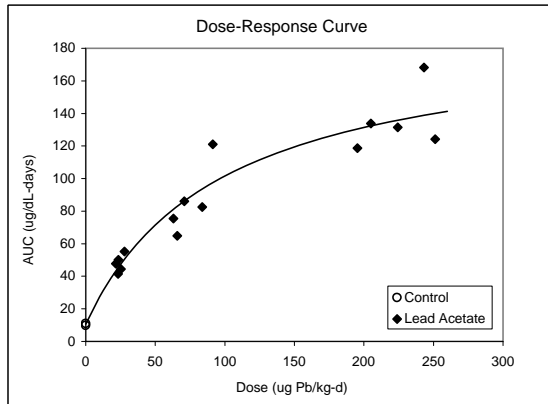
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Figure 1c - All Data

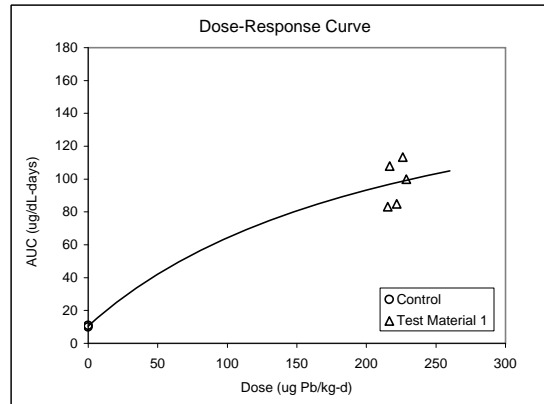
Phase II Experiment 1a: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

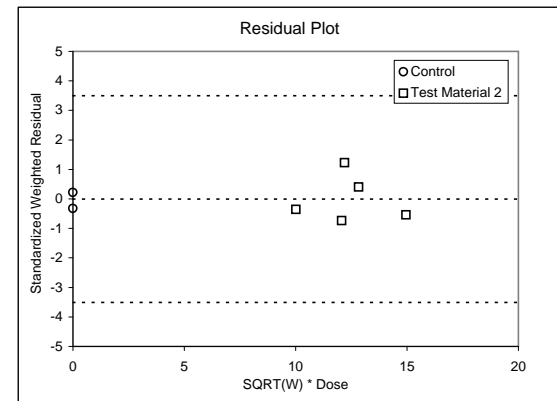
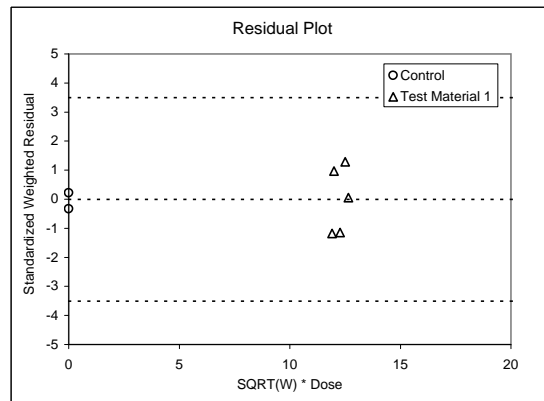
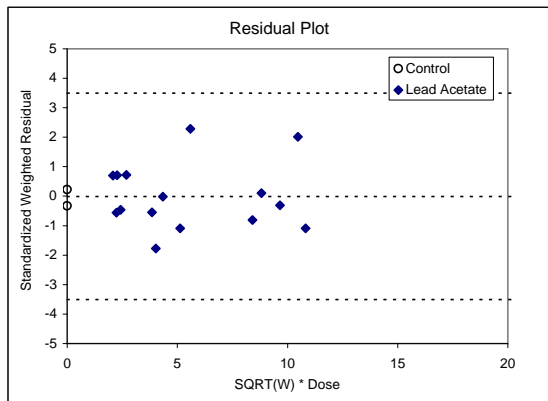
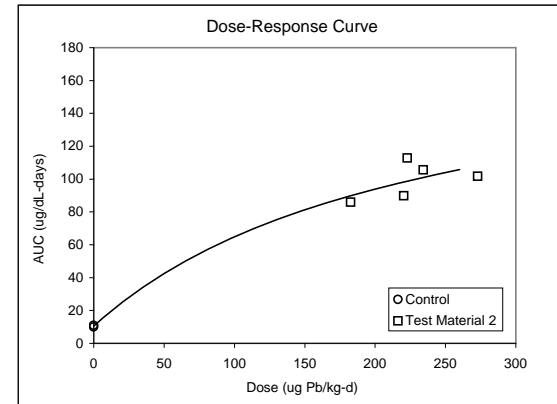
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.06E+01	1.53E+00
b	1.80E+02	1.89E+01
c1	9.75E+01	2.02E+01
c2	2.35E+02	5.70E+01
c3	2.31E+02	5.70E+01
Covariance (c1,c2)	0.8053	--
Covariance (c1,c3)	0.8061	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	211.024
p	< 0.001
Adjusted R ²	0.9700
AIC	215.293

RBA and Uncertainty

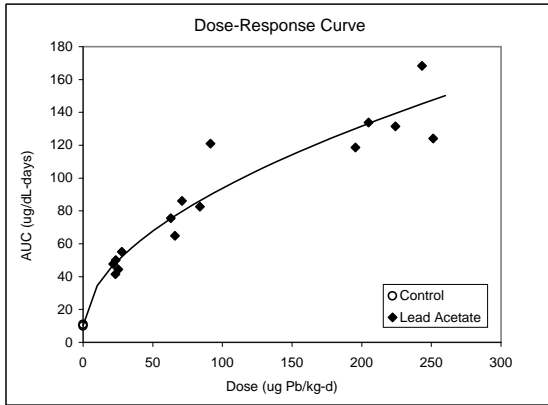
	PbAc, 0 hr	PbAc, +2 hr
RBA	0.42	0.42
Lower bound	0.33	0.33
Upper bound	0.56	0.57
Standard Error	0.060*	0.062*

* g ≥ 0.05, estimate is uncertain

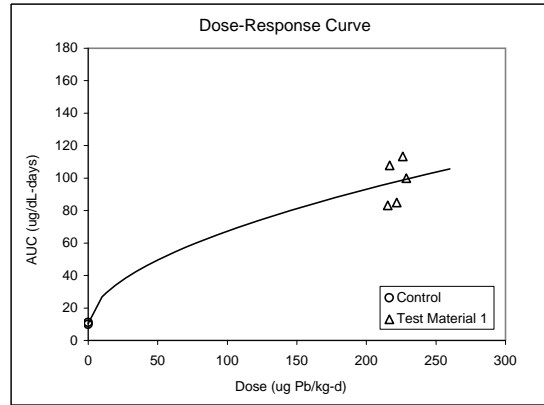
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Figure 1d - All Data
Phase II Experiment 1a: Blood AUC
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

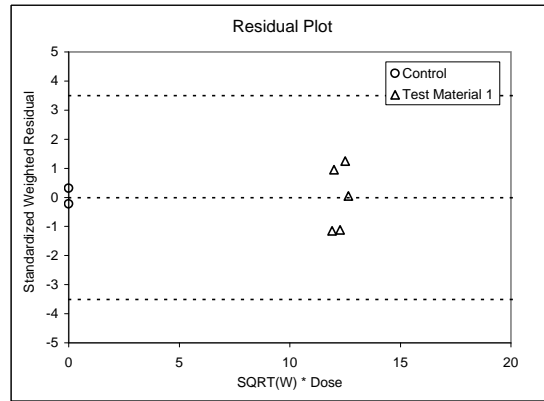
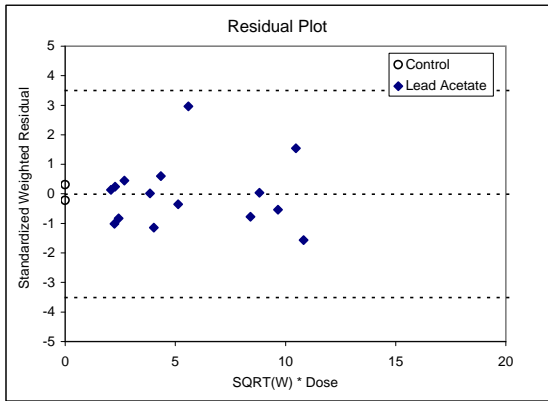
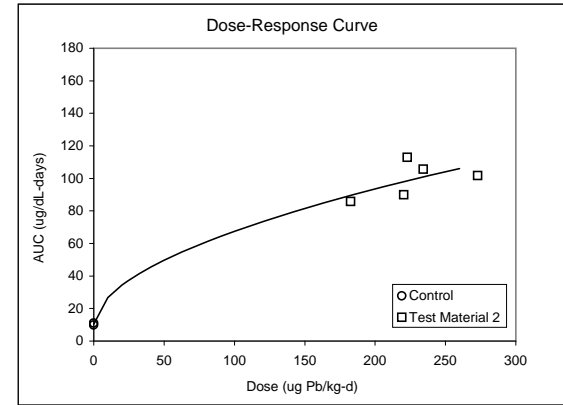
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.04E+01	1.58E+00
b1	6.94E+00	1.53E+00
b2	4.74E+00	1.23E+00
b3	4.75E+00	1.24E+00
c	5.40E-01	4.57E-02
Covariance (b1,b2)	0.9528	--
Covariance (b1,b3)	0.9534	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	199.941
p	< 0.001
Adjusted R ²	0.9684
AIC	215.846

RBA and Uncertainty

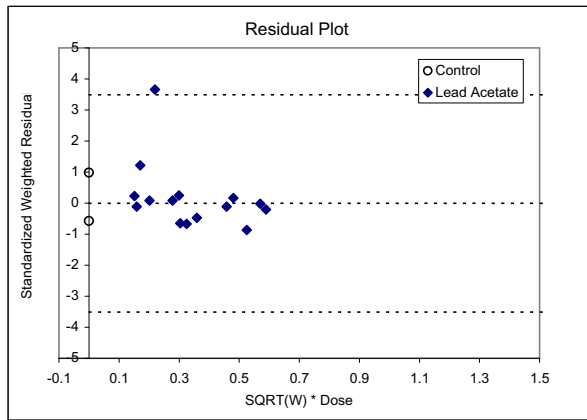
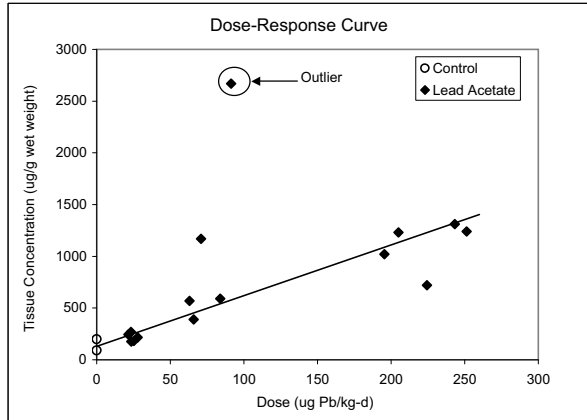
	PbAc, 0 hr	PbAc, +2 hr
RBA	0.49	0.50
Lower bound	0.34	0.34
Upper bound	0.62	0.63
Standard Error	--	--

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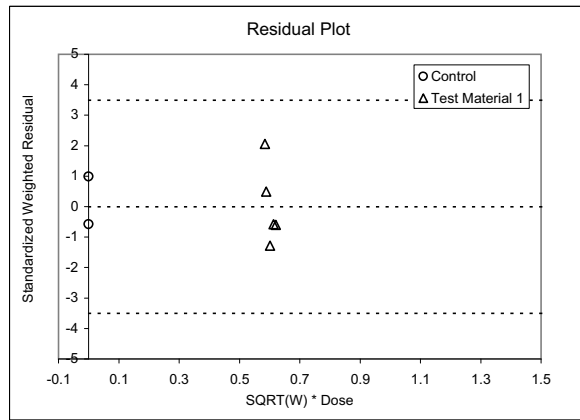
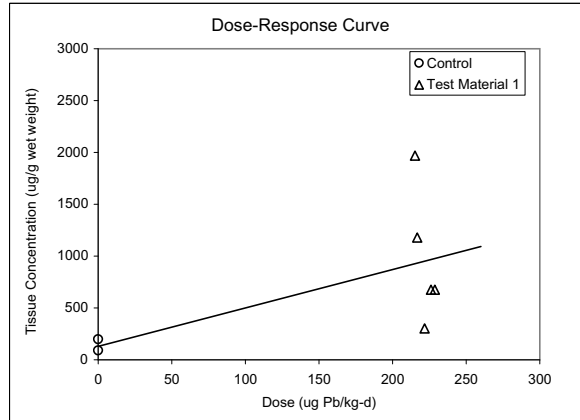
Figure 2a - All Data

Phase II Experiment 1a: Liver
 Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

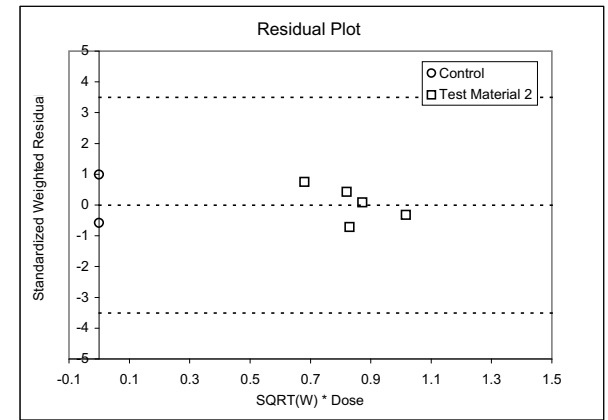
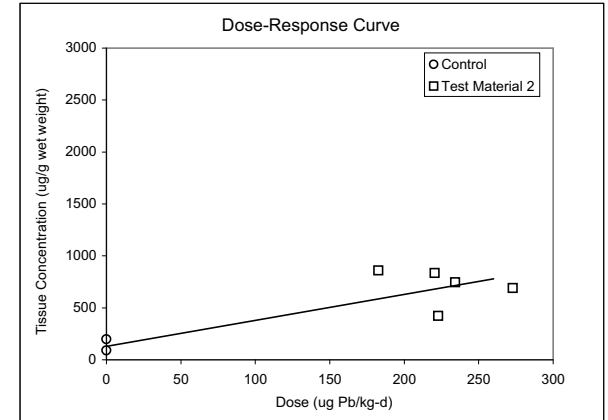
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.30E+02	4.11E+01
b1	4.89E+00	1.18E+00
b2	3.70E+00	1.11E+00
b3	2.49E+00	7.94E-01
Covariance (c1,c2)	0.0810	--
Covariance (c1,c3)	0.1091	--
Degrees of Freedom	23	--

Goodness of Fit

Statistic	Estimate
F	11.055
p	< 0.001
Adjusted R ²	0.5371
AIC	402.563

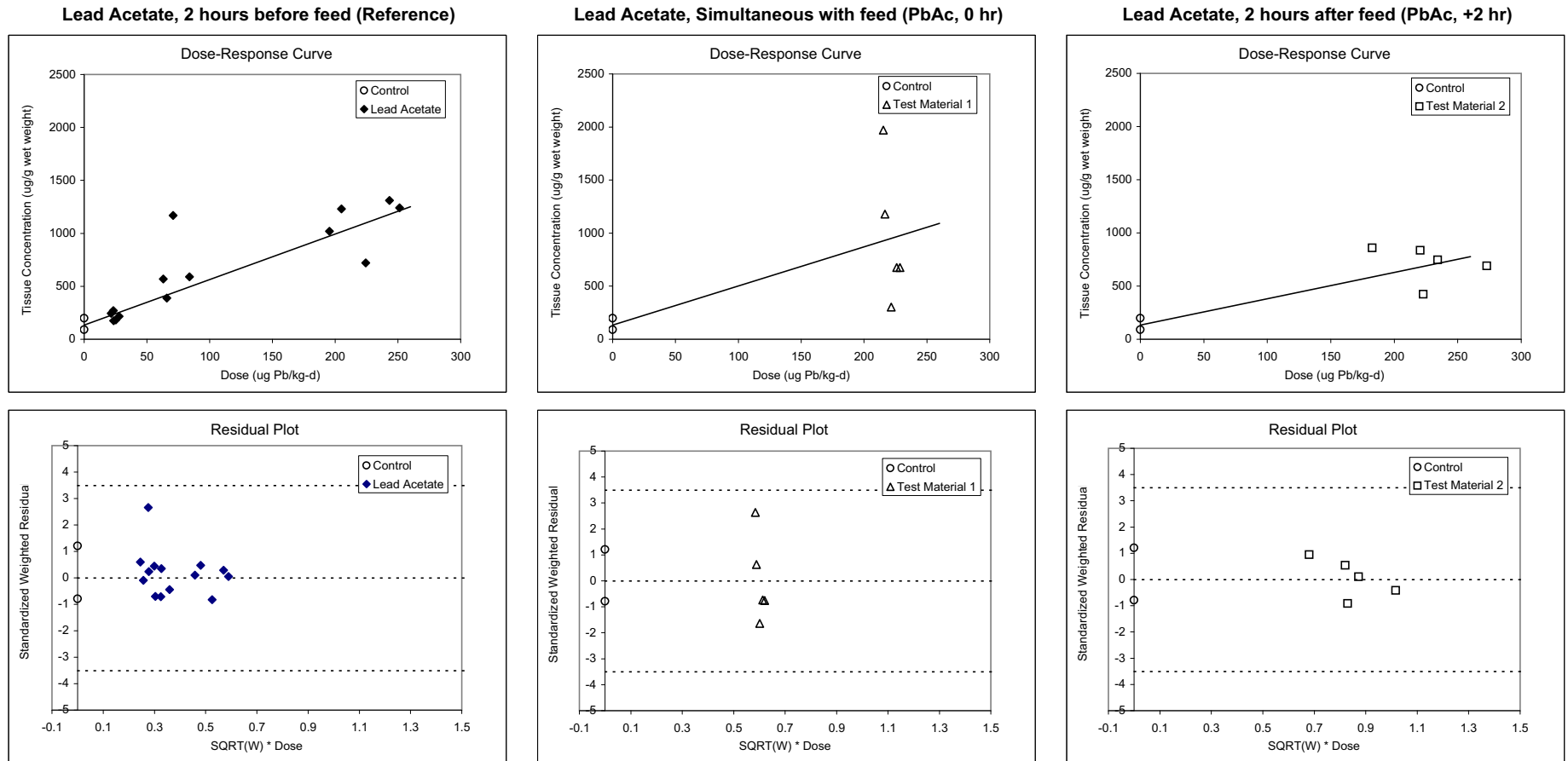
RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.76	0.51
Lower bound	0.35	0.23
Upper bound	1.44	0.97
Standard Error	0.279*	0.192*

* $g \geq 0.05$, estimate is uncertain

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Figure 2a - Outlier Excluded
Phase II Experiment 1a: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.33E+02	2.91E+01
b1	4.31E+00	8.43E-01
b2	3.69E+00	7.86E-01
b3	2.48E+00	5.63E-01
Covariance (c1,c2)	0.0807	--
Covariance (c1,c3)	0.1085	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	16.332
p	< 0.001
Adjusted R ²	0.6479
AIC	364.272

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.86	0.58
Lower bound	0.51	0.34
Upper bound	1.40	0.94
Standard Error	0.238*	0.163*

* $g \geq 0.05$, estimate is uncertain

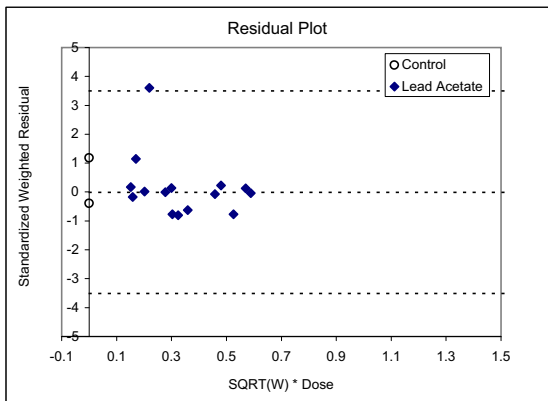
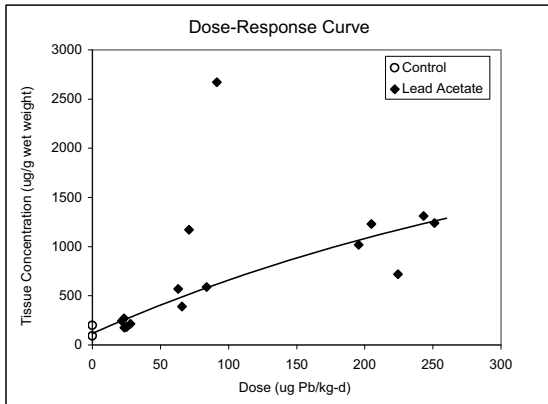
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Figure 2b - All Data

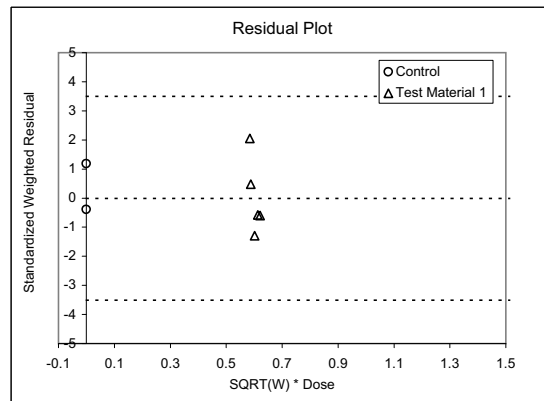
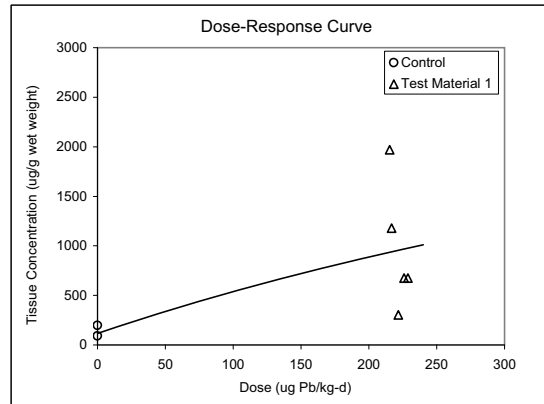
Phase II Experiment 1a: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

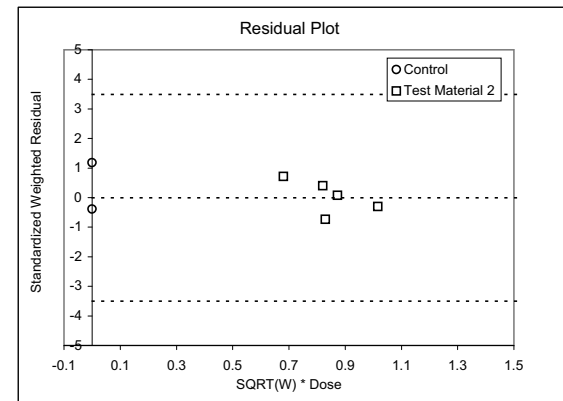
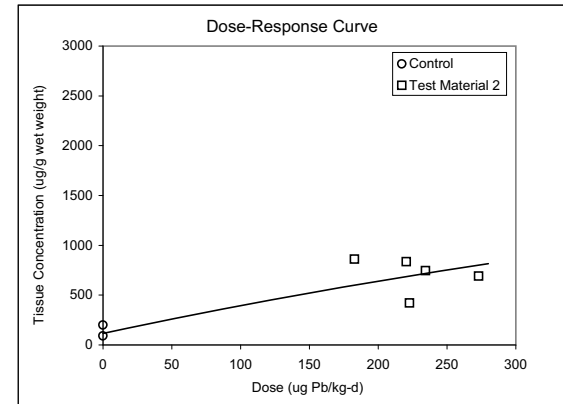
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.17E+02	5.17E+01
b	2.45E+03	4.45E+03
c1	2.50E-03	5.67E-03
c2	1.88E-03	4.39E-03
c3	1.20E-03	2.61E-03
Covariance (c1,c2)	0.9805	--
Covariance (c1,c3)	0.9802	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	8.087
p	< 0.001
Adjusted R ²	0.5216
AIC	403.989

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.75	0.48
Lower bound	?	?
Upper bound	?	?
Standard Error	0.345*	0.216*

* $g \geq 0.05$, estimate is uncertain

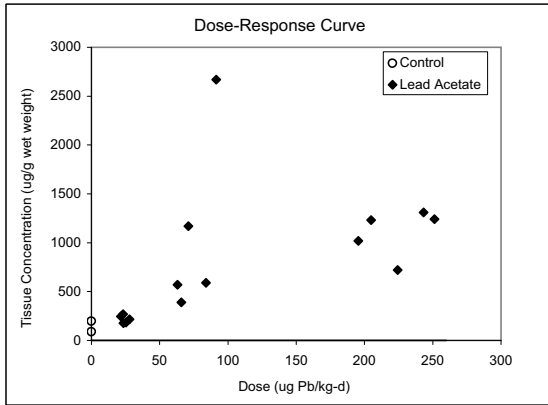
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Figure 2c - All Data

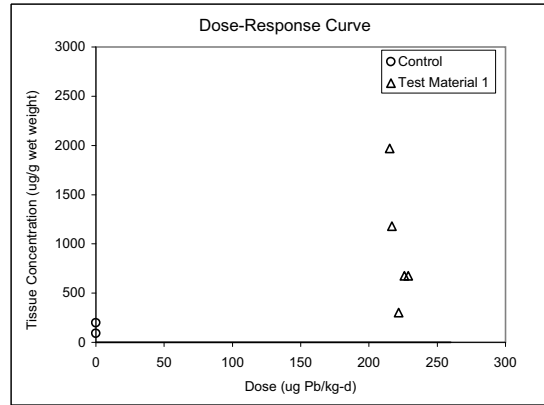
Phase II Experiment 1a: Liver

Michaelis-Menton Model: $y = a + b \cdot x1 / (c1 + x1) + b \cdot x2 / (c2 + x2) + b \cdot x3 / (c3 + x3)$

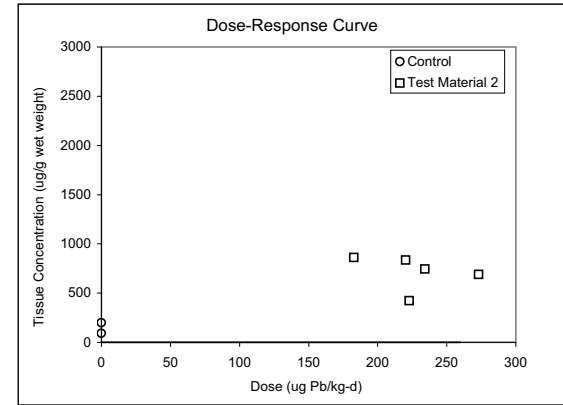
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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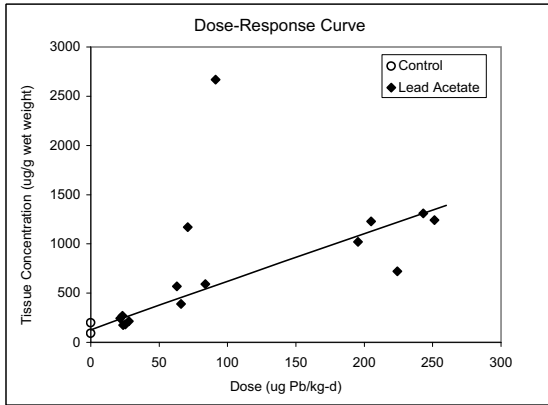
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Figure 2d - All Data

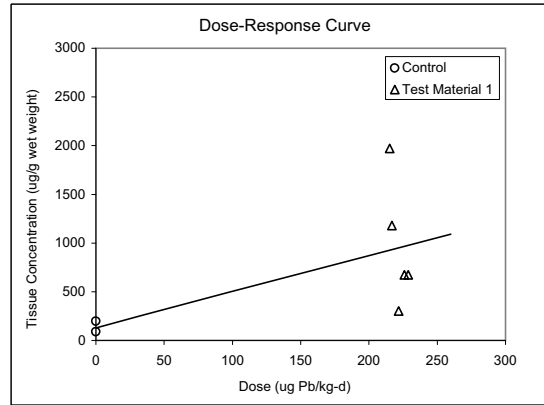
Phase II Experiment 1a: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

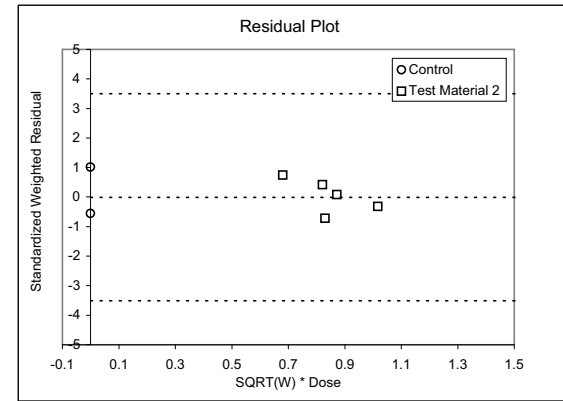
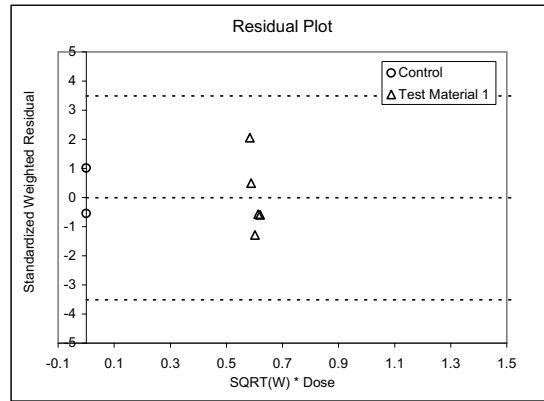
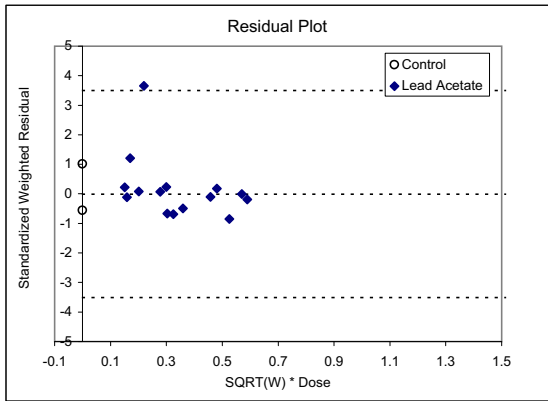
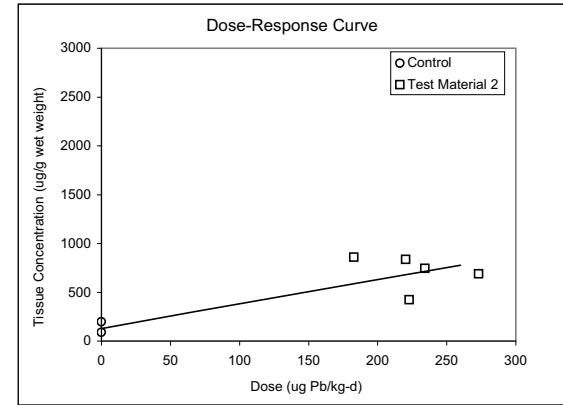
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.28E+02	5.30E+01
b1	5.34E+00	7.63E+00
b2	4.06E+00	6.34E+00
b3	2.74E+00	4.37E+00
c	9.83E-01	2.76E-01
Covariance (b1,b2)	0.9689	--
Covariance (b1,b3)	0.9684	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	7.934
p	< 0.001
Adjusted R ²	0.5162
AIC	404.552

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.76	0.51
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

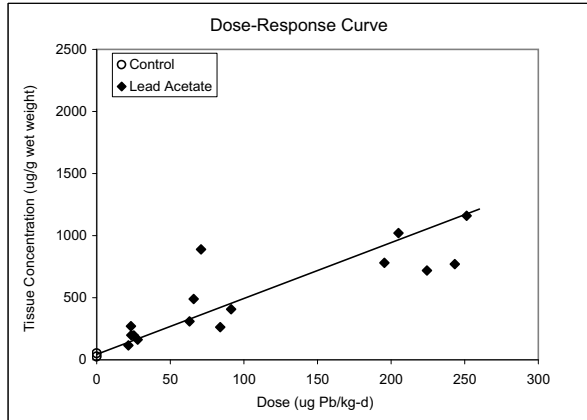
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Figure 3a - All Data

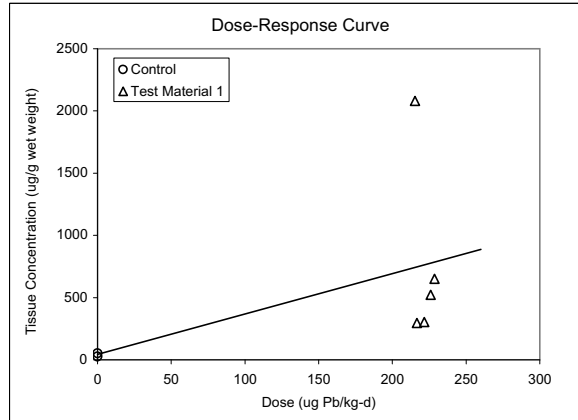
Phase II Experiment 1a: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

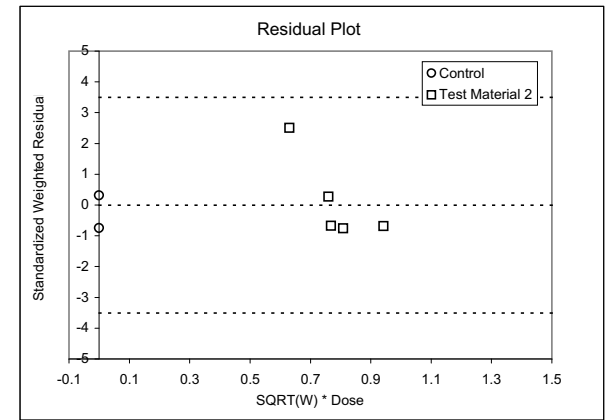
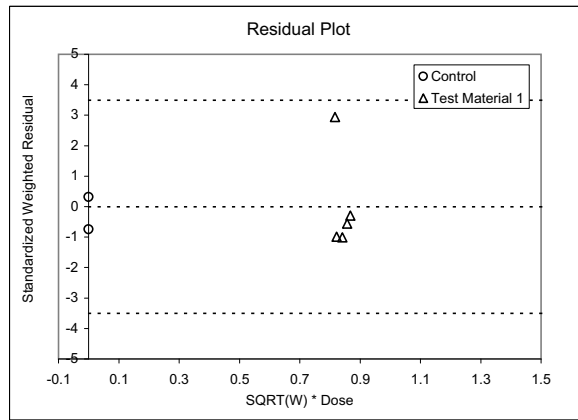
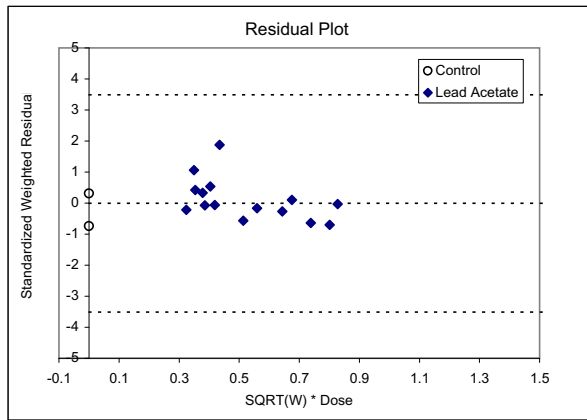
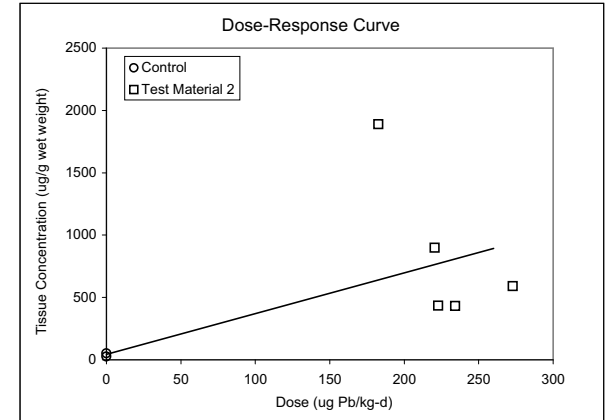
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.43E+01	1.79E+01
b1	4.50E+00	8.93E-01
b2	3.24E+00	9.81E-01
b3	3.26E+00	1.05E+00
Covariance (c1,c2)	0.0197	--
Covariance (c1,c3)	0.0178	--
Degrees of Freedom	23	--

Goodness of Fit

Statistic	Estimate
F	14.903
p	< 0.001
Adjusted R ²	0.6160
AIC	408.462

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.72	0.73
Lower bound	0.33	0.31
Upper bound	1.29	1.32
Standard Error	0.259*	0.271*

* $g \geq 0.05$, estimate is uncertain

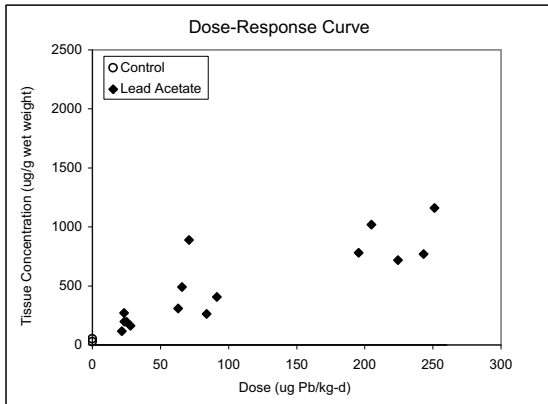
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Figure 3b - All Data

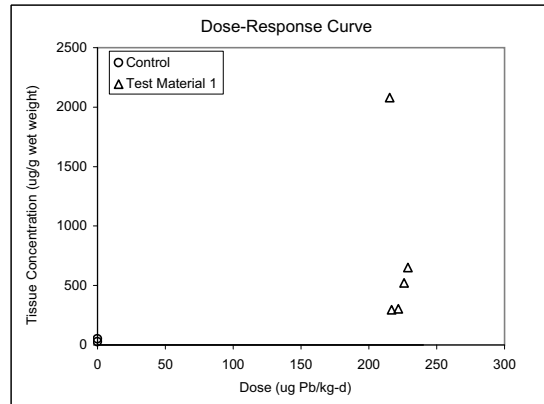
Phase II Experiment 1a: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

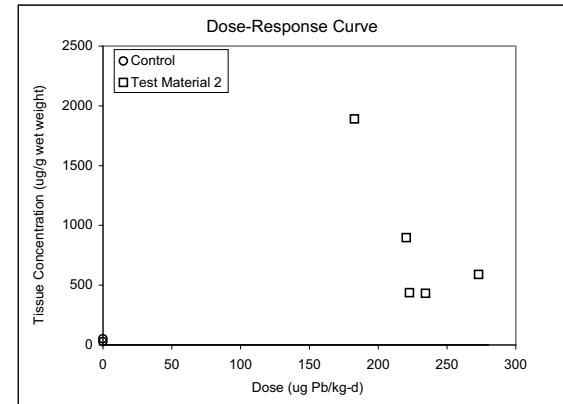
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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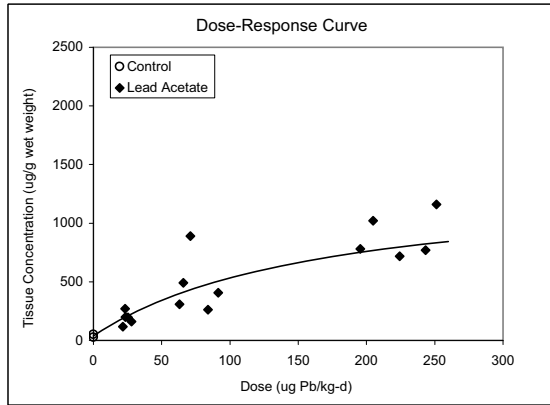
APPENDIX E

Figure 3c - All Data

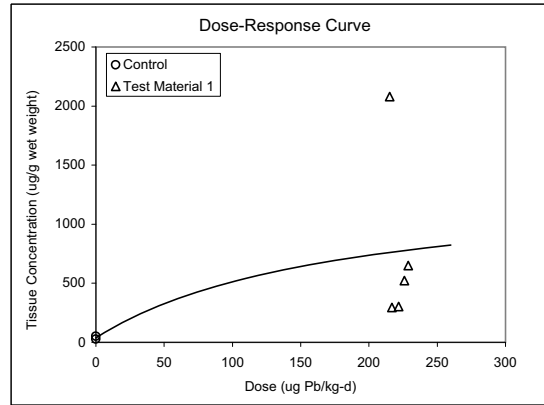
Phase II Experiment 1a: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

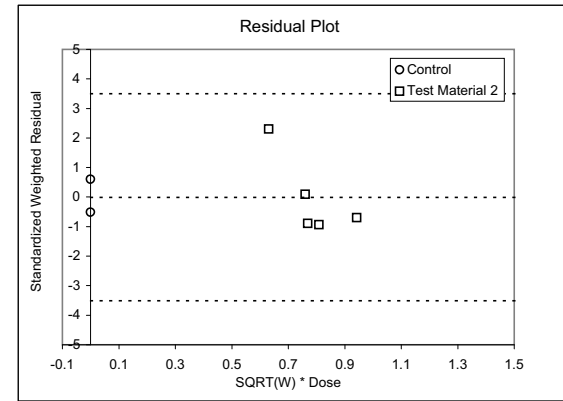
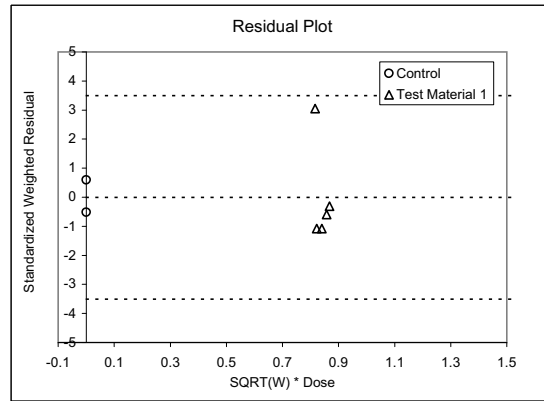
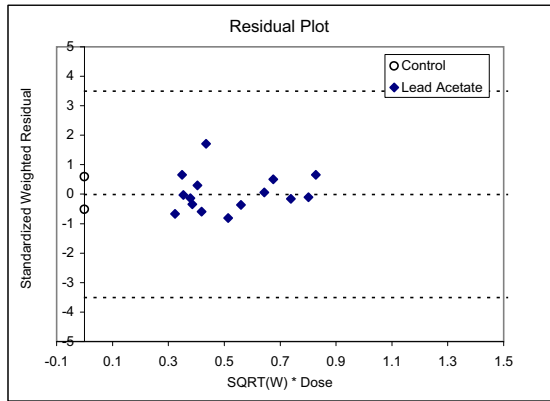
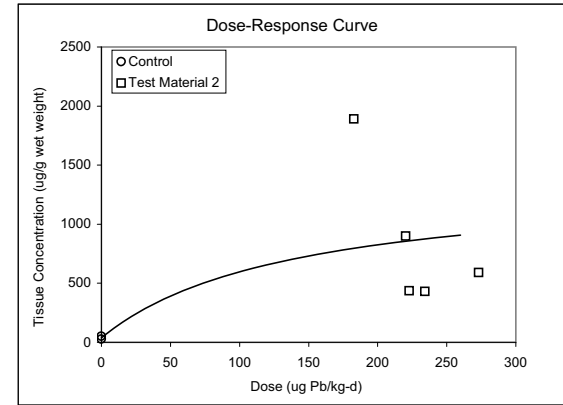
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	3.80E+01	1.79E+01
b	1.33E+03	9.08E+02
c1	1.69E+02	1.69E+02
c2	1.81E+02	2.99E+02
c3	1.38E+02	2.69E+02
Covariance (c1,c2)	0.8873	--
Covariance (c1,c3)	0.8896	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	12.449
p	< 0.001
Adjusted R ²	0.6379
AIC	402.853

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.94	1.22
Lower bound	?	?
Upper bound	?	?
Standard Error	0.835*	1.405*

* g ≥ 0.05, estimate is uncertain

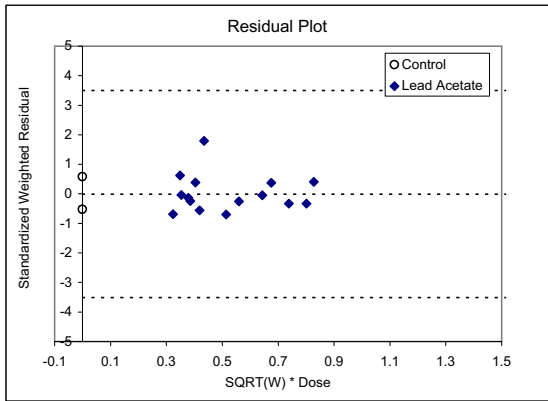
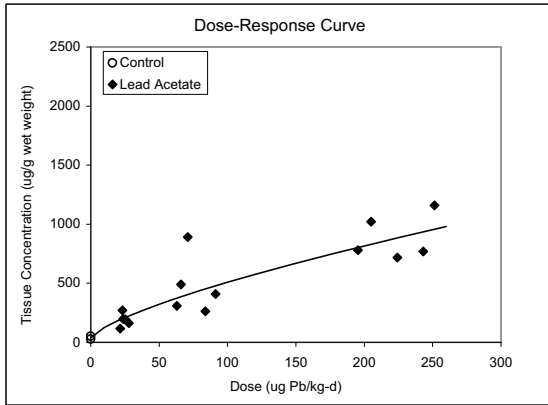
APPENDIX E

Figure 3d - All Data

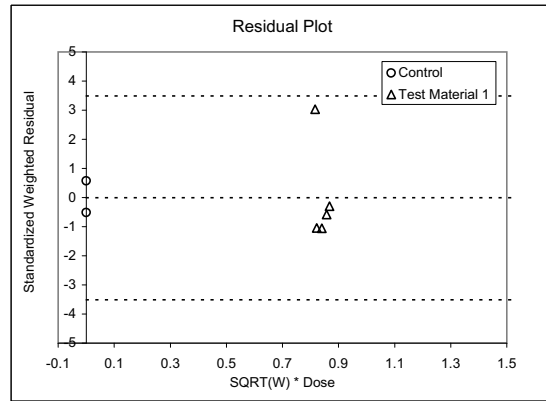
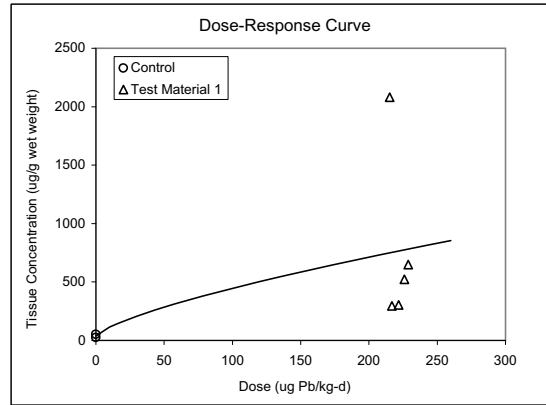
Phase II Experiment 1a: Kidney

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

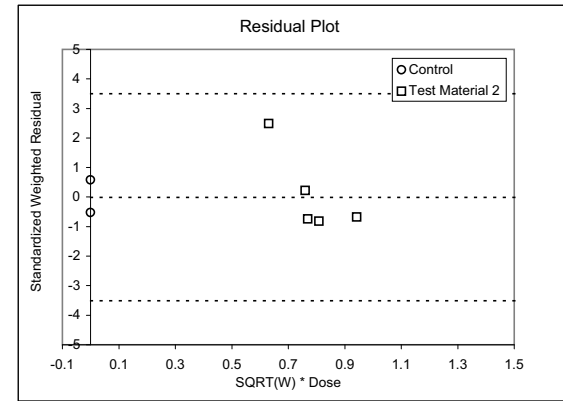
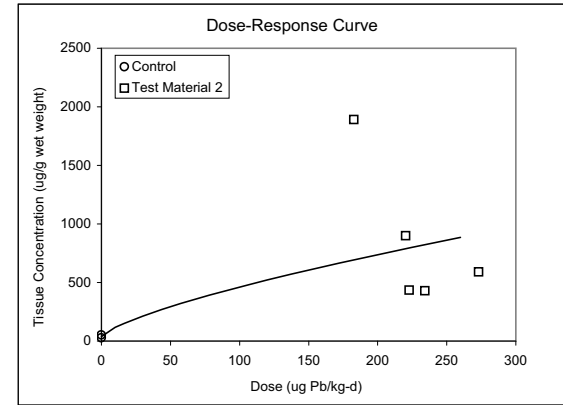
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	3.83E+01	1.82E+01
b1	1.65E+01	1.48E+01
b2	1.43E+01	1.58E+01
b3	1.48E+01	1.65E+01
c	7.27E-01	1.96E-01
Covariance (b1,b2)	0.9430	--
Covariance (b1,b3)	0.9407	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	11.992
p	< 0.001
Adjusted R ²	0.6284
AIC	404.685

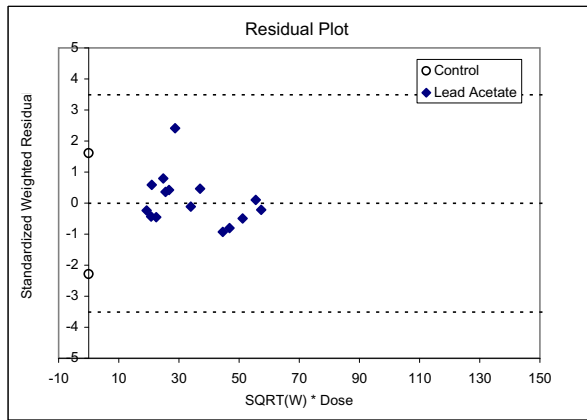
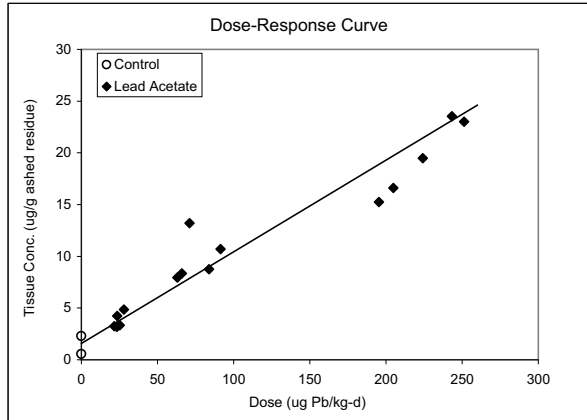
RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.82	0.86
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

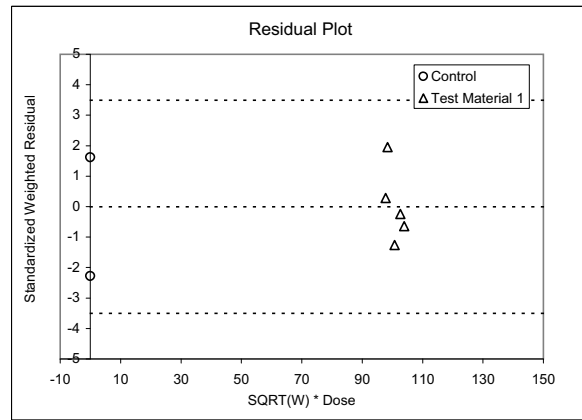
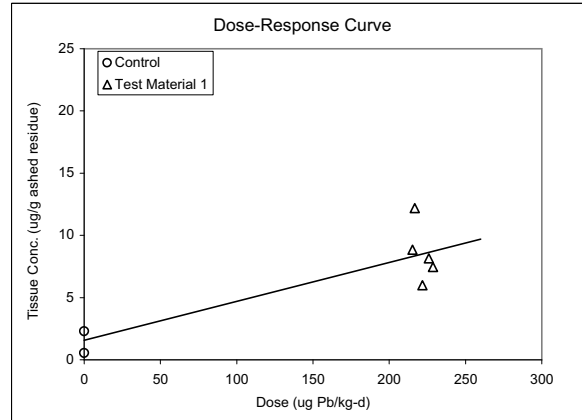
APPENDIX E

Figure 4a - All Data
Phase II Experiment 1a: Femur
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

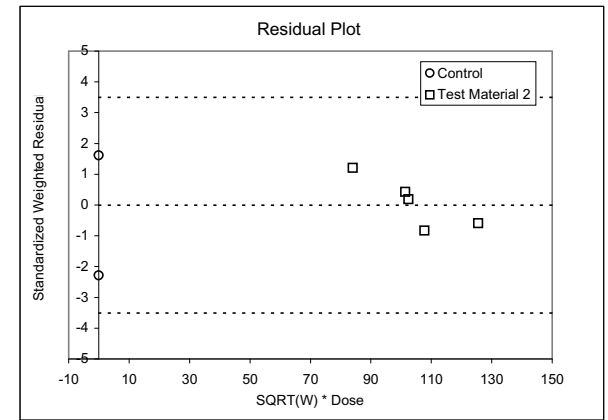
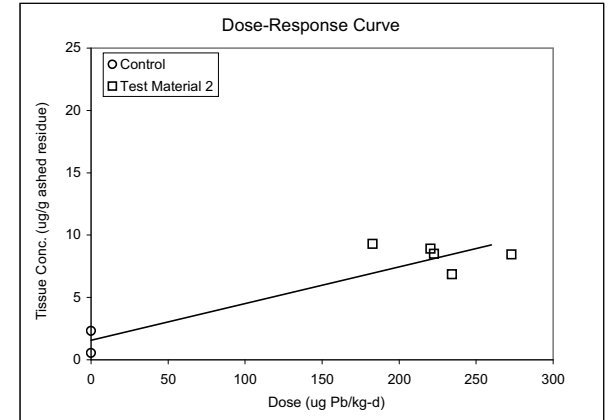
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.58E+00	2.91E-01
b1	8.87E-02	7.40E-03
b2	3.12E-02	4.44E-03
b3	2.94E-02	4.26E-03
Covariance (c1,c2)	0.1245	--
Covariance (c1,c3)	0.1250	--
Degrees of Freedom	23	--

Goodness of Fit

Statistic	Estimate
F	66.771
p	< 0.001
Adjusted R ²	0.8836
AIC	116.460

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.35	0.33
Lower bound	0.26	0.25
Upper bound	0.45	0.43
Standard Error	0.055	0.052

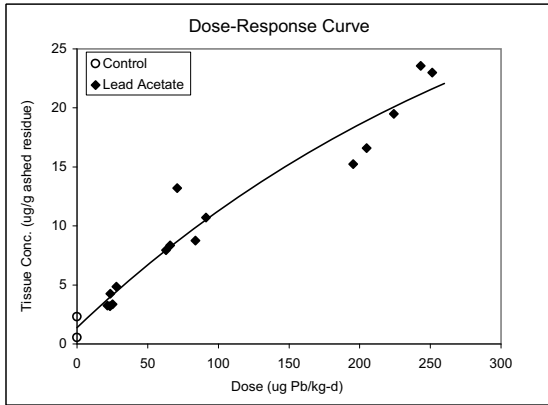
APPENDIX E

Figure 4b - All Data

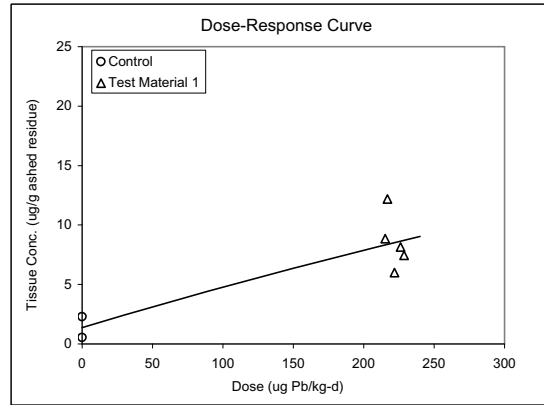
Phase II Experiment 1a: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

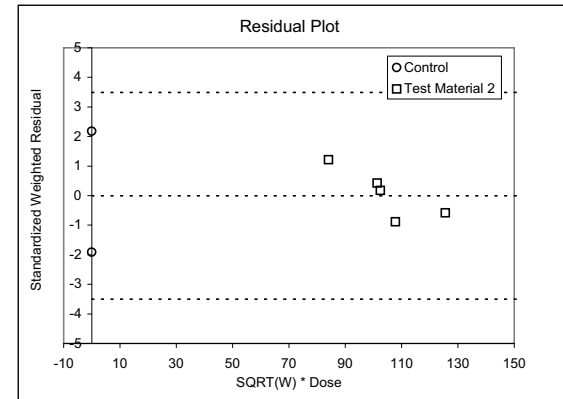
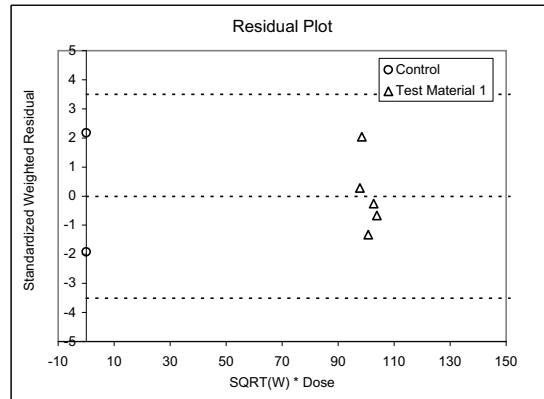
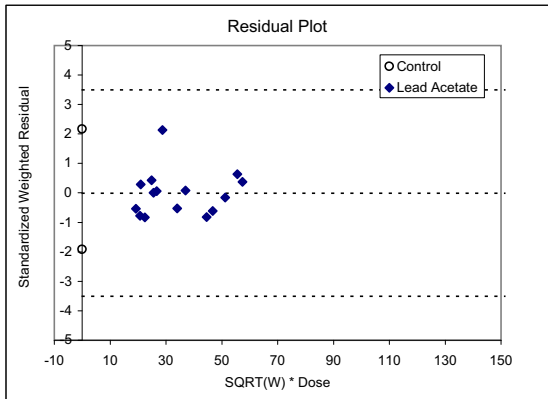
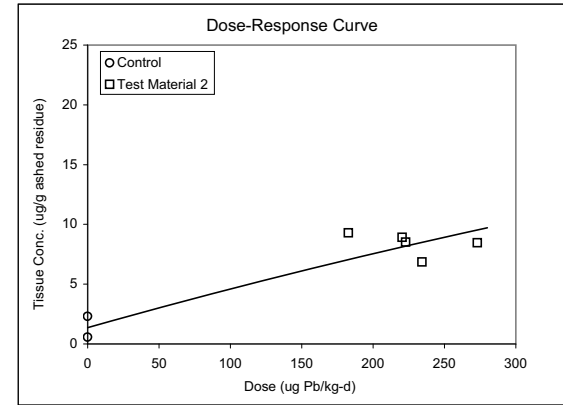
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.37E+00	3.17E-01
b	3.83E+01	2.07E+01
c1	2.99E-03	2.07E-03
c2	9.31E-04	5.92E-04
c3	8.80E-04	5.60E-04
Covariance (c1,c2)	0.9665	--
Covariance (c1,c3)	0.9659	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	53.359
p	< 0.001
Adjusted R ²	0.8896
AIC	116.514

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.31	0.29
Lower bound	?	?
Upper bound	?	?
Standard Error	0.056*	0.053*

* $g \geq 0.05$, estimate is uncertain

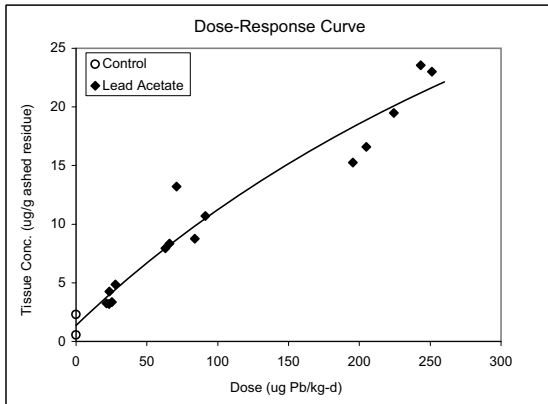
APPENDIX E

Figure 4c - All Data

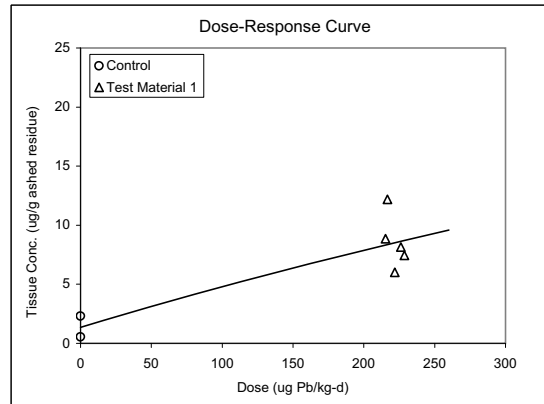
Phase II Experiment 1a: Femur

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

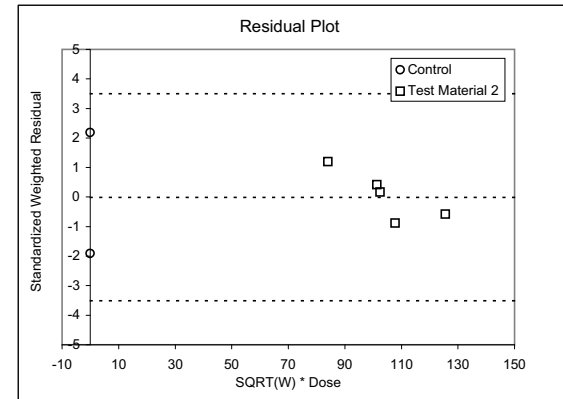
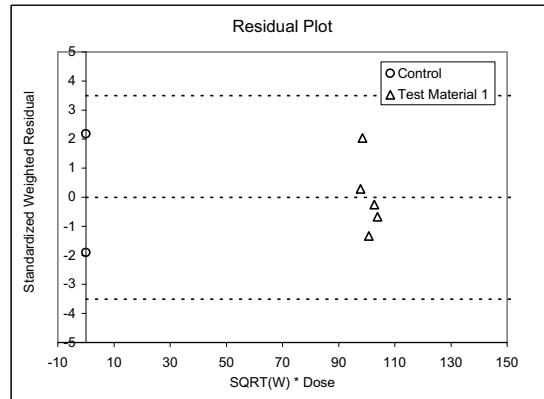
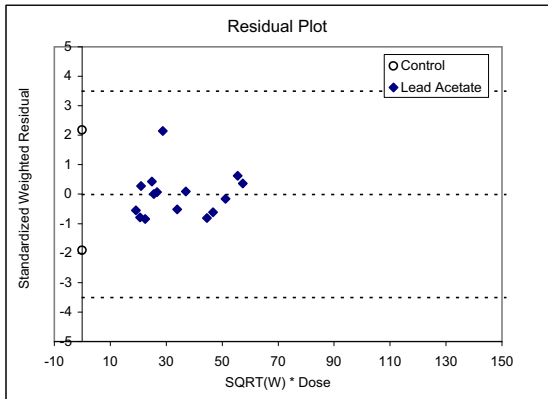
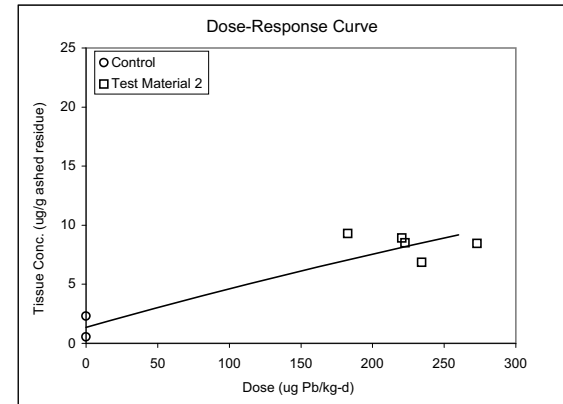
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.37E+00	3.18E-01
b	6.71E+01	4.16E+01
c1	5.80E+02	4.53E+02
c2	1.86E+03	1.35E+03
c3	1.97E+03	1.43E+03
Covariance (c1,c2)	0.9741	--
Covariance (c1,c3)	0.9736	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	53.403
p	< 0.001
Adjusted R ²	0.8896
AIC	116.500

RBA and Uncertainty

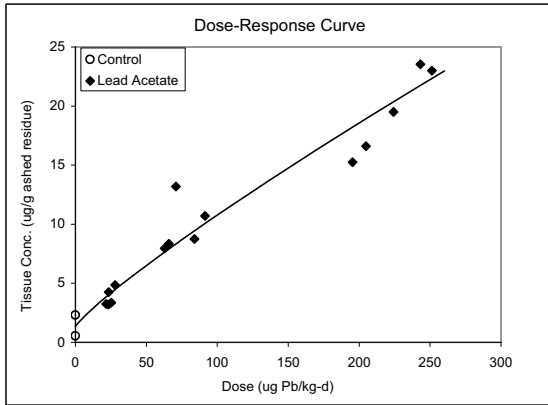
	PbAc, 0 hr	PbAc, +2 hr
RBA	0.31	0.29
Lower bound	?	?
Upper bound	?	?
Standard Error	0.056*	0.053*

* $g \geq 0.05$, estimate is uncertain

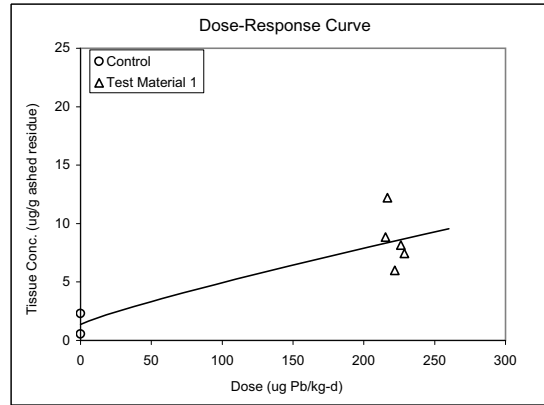
APPENDIX E

Figure 4d - All Data
Phase II Experiment 1a: Femur
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

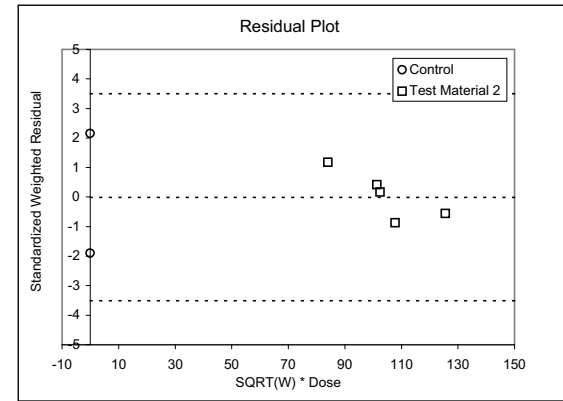
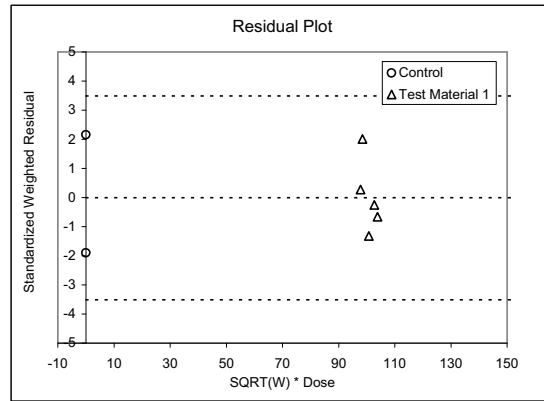
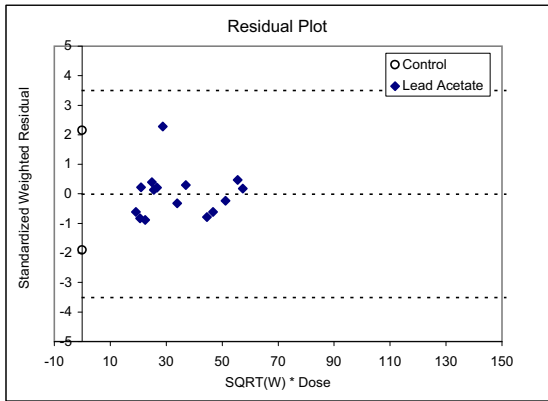
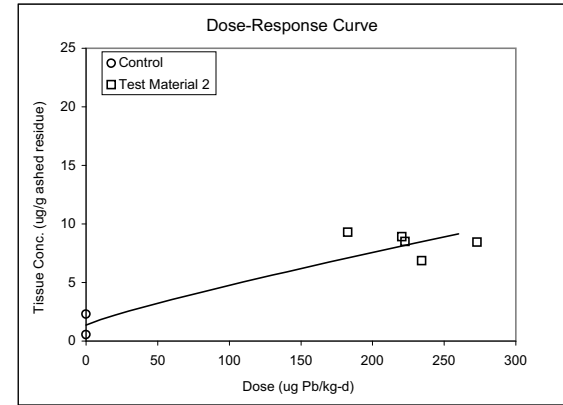
Lead Acetate, 2 hours before feed (Reference)



Lead Acetate, Simultaneous with feed (PbAc, 0 hr)



Lead Acetate, 2 hours after feed (PbAc, +2 hr)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.37E+00	3.29E-01
b1	1.71E-01	8.08E-02
b2	6.47E-02	3.54E-02
b3	6.15E-02	3.39E-02
c	8.71E-01	9.43E-02
Covariance (b1,b2)	0.9601	--
Covariance (b1,b3)	0.9598	--
Degrees of Freedom	22	--

Goodness of Fit

Statistic	Estimate
F	52.175
p	< 0.001
Adjusted R ²	0.8873
AIC	116.905

RBA and Uncertainty

	PbAc, 0 hr	PbAc, +2 hr
RBA	0.33	0.31
Lower bound	0.07	0.06
Upper bound	0.45	0.42
Standard Error	--	--

APPENDIX E

EXPERIMENT 2

Test Material 1: Bingham Creek Residential
Test Material 2: Bingham Creek Channel Soil

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

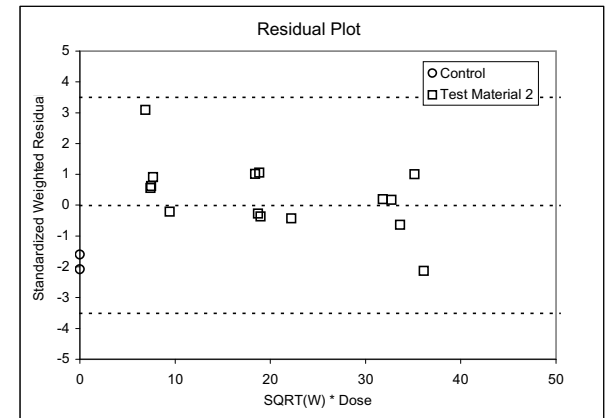
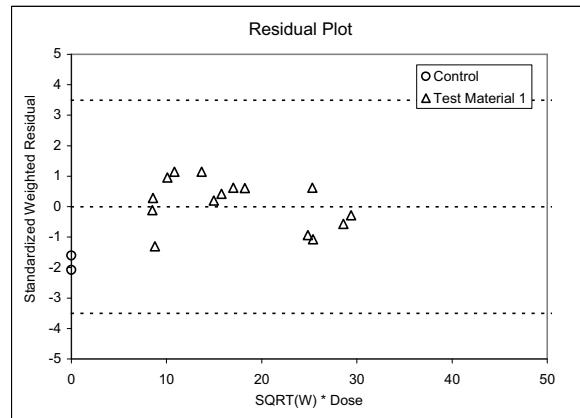
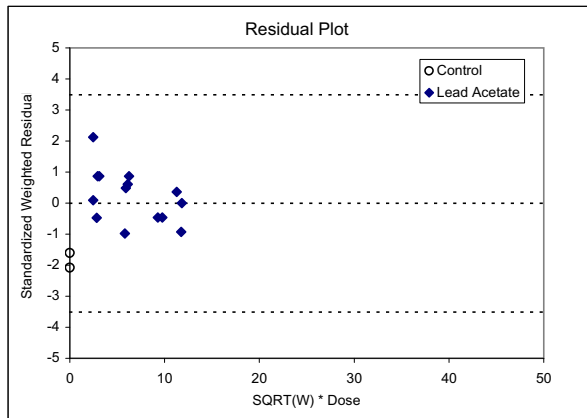
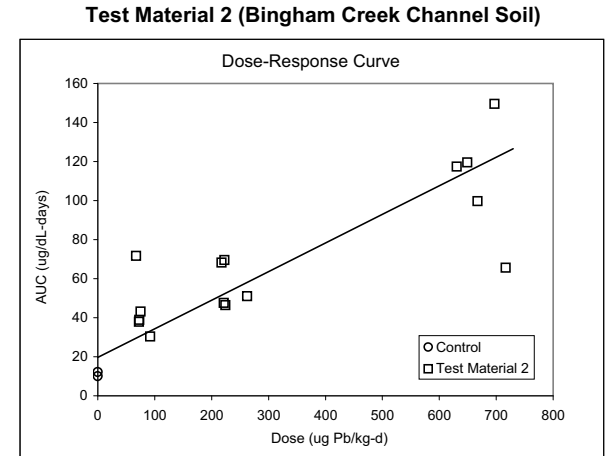
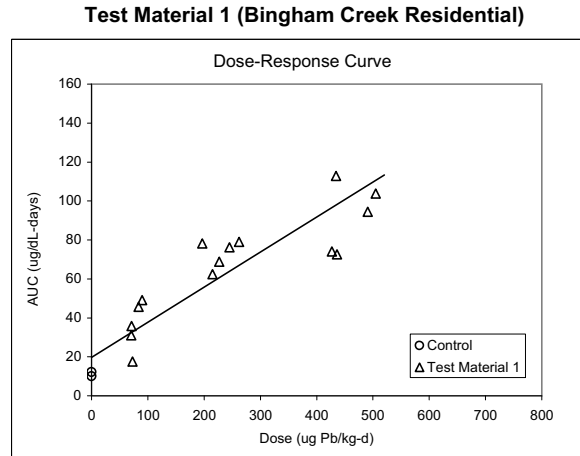
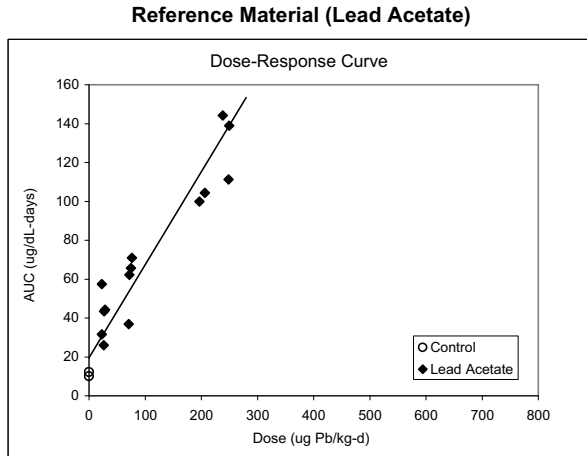
- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

Figure 1a - All Data

Phase II Experiment 2: Blood AUC
 Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.97E+01	2.56E+00
b1	4.78E-01	5.61E-02
b2	1.80E-01	2.19E-02
b3	1.46E-01	1.76E-02
Covariance (c1,c2)	0.1488	--
Covariance (c1,c3)	0.1354	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	53.890
p	< 0.001
Adjusted R ²	0.7791
AIC	412.401

RBA and Uncertainty

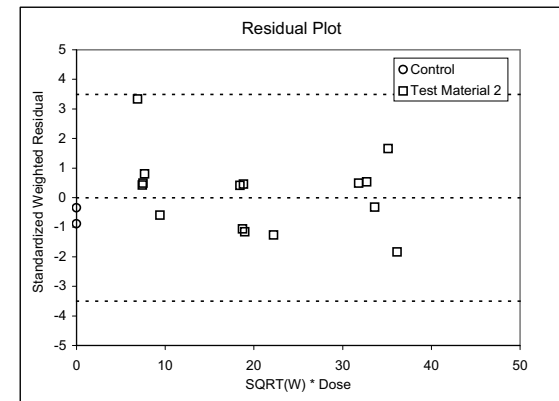
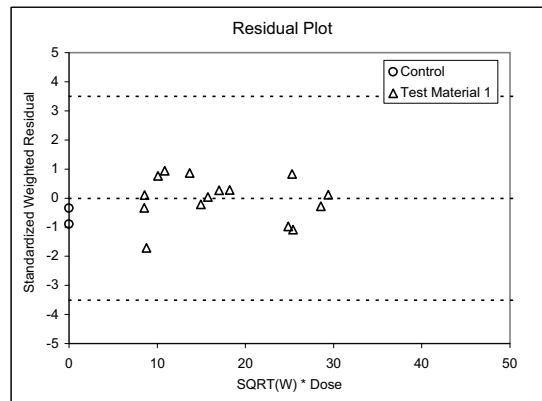
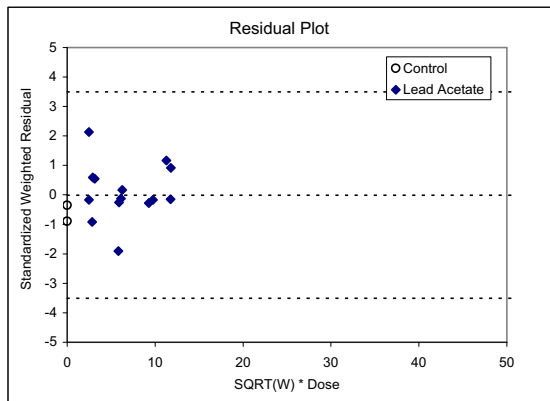
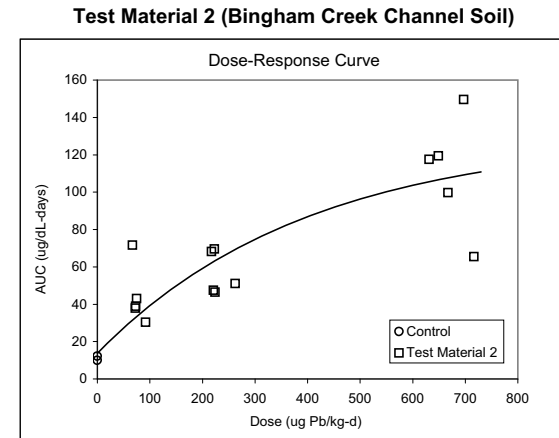
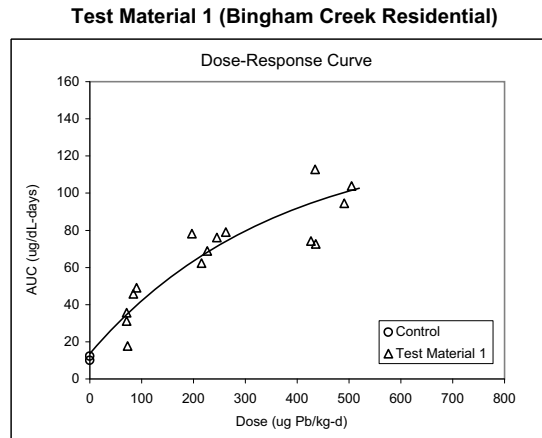
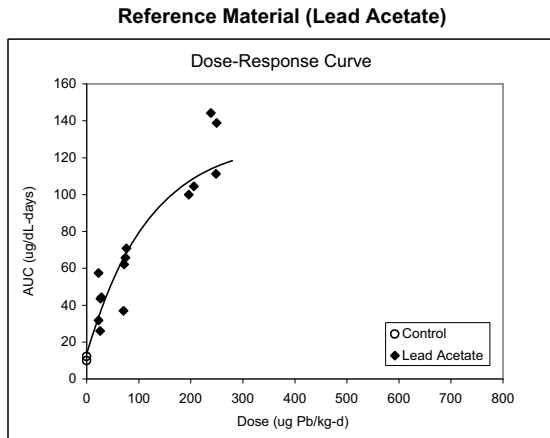
	Test Material 1	Test Material 2
RBA	0.38	0.31
Lower bound	0.29	0.23
Upper bound	0.49	0.40
Standard Error	0.059	0.048

APPENDIX E

Figure 1b - All Data

Phase II Experiment 2: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.36E+01	2.84E+00
b	1.16E+02	1.83E+01
c1	8.36E-03	2.64E-03
c2	2.81E-03	8.42E-04
c3	2.50E-03	7.72E-04
Covariance (c1,c2)	0.7931	--
Covariance (c1,c3)	0.7868	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	54.613
p	< 0.001
Adjusted R ²	0.8266
AIC	393.655

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.34	0.30
Lower bound	0.23	0.20
Upper bound	0.50	0.45
Standard Error	0.067*	0.061*

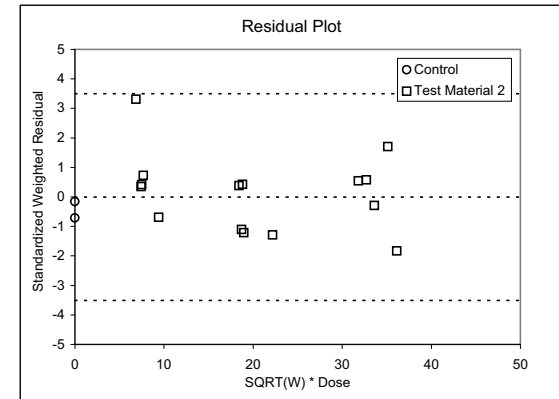
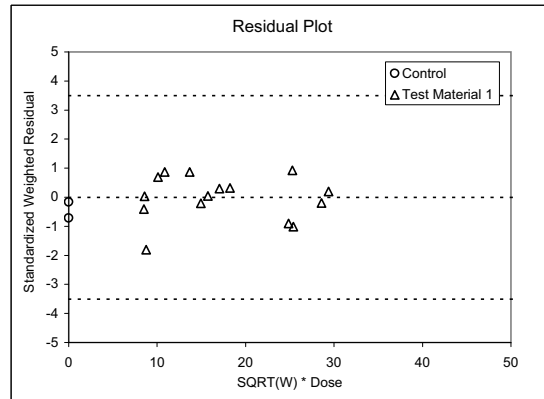
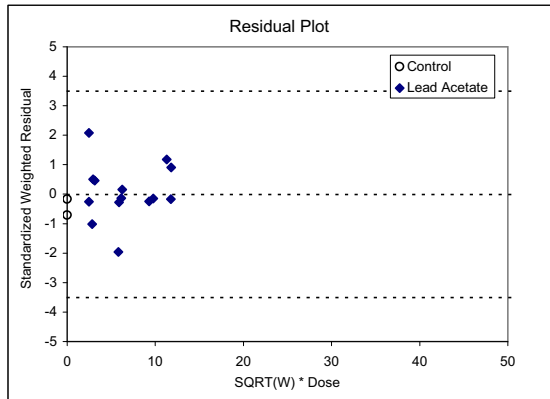
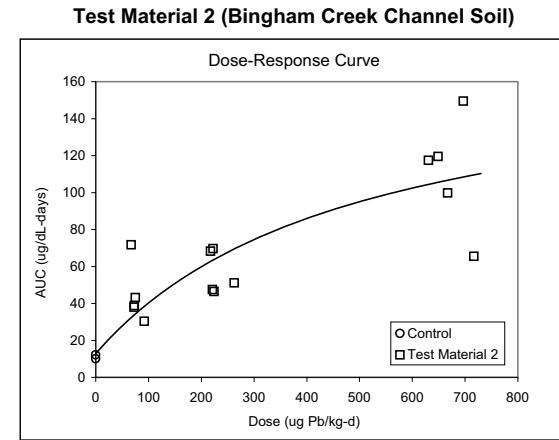
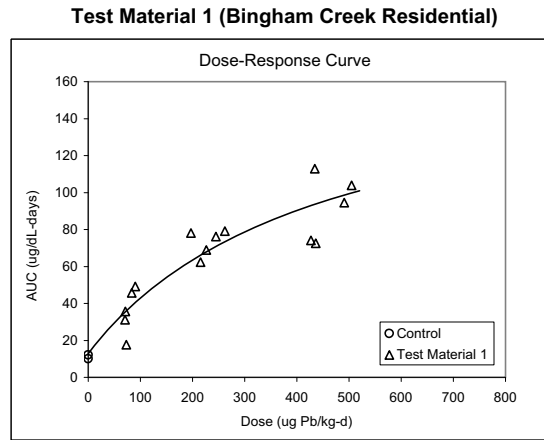
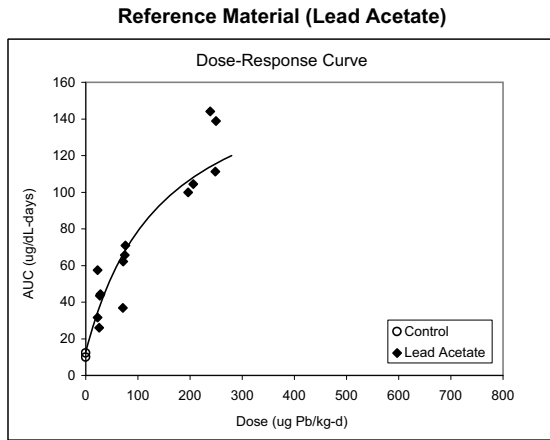
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1c - All Data

Phase II Experiment 2: Blood AUC

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.29E+01	2.88E+00
b	1.64E+02	3.13E+01
c1	1.48E+02	5.60E+01
c2	4.46E+02	1.62E+02
c3	4.97E+02	1.85E+02
Covariance (c1,c2)	0.8595	--
Covariance (c1,c3)	0.8572	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	56.405
p	< 0.001
Adjusted R ²	0.8312
AIC	391.826

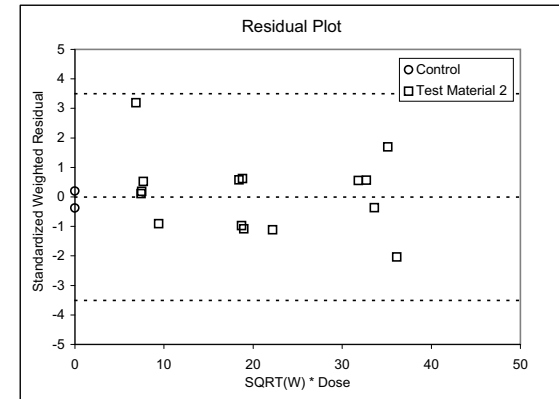
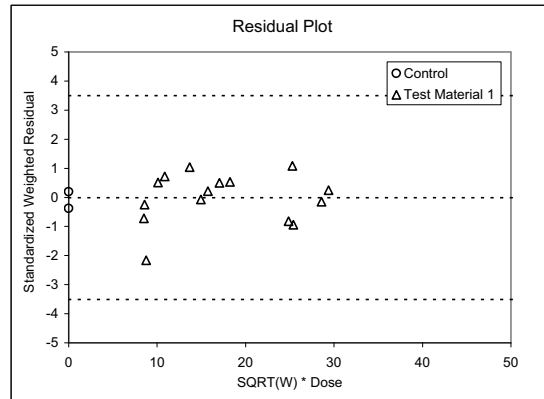
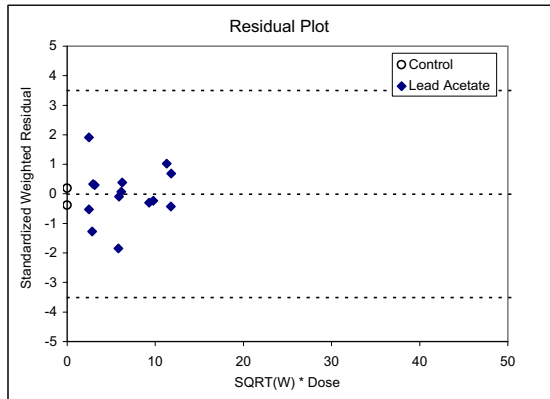
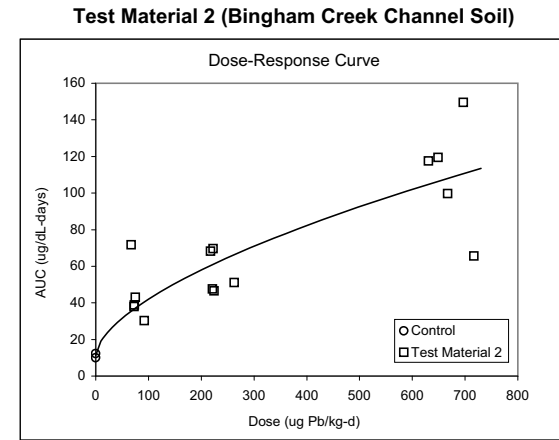
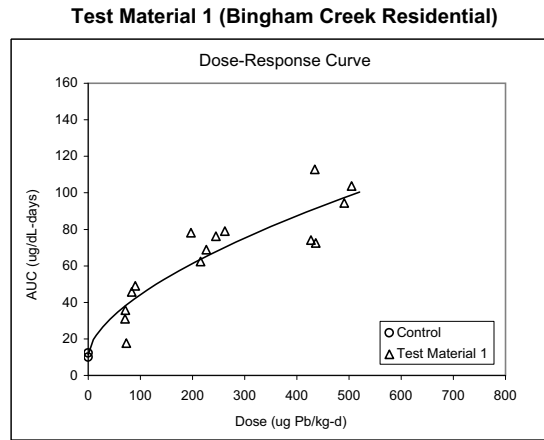
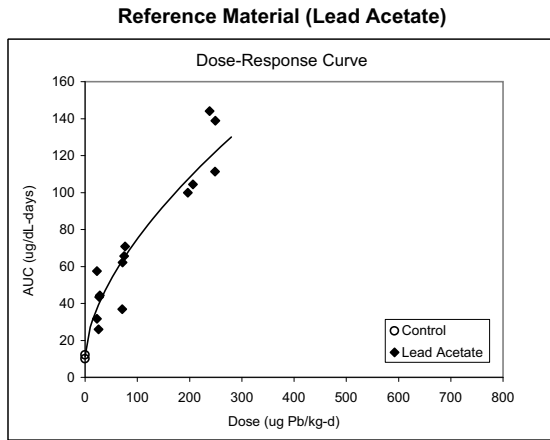
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.33	0.30
Lower bound	0.21	0.19
Upper bound	0.49	0.46
Standard Error	0.065*	0.060*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 2: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.14E+01	2.84E+00
b1	3.90E+00	1.36E+00
b2	2.01E+00	8.18E-01
b3	1.88E+00	7.93E-01
c	6.06E-01	6.68E-02
Covariance (b1,b2)	0.9568	--
Covariance (b1,b3)	0.9581	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	62.696
p	< 0.001
Adjusted R ²	0.8458
AIC	386.116

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.34	0.30
Lower bound	0.17	0.14
Upper bound	0.46	0.41
Standard Error	--	--

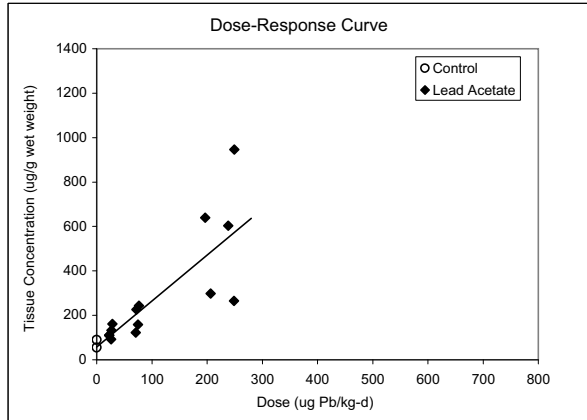
APPENDIX E

Figure 2a - All Data

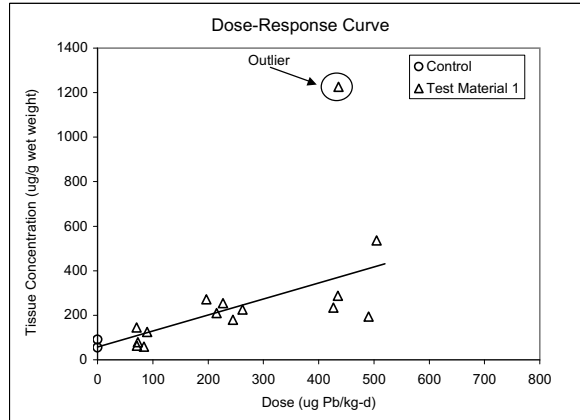
Phase II Experiment 2: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

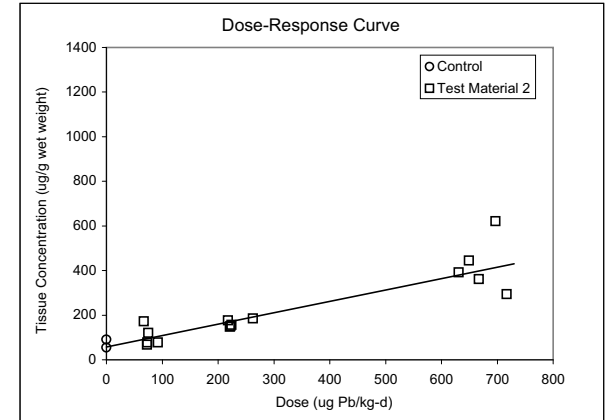
Reference Material (Lead Acetate)



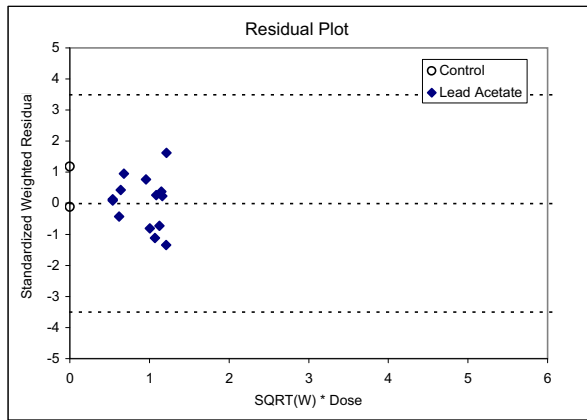
Test Material 1 (Bingham Creek Residential)



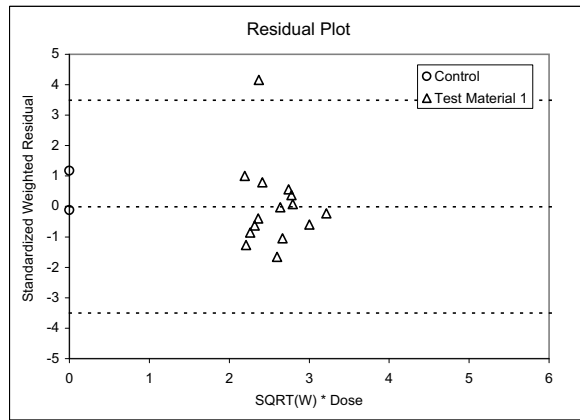
Test Material 2 (Bingham Creek Channel Soil)



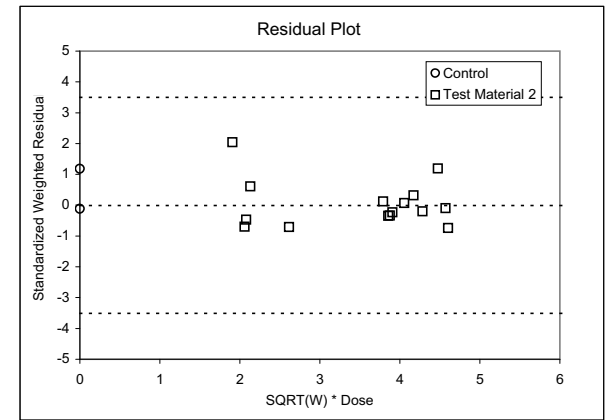
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.79E+01	1.18E+01
b1	2.07E+00	3.55E-01
b2	7.17E-01	1.36E-01
b3	5.10E-01	9.51E-02
Covariance (c1,c2)	0.2250	--
Covariance (c1,c3)	0.2118	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	20.611
p	< 0.001
Adjusted R ²	0.5666
AIC	543.299

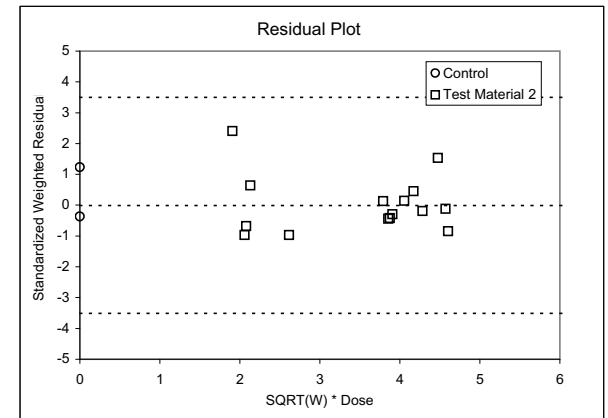
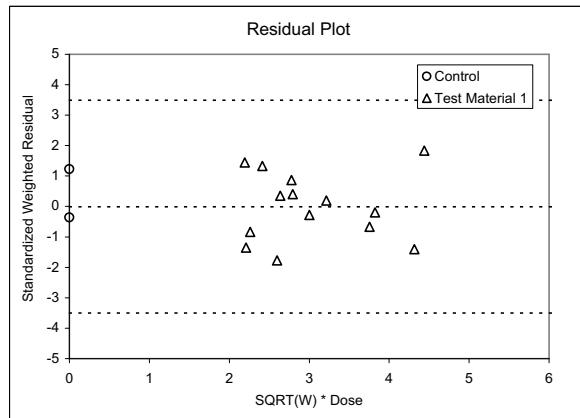
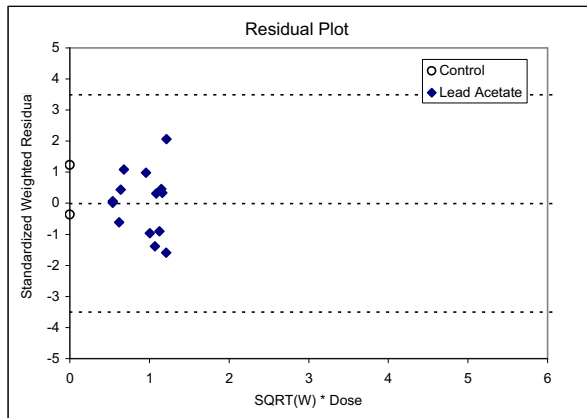
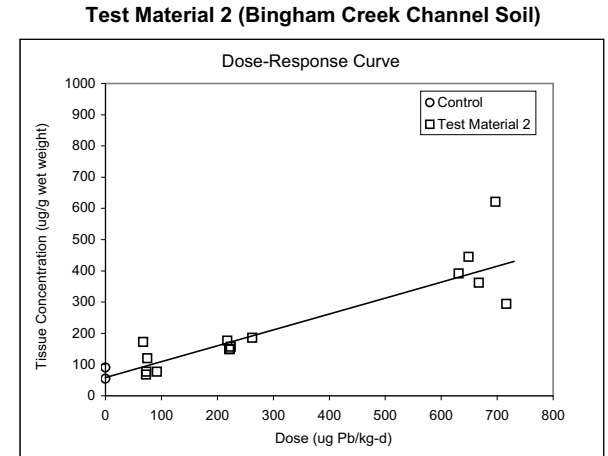
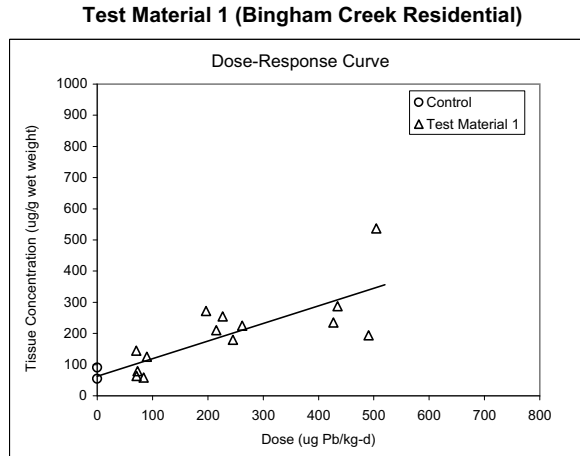
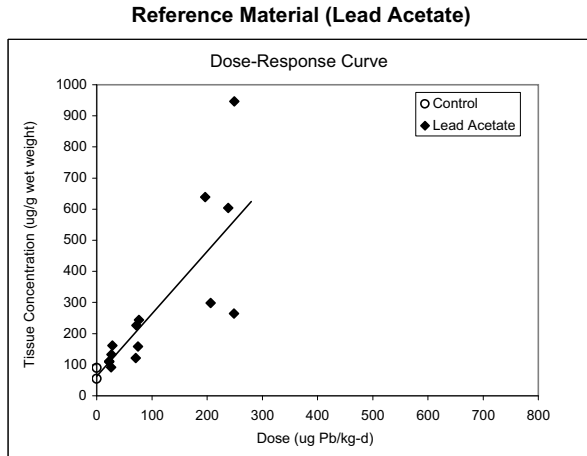
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.35	0.25
Lower bound	0.23	0.16
Upper bound	0.51	0.36
Standard Error	0.078*	0.055*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 2: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.28E+01	9.37E+00
b1	2.01E+00	2.87E-01
b2	5.63E-01	9.34E-02
b3	4.90E-01	7.67E-02
Covariance (c1,c2)	0.2120	--
Covariance (c1,c3)	0.2047	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	29.241
p	< 0.001
Adjusted R ²	0.6582
AIC	507.050

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.28	0.24
Lower bound	0.20	0.17
Upper bound	0.39	0.34
Standard Error	0.055*	0.046*

* $g \geq 0.05$, estimate is uncertain

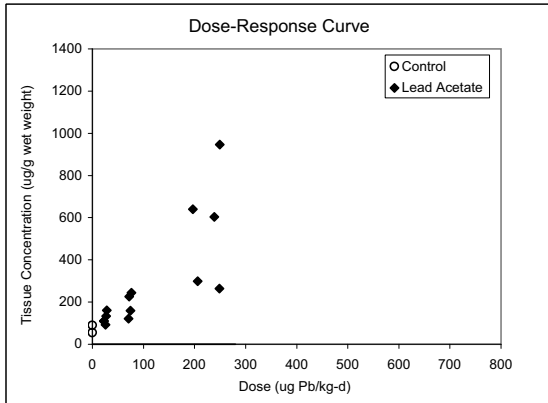
APPENDIX E

Figure 2b - All Data

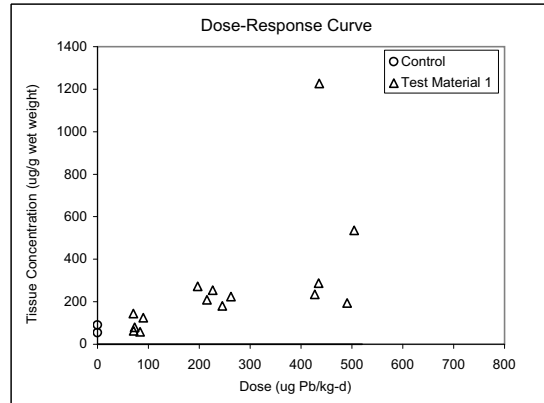
Phase II Experiment 2: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

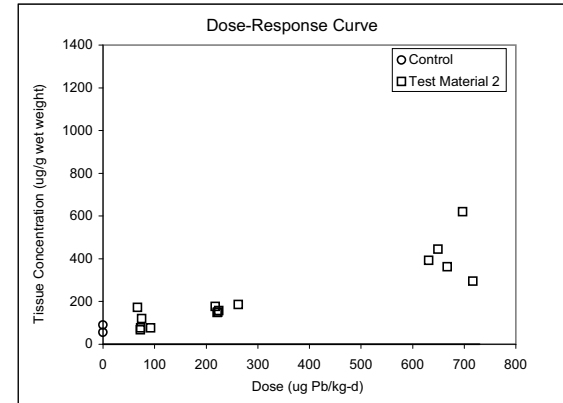
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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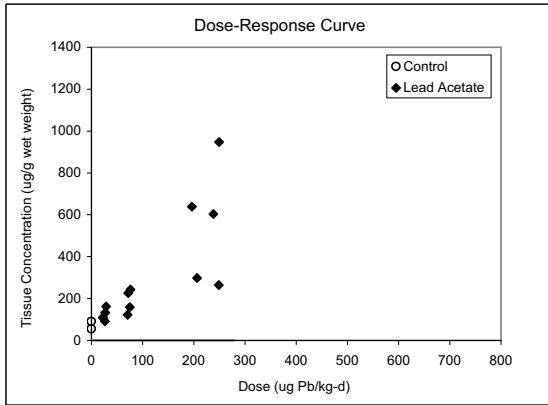
APPENDIX E

Figure 2c - All Data

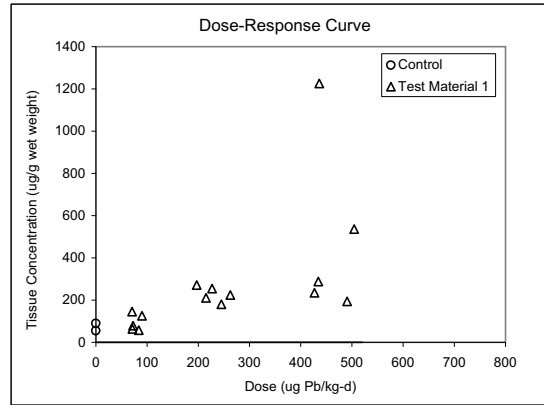
Phase II Experiment 2: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

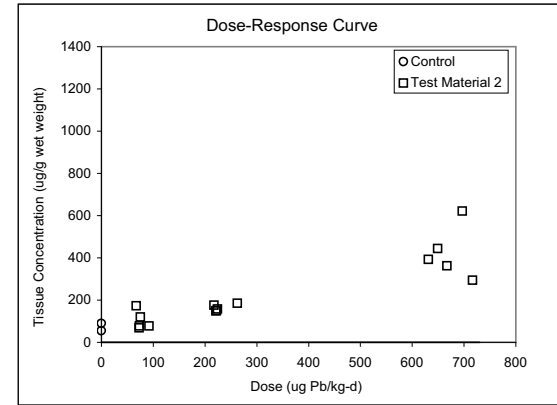
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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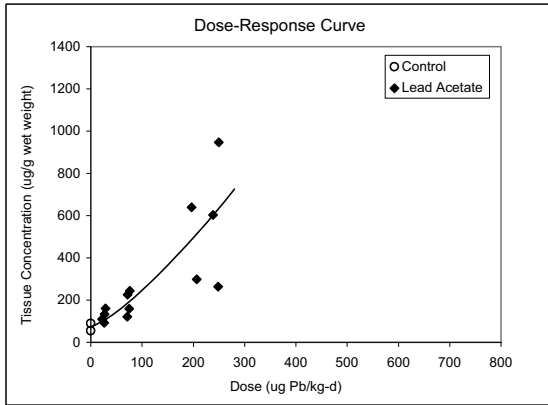
APPENDIX E

Figure 2d - All Data

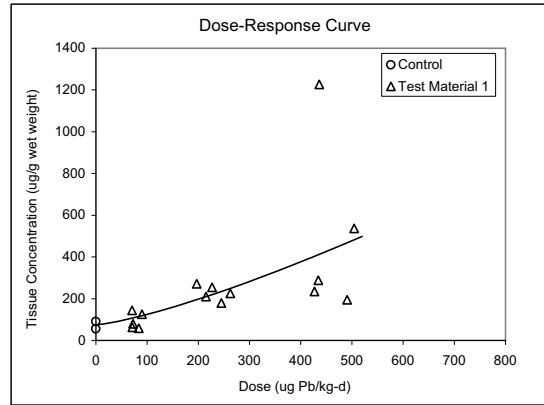
Phase II Experiment 2: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

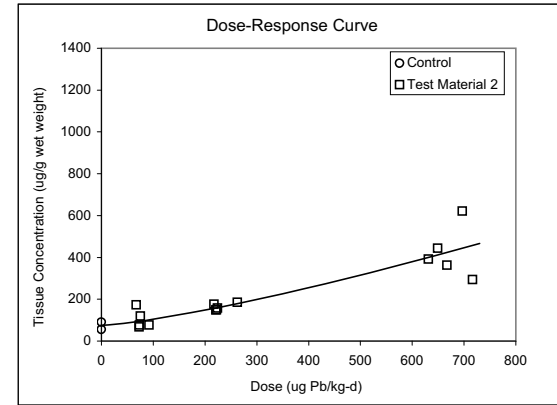
Reference Material (Lead Acetate)



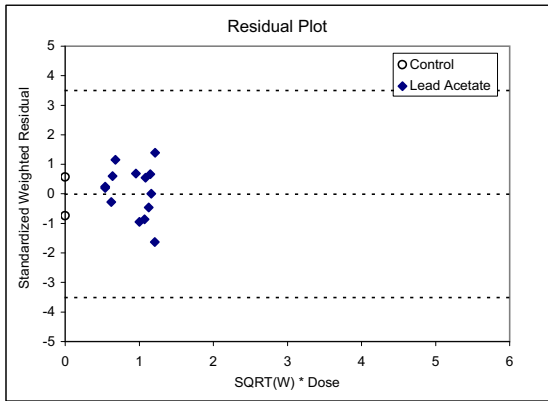
Test Material 1 (Bingham Creek Residential)



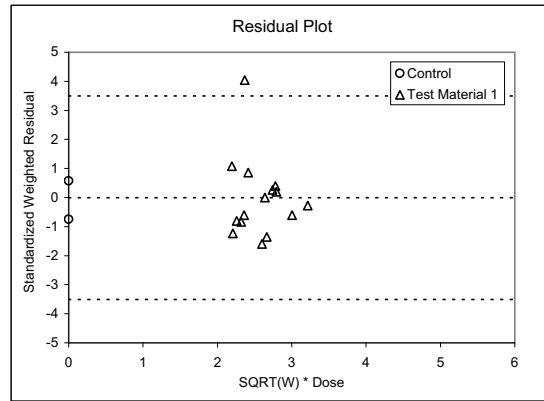
Test Material 2 (Bingham Creek Channel Soil)



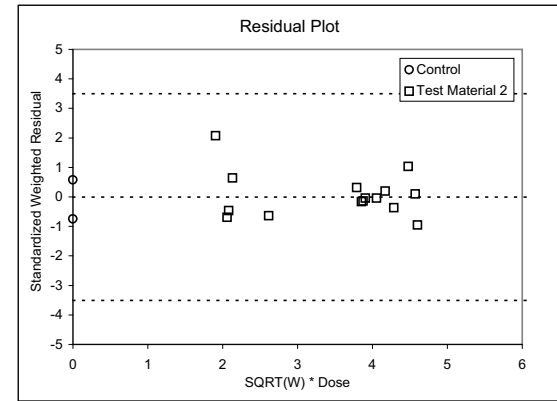
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.47E+01	1.60E+01
b1	4.40E-01	5.88E-01
b2	1.29E-01	1.95E-01
b3	7.68E-02	1.25E-01
c	1.30E+00	2.51E-01
Covariance (b1,b2)	0.9848	--
Covariance (b1,b3)	0.9854	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	16.144
p	< 0.001
Adjusted R ²	0.5738
AIC	543.050

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.39	0.26
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

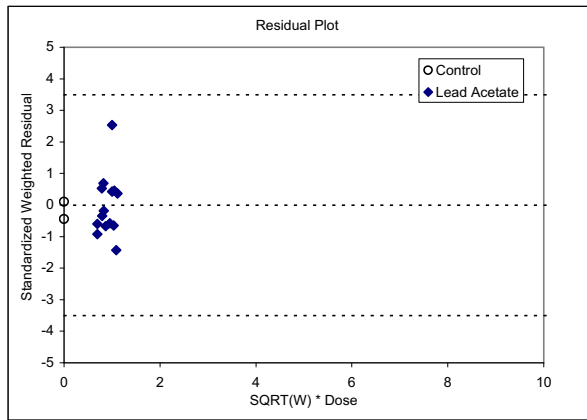
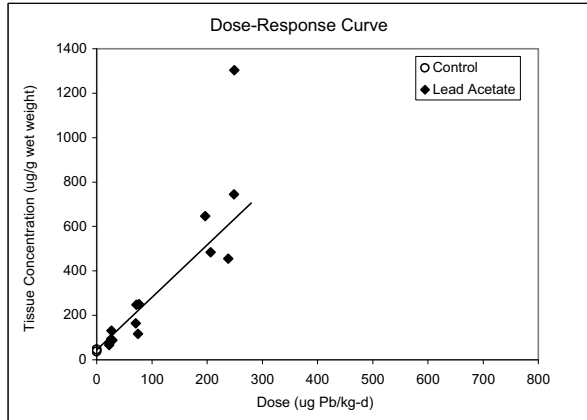
APPENDIX E

Figure 3a - All Data

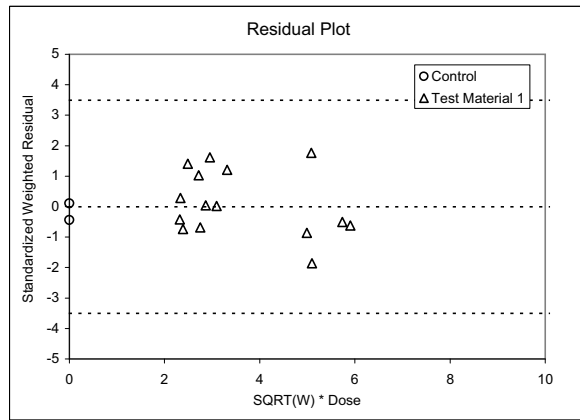
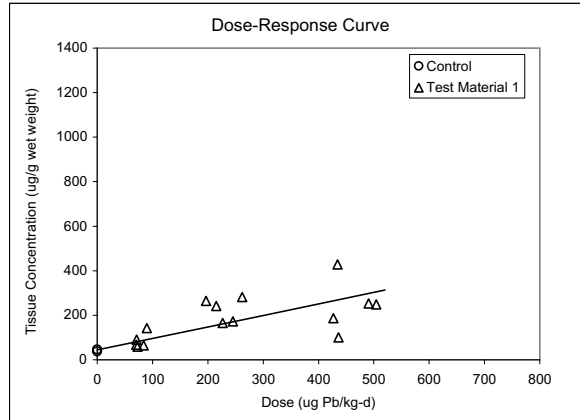
Phase II Experiment 2: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

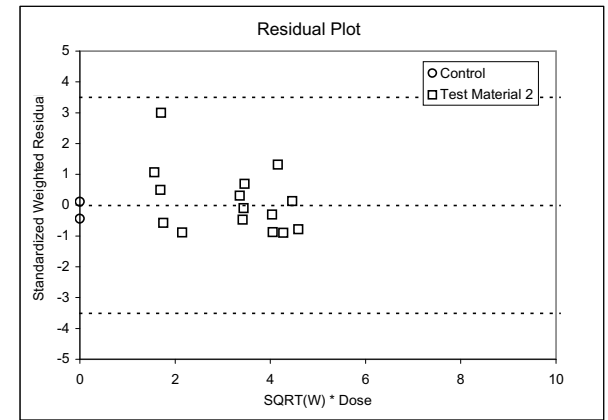
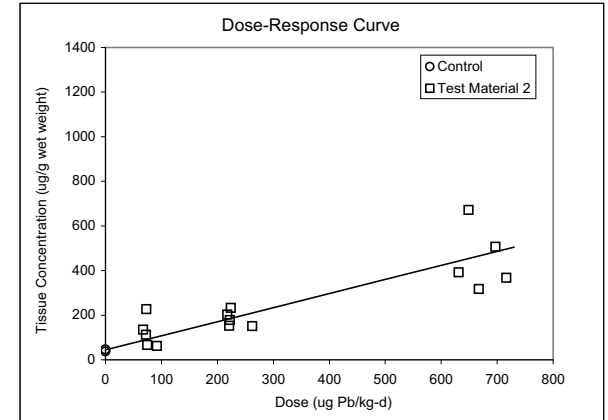
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.42E+01	8.71E+00
b1	2.36E+00	3.52E-01
b2	5.17E-01	8.26E-02
b3	6.32E-01	8.95E-02
Covariance (c1,c2)	0.1831	--
Covariance (c1,c3)	0.1458	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	33.908
p	< 0.001
Adjusted R ²	0.6869
AIC	530.223

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.22	0.27
Lower bound	0.15	0.19
Upper bound	0.31	0.37
Standard Error	0.043*	0.051*

* $g \geq 0.05$, estimate is uncertain

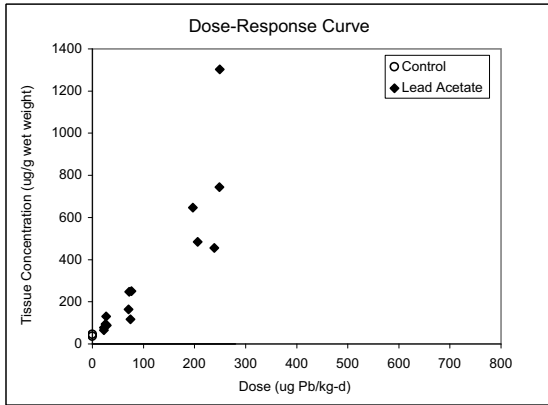
APPENDIX E

Figure 3b - All Data

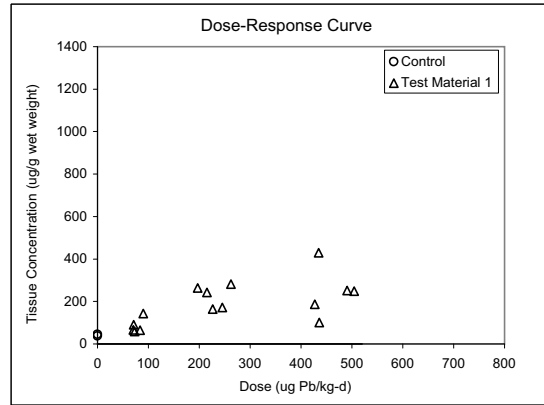
Phase II Experiment 2: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

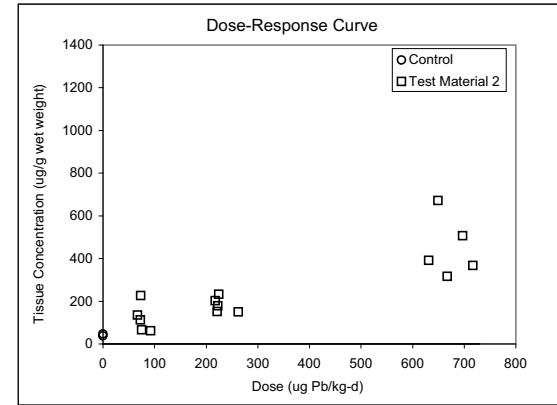
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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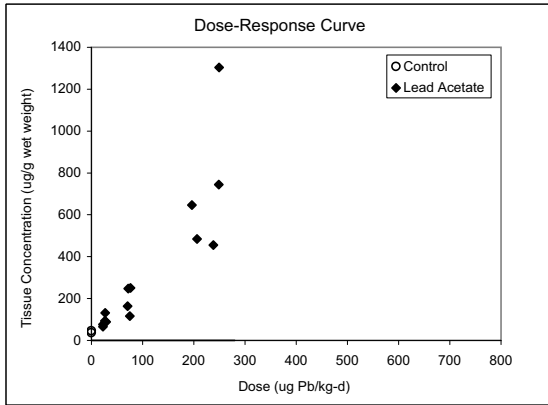
APPENDIX E

Figure 3c - All Data

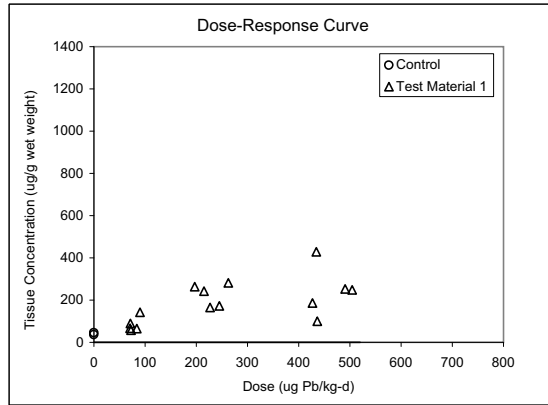
Phase II Experiment 2: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

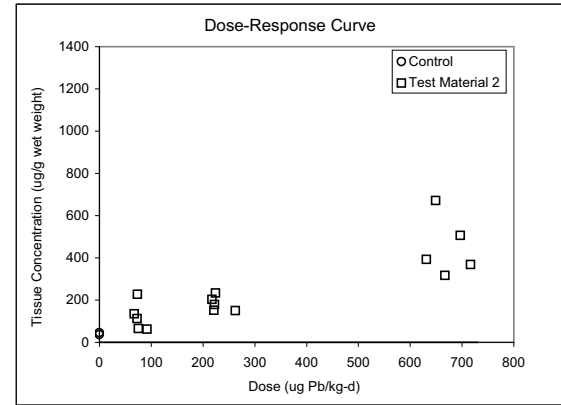
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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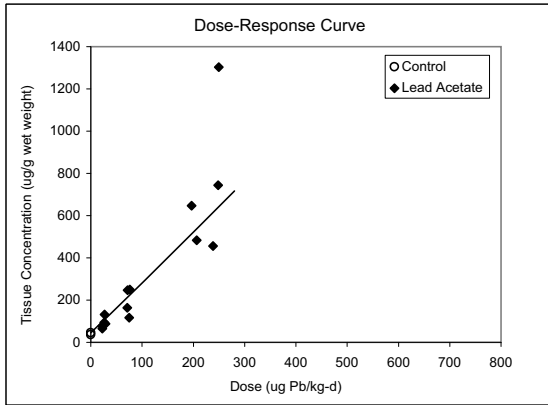
APPENDIX E

Figure 3d - All Data

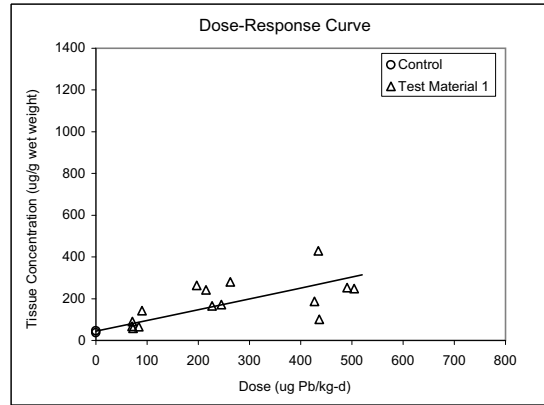
Phase II Experiment 2: Kidney

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

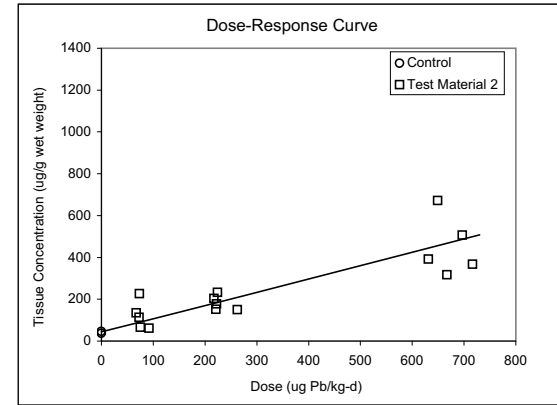
Reference Material (Lead Acetate)



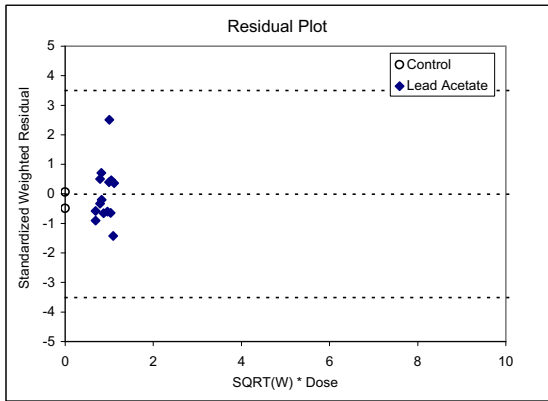
Test Material 1 (Bingham Creek Residential)



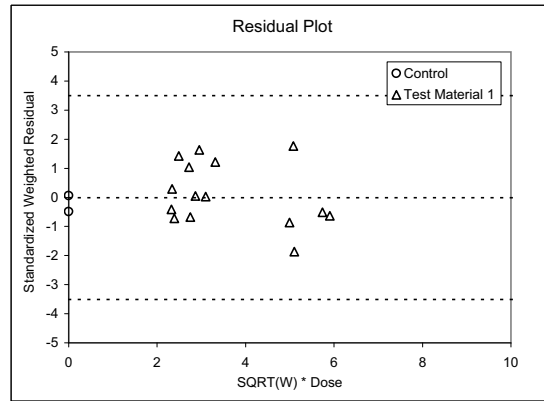
Test Material 2 (Bingham Creek Channel Soil)



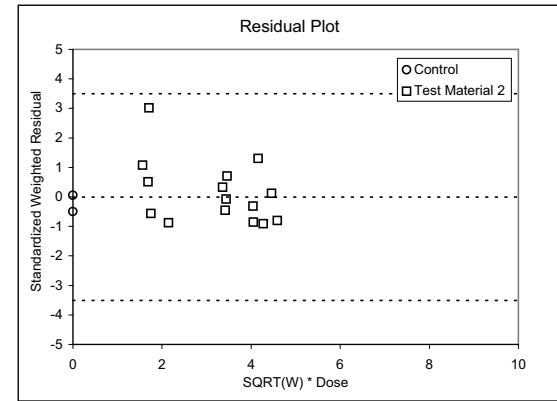
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.50E+01	1.12E+01
b1	2.20E+00	1.51E+00
b2	4.69E-01	4.10E-01
b3	5.73E-01	5.04E-01
c	1.02E+00	1.39E-01
Covariance (b1,b2)	0.9660	--
Covariance (b1,b3)	0.9676	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	24.834
p	< 0.001
Adjusted R ²	0.6793
AIC	532.210

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.22	0.27
Lower bound	0.50	0.63
Upper bound	0.32	0.38
Standard Error	--	--

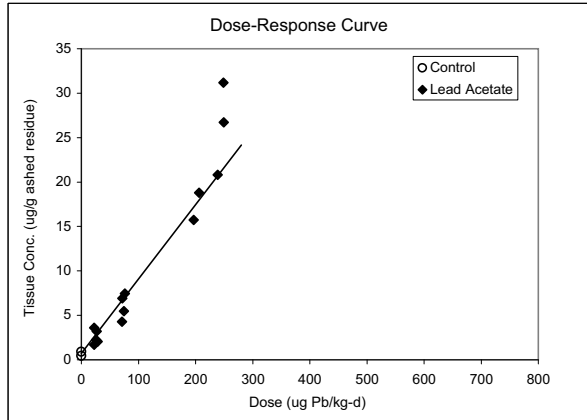
APPENDIX E

Figure 4a - All Data

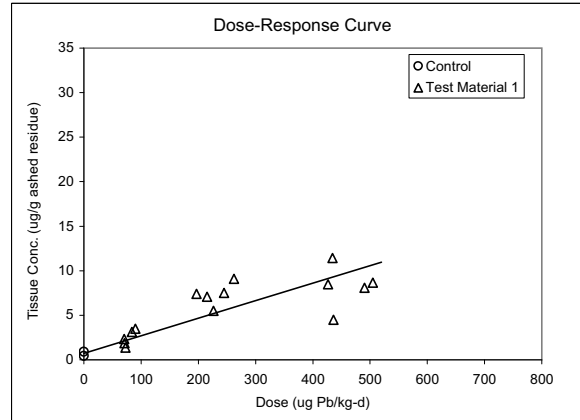
Phase II Experiment 2: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

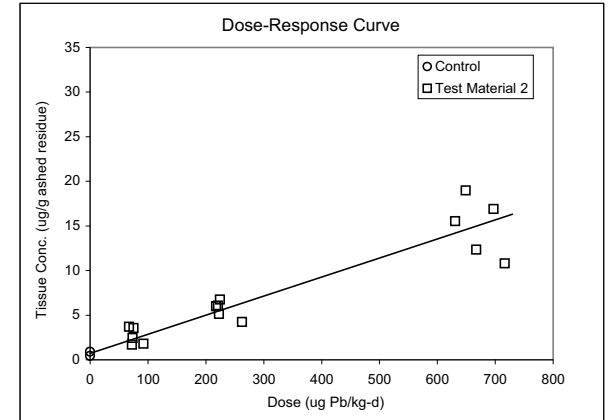
Reference Material (Lead Acetate)



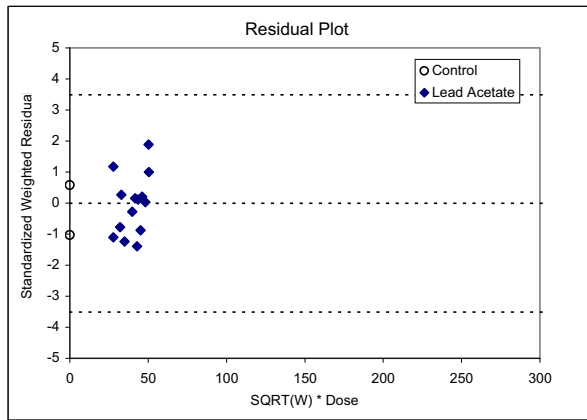
Test Material 1 (Bingham Creek Residential)



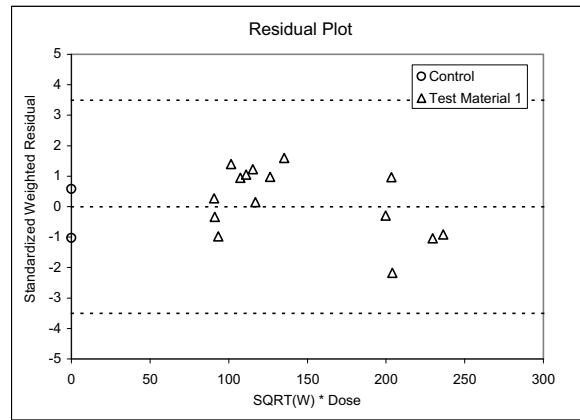
Test Material 2 (Bingham Creek Channel Soil)



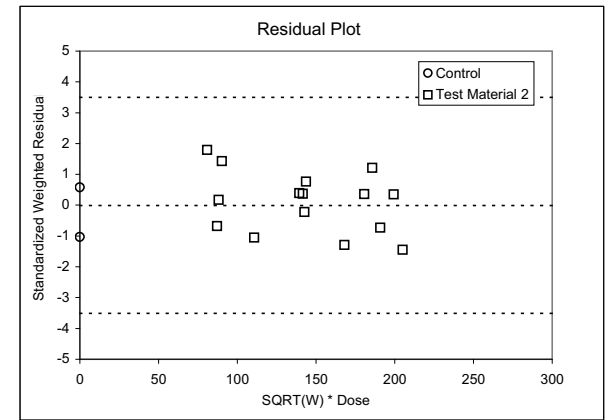
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.25E-01	1.66E-01
b1	8.37E-02	7.42E-03
b2	1.97E-02	1.94E-03
b3	2.14E-02	1.96E-03
Covariance (c1,c2)	0.1156	--
Covariance (c1,c3)	0.1070	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	95.226
p	< 0.001
Adjusted R ²	0.8627
AIC	180.521

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.24	0.26
Lower bound	0.19	0.21
Upper bound	0.29	0.31
Standard Error	0.029	0.031

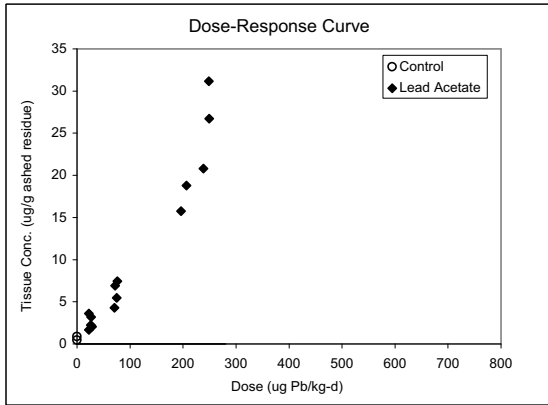
APPENDIX E

Figure 4b - All Data

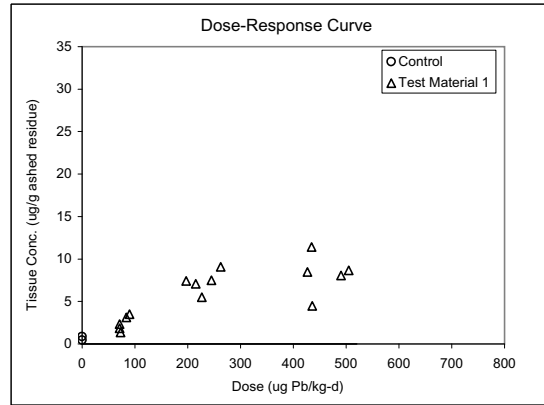
Phase II Experiment 2: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

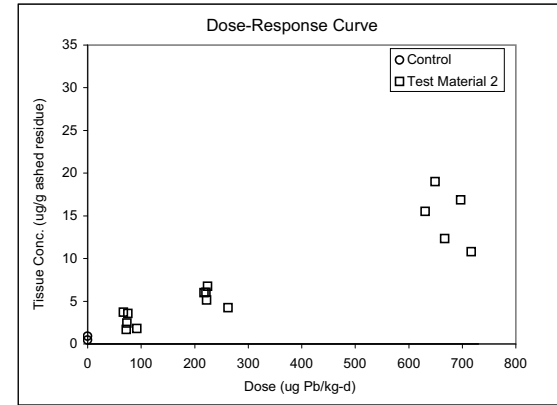
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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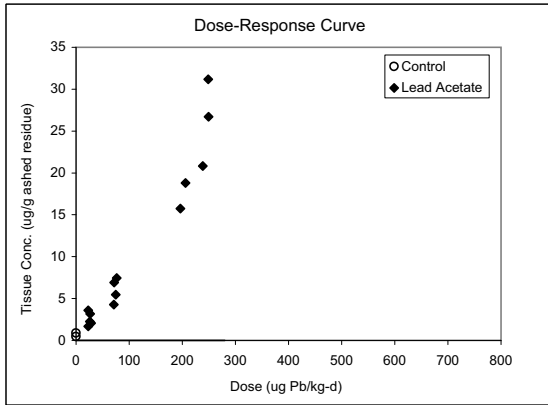
APPENDIX E

Figure 4c - All Data

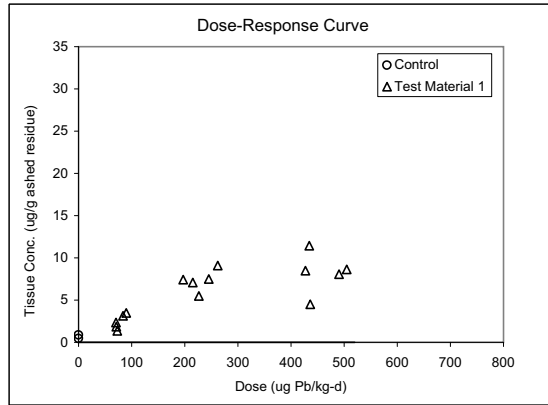
Phase II Experiment 2: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

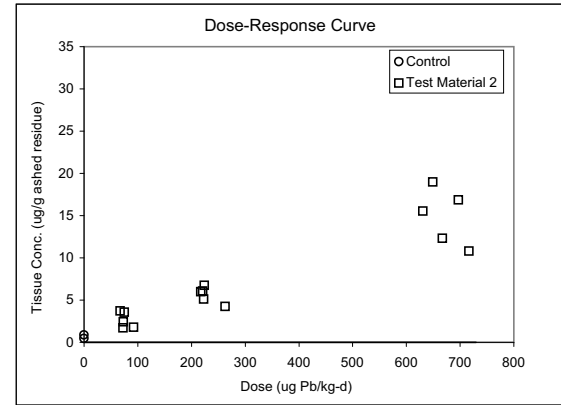
Reference Material (Lead Acetate)



Test Material 1 (Bingham Creek Residential)



Test Material 2 (Bingham Creek Channel Soil)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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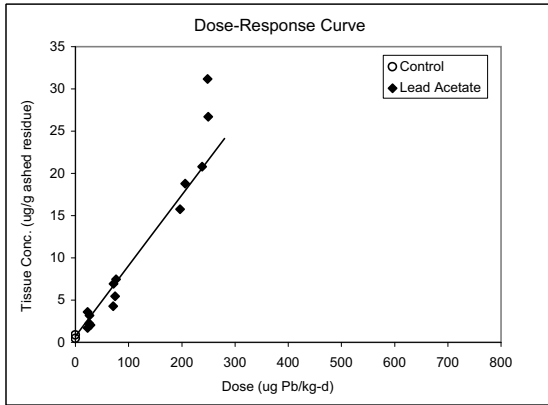
APPENDIX E

Figure 4d - All Data

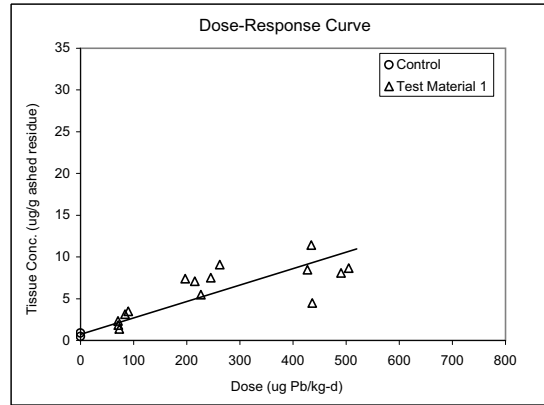
Phase II Experiment 2: Femur

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

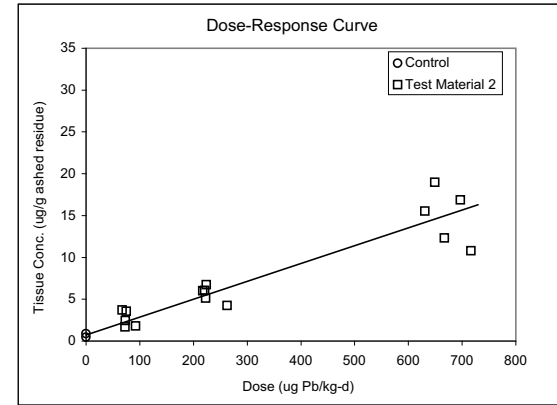
Reference Material (Lead Acetate)



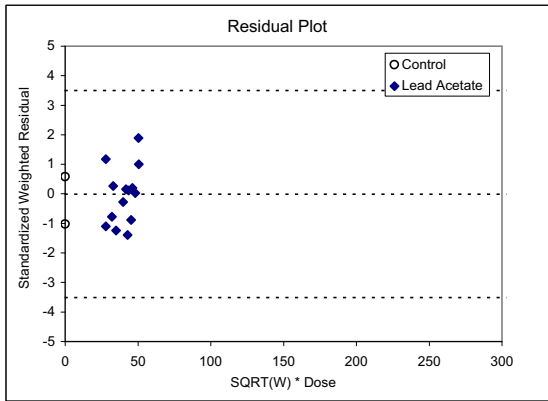
Test Material 1 (Bingham Creek Residential)



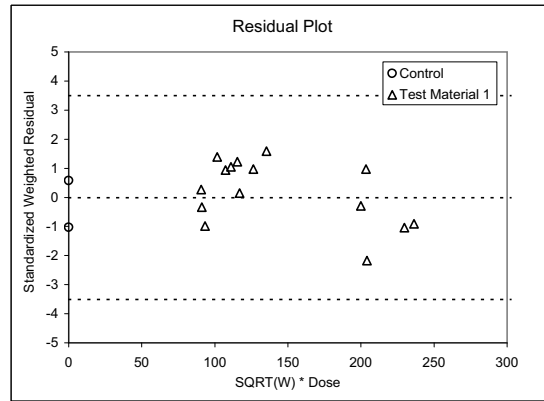
Test Material 2 (Bingham Creek Channel Soil)



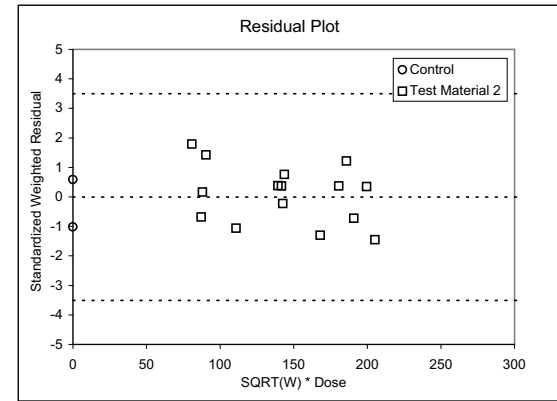
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.23E-01	1.98E-01
b1	8.43E-02	3.29E-02
b2	1.99E-02	9.63E-03
b3	2.16E-02	1.06E-02
c	9.99E-01	7.87E-02
Covariance (b1,b2)	0.9581	--
Covariance (b1,b3)	0.9605	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	69.720
p	< 0.001
Adjusted R ²	0.8593
AIC	182.521

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.24	0.26
Lower bound	0.11	0.12
Upper bound	0.29	0.31
Standard Error	--	--

APPENDIX E

EXPERIMENT 3

Test Material 1: Jasper County High Lead Smelter

Test Material 2: Jasper County Low Lead Yard

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

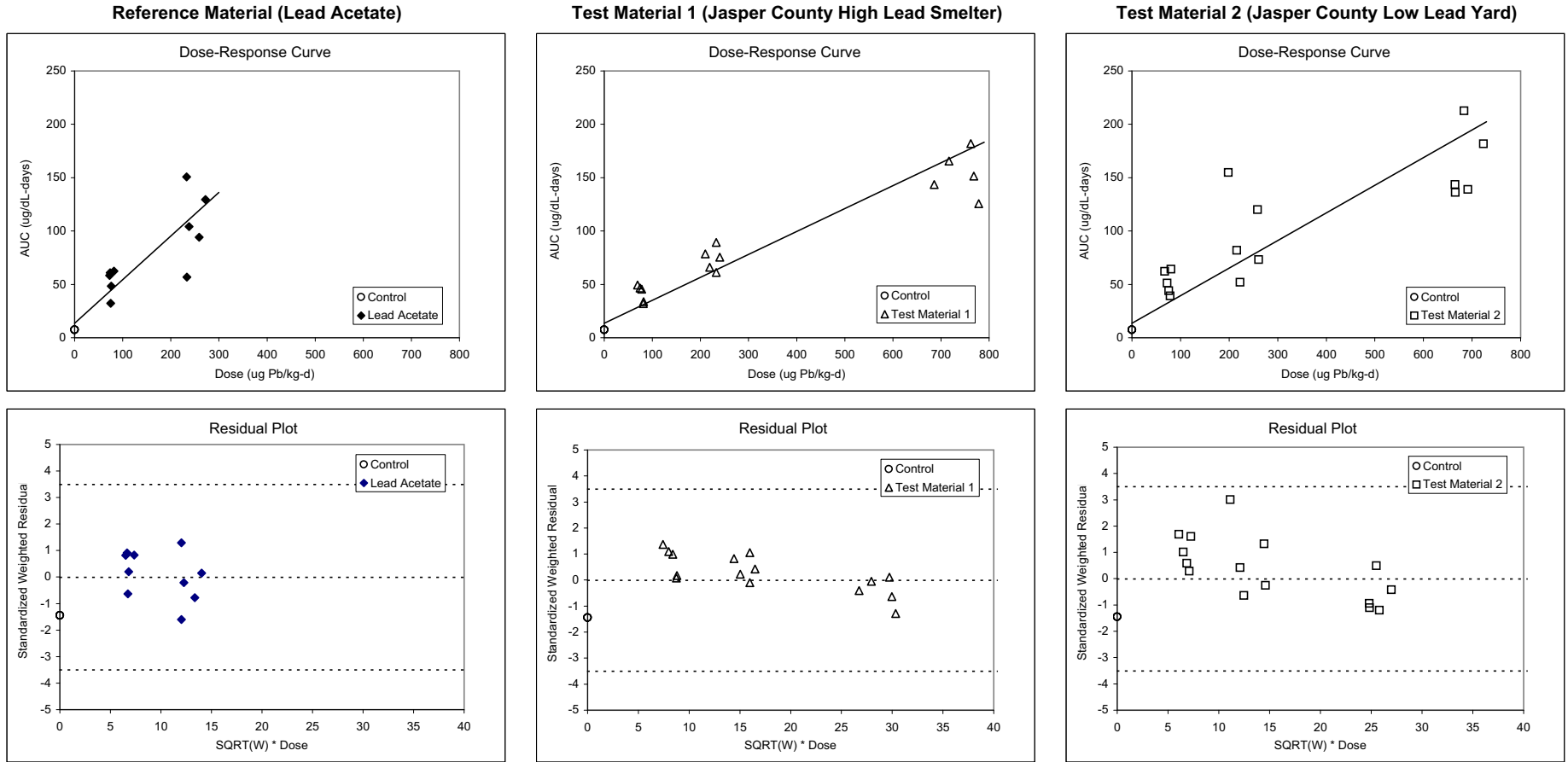
- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

Figure 1a - All Data

Phase II Experiment 3: Blood AUC
 Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.35E+01	2.71E+00
b1	4.09E-01	5.70E-02
b2	2.15E-01	2.44E-02
b3	2.59E-01	2.77E-02
Covariance (c1,c2)	0.0086	--
Covariance (c1,c3)	0.0740	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	62.590
p	< 0.001
Adjusted R ²	0.8184
AIC	428.514

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.53	0.63
Lower bound	0.39	0.48
Upper bound	0.72	0.86
Standard Error	0.094*	0.107*

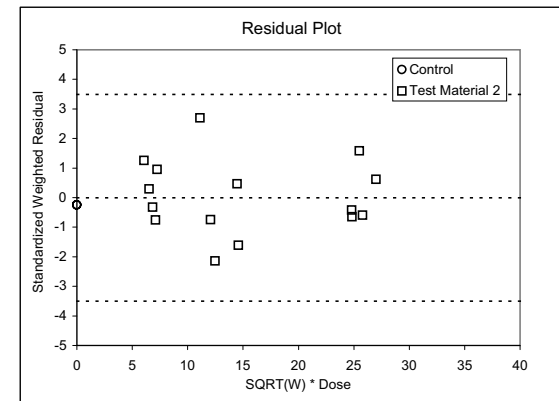
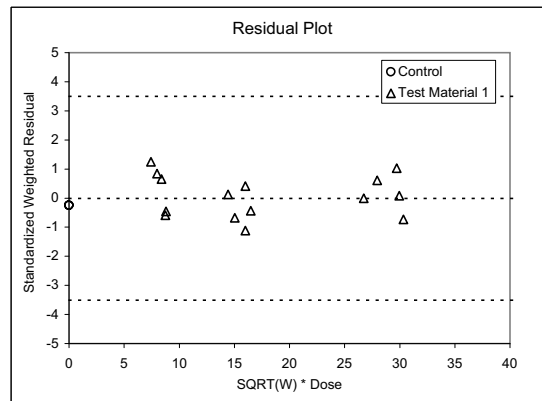
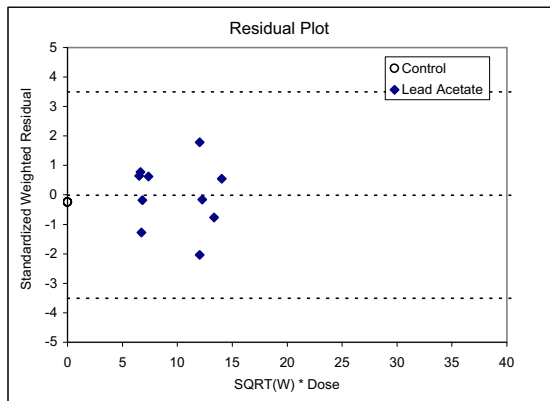
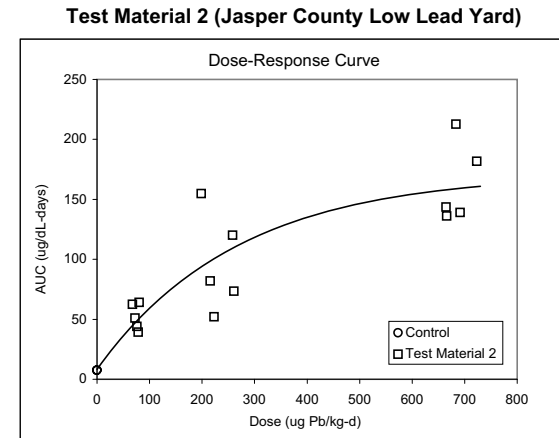
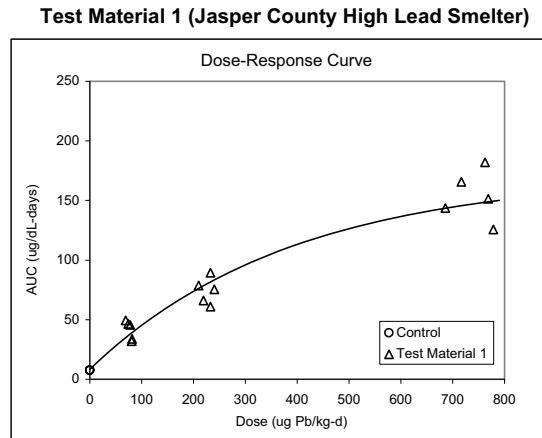
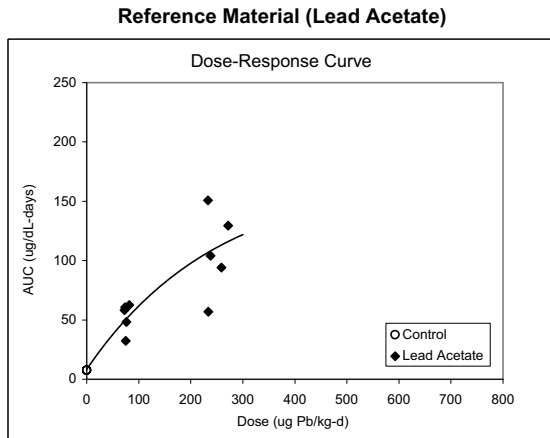
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1b - All Data

Phase II Experiment 3: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.27E+00	2.27E+00
b	1.63E+02	1.92E+01
c1	3.97E-03	8.75E-04
c2	2.56E-03	5.70E-04
c3	3.73E-03	8.76E-04
Covariance (c1,c2)	0.6715	--
Covariance (c1,c3)	0.6719	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	89.559
p	< 0.001
Adjusted R ²	0.8963
AIC	377.849

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.65	0.94
Lower bound	0.47	0.66
Upper bound	0.89	1.30
Standard Error	0.116*	0.174*

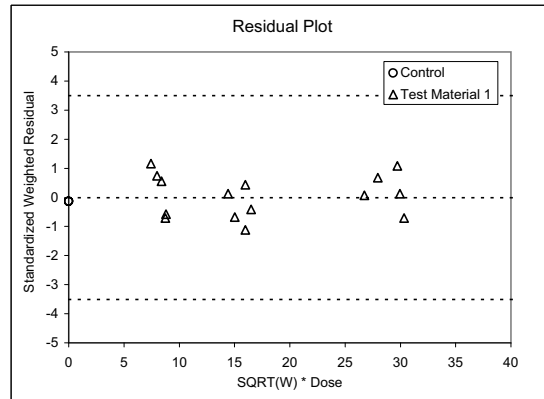
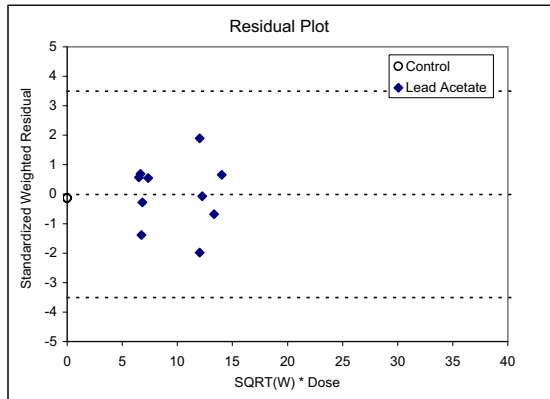
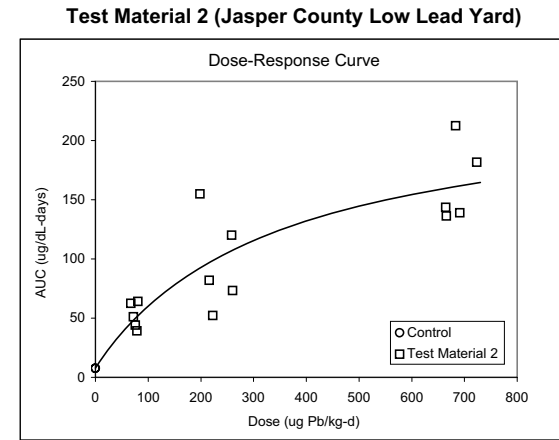
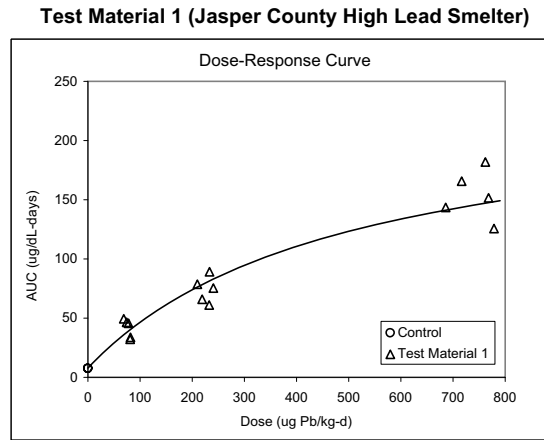
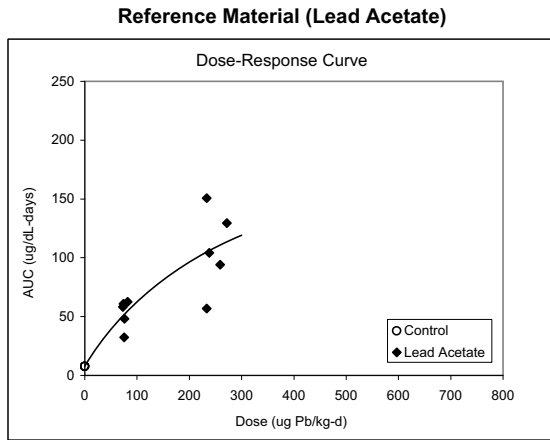
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1c - All Data

Phase II Experiment 3: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.92E+00	2.27E+00
b	2.29E+02	3.48E+01
c1	3.19E+02	8.73E+01
c2	4.94E+02	1.37E+02
c3	3.40E+02	1.01E+02
Covariance (c1,c2)	0.7827	--
Covariance (c1,c3)	0.7877	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	92.316
p	< 0.001
Adjusted R ²	0.8991
AIC	376.057

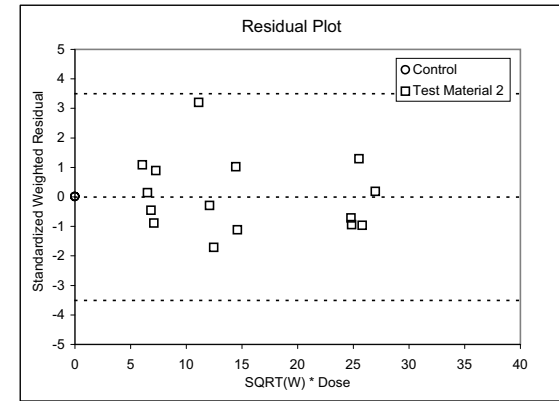
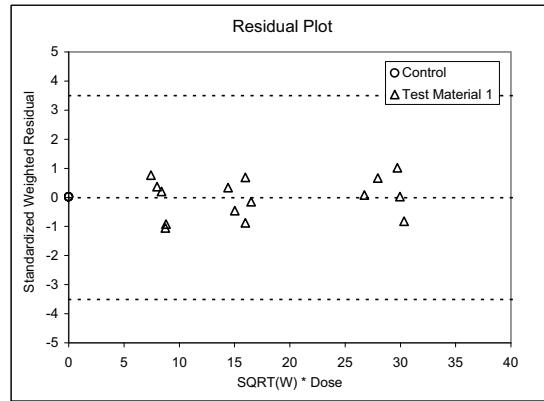
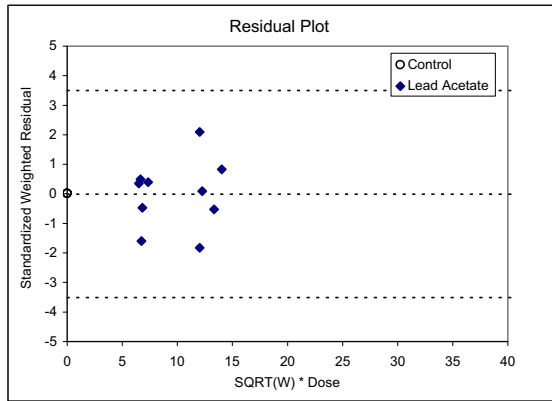
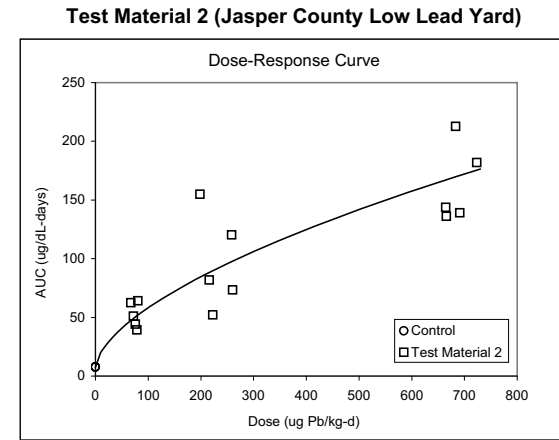
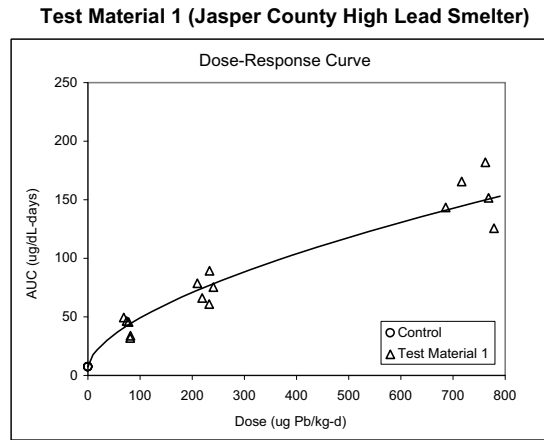
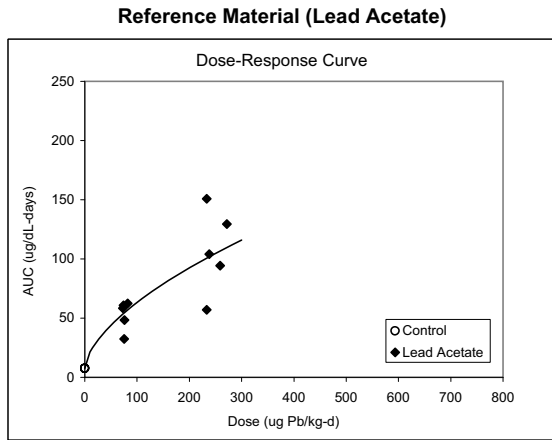
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.65	0.94
Lower bound	0.46	0.67
Upper bound	0.91	1.38
Standard Error	0.117*	0.176*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 3: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.46E+00	2.26E+00
b1	3.43E+00	1.05E+00
b2	2.56E+00	8.65E-01
b3	3.11E+00	1.05E+00
c	6.06E-01	5.57E-02
Covariance (b1,b2)	0.9351	--
Covariance (b1,b3)	0.9366	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	94.960
p	< 0.001
Adjusted R ²	0.9016
AIC	374.429

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.62	0.85
Lower bound	0.38	0.53
Upper bound	0.86	1.19
Standard Error	--	--

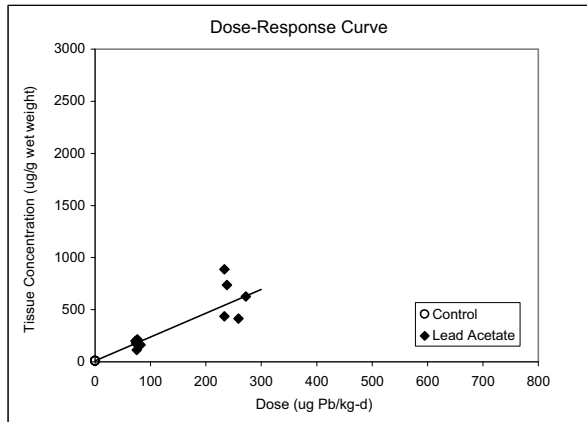
APPENDIX E

Figure 2a - All Data

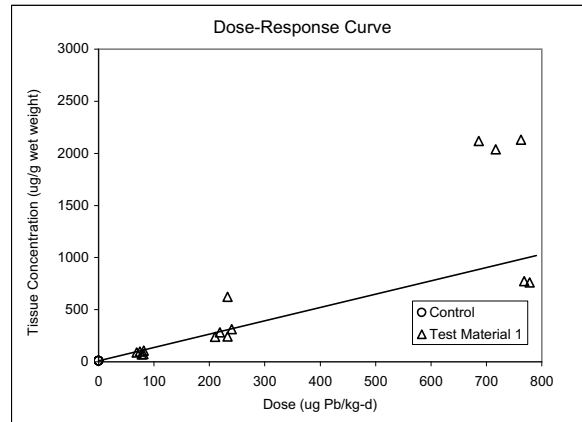
Phase II Experiment 3: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

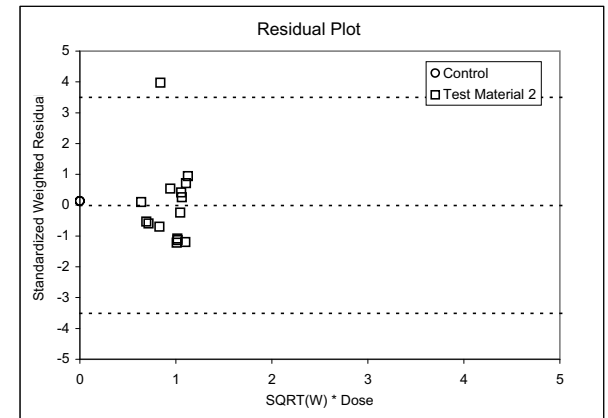
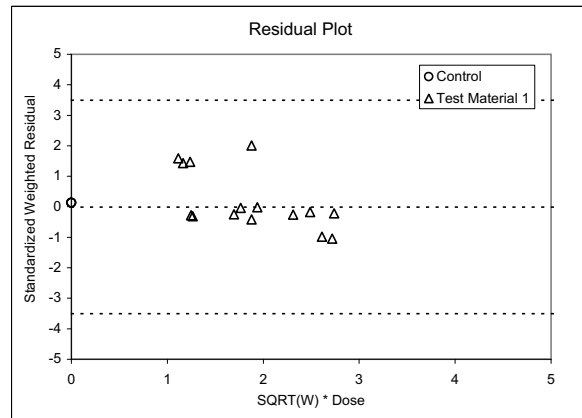
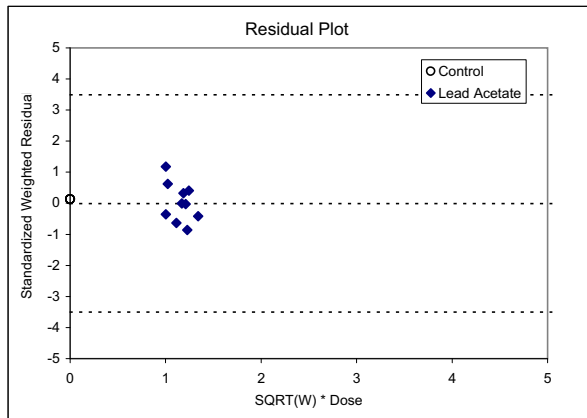
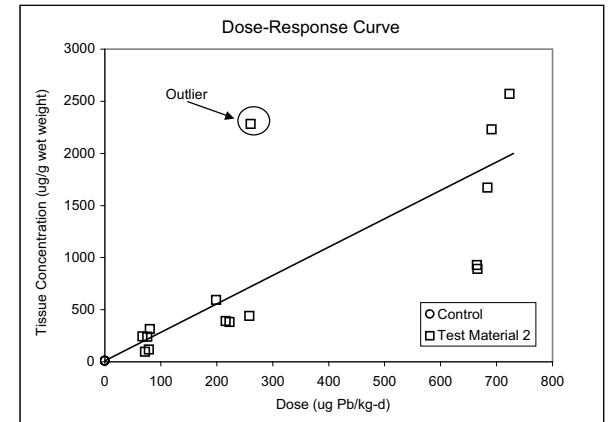
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.51E+00	2.83E+00
b1	2.28E+00	3.60E-01
b2	1.28E+00	1.76E-01
b3	2.73E+00	3.54E-01
Covariance (c1,c2)	0.0105	--
Covariance (c1,c3)	0.0039	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	50.038
p	< 0.001
Adjusted R ²	0.7820
AIC	562.298

RBA and Uncertainty

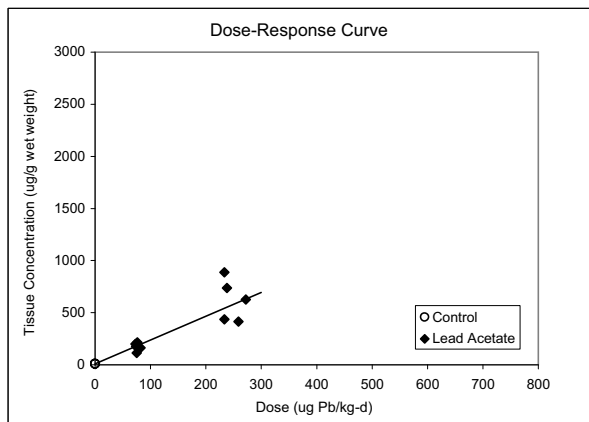
	Test Material 1	Test Material 2
RBA	0.56	1.20
Lower bound	0.40	0.85
Upper bound	0.81	1.73
Standard Error	0.117*	0.245*

* $g \geq 0.05$, estimate is uncertain

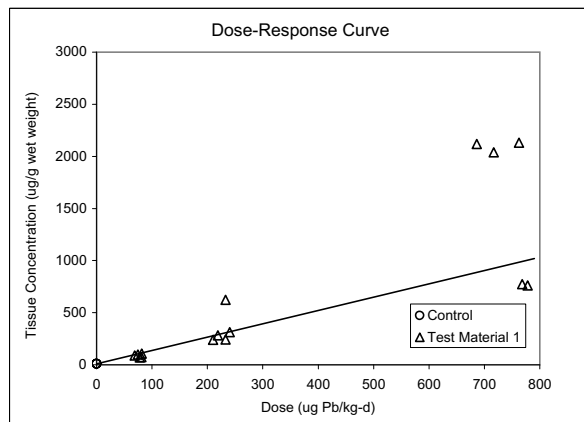
APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 3: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

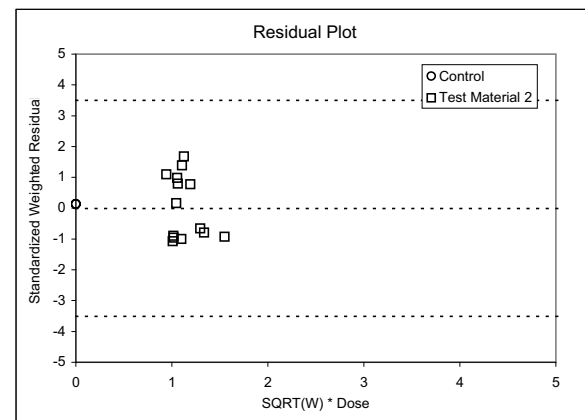
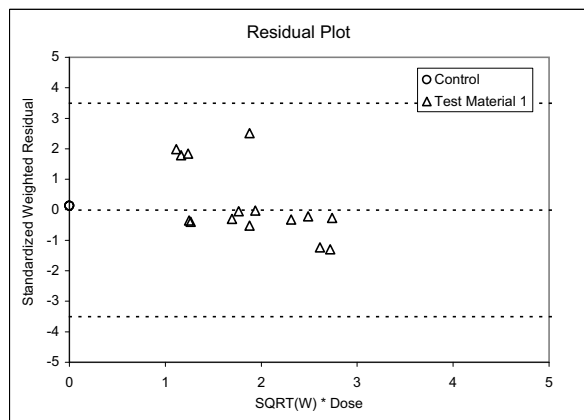
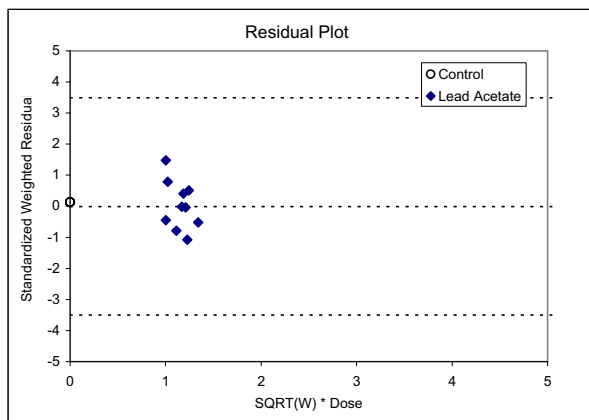
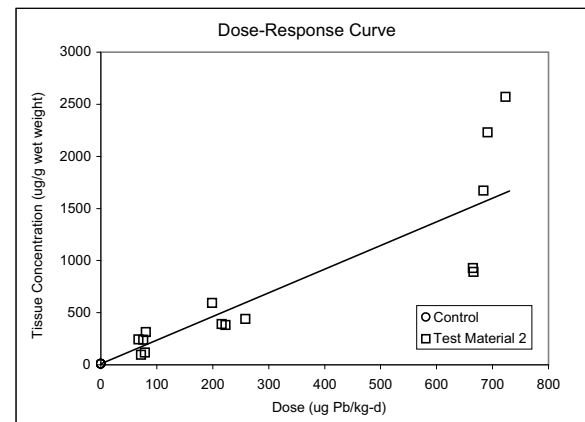
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.59E+00	2.27E+00
b1	2.28E+00	2.90E-01
b2	1.28E+00	1.41E-01
b3	2.27E+00	2.47E-01
Covariance (c1,c2)	0.0105	--
Covariance (c1,c3)	0.0041	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	75.057
p	< 0.001
Adjusted R ²	0.8474
AIC	519.560

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.56	1.00
Lower bound	0.42	0.75
Upper bound	0.75	1.34
Standard Error	0.094	0.167

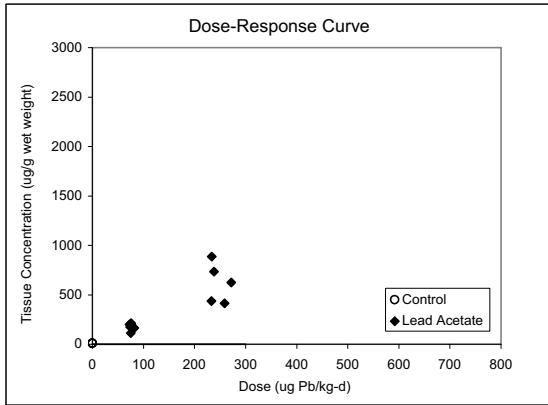
APPENDIX E

Figure 2b - All Data

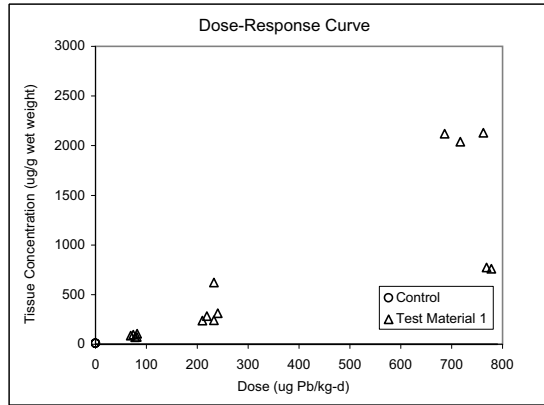
Phase II Experiment 3: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

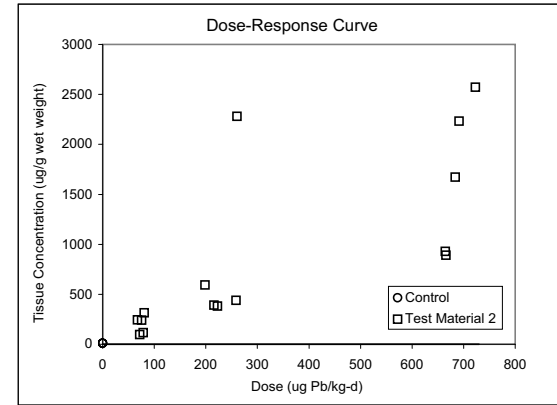
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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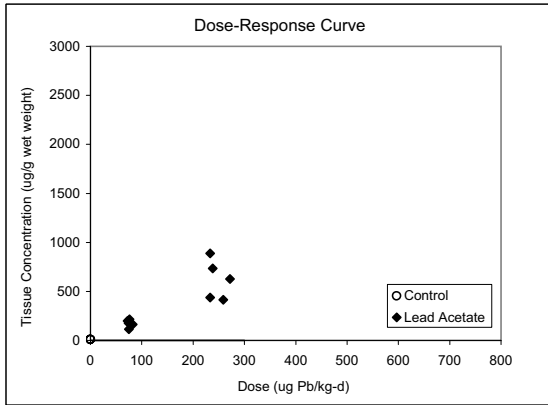
APPENDIX E

Figure 2c - All Data

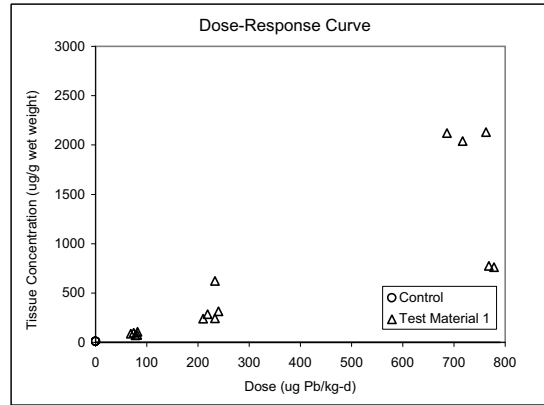
Phase II Experiment 3: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

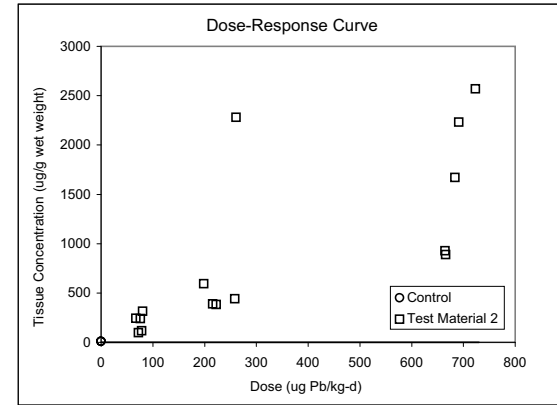
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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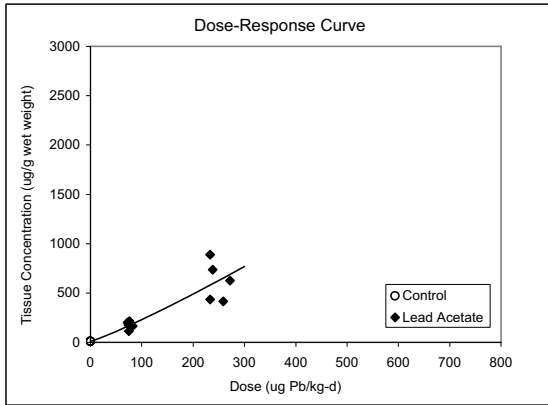
APPENDIX E

Figure 2d - All Data

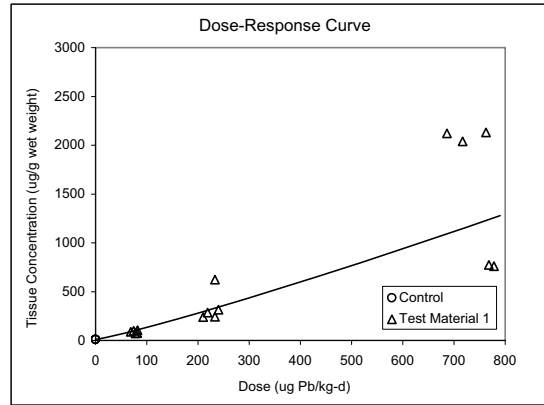
Phase II Experiment 3: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

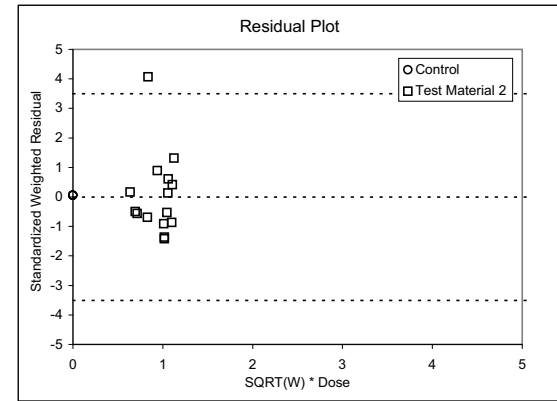
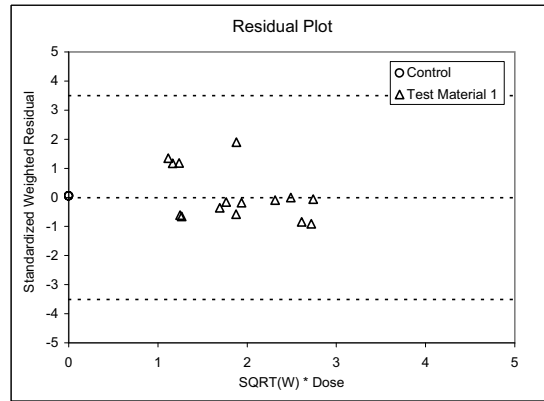
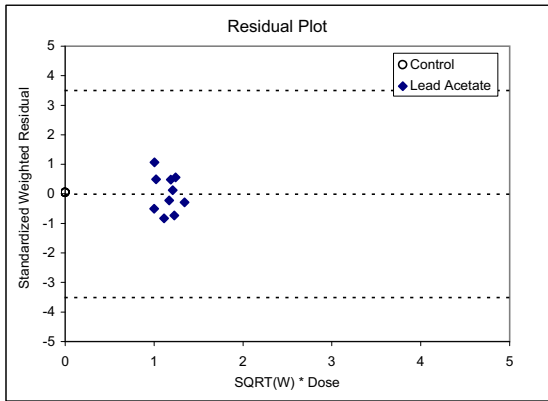
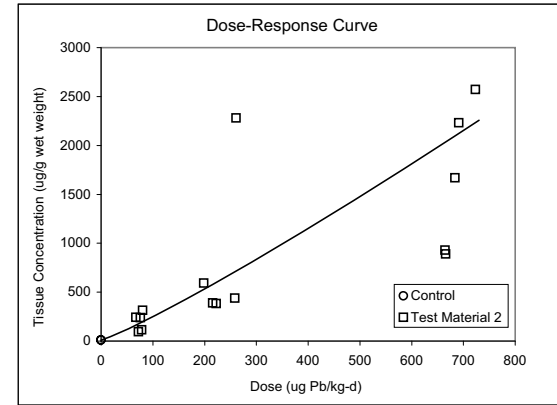
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.80E+00	2.81E+00
b1	1.23E+00	6.09E-01
b2	6.94E-01	3.51E-01
b3	1.34E+00	7.45E-01
c	1.13E+00	9.49E-02
Covariance (b1,b2)	0.9157	--
Covariance (b1,b3)	0.9221	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	38.601
p	< 0.001
Adjusted R ²	0.7858
AIC	561.470

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.60	1.08
Lower bound	0.32	0.32
Upper bound	1.00	1.62
Standard Error	--	--

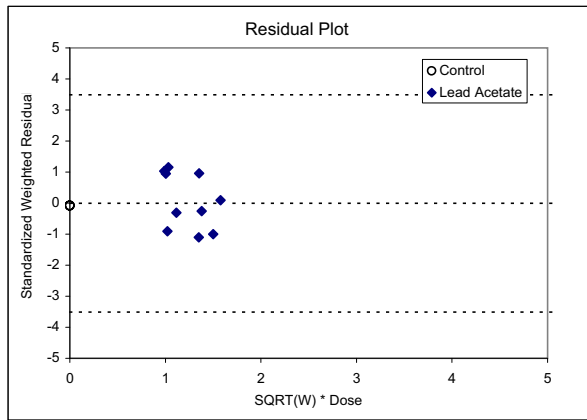
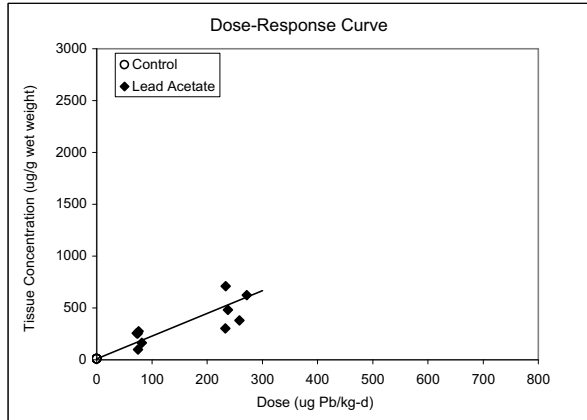
APPENDIX E

Figure 3a - All Data

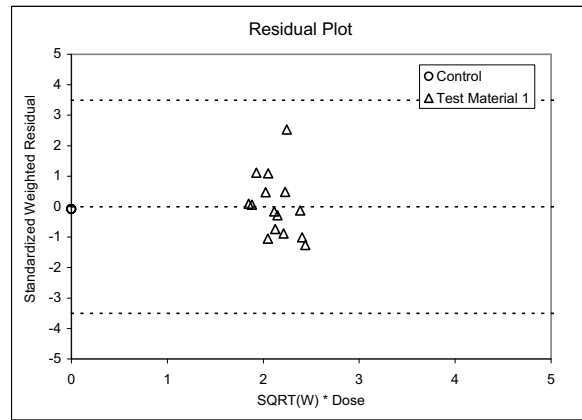
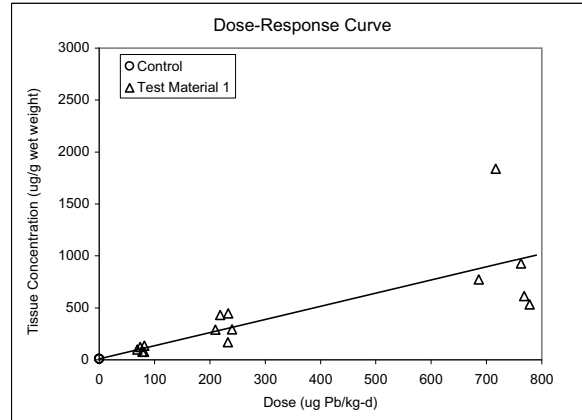
Phase II Experiment 3: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

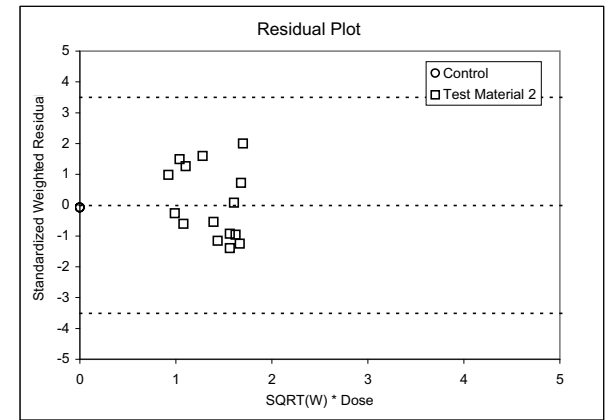
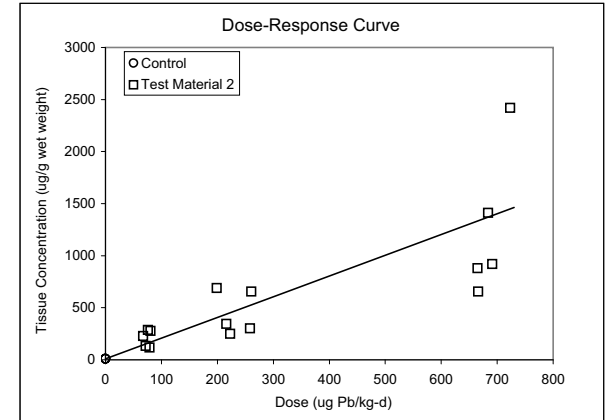
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.04E+01	3.14E+00
b1	2.19E+00	3.02E-01
b2	1.26E+00	1.44E-01
b3	1.99E+00	2.19E-01
Covariance (c1,c2)	0.0096	--
Covariance (c1,c3)	0.0050	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	69.473
p	< 0.001
Adjusted R ²	0.8336
AIC	533.597

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.58	0.91
Lower bound	0.43	0.68
Upper bound	0.79	1.24
Standard Error	0.103*	0.160*

* $g \geq 0.05$, estimate is uncertain

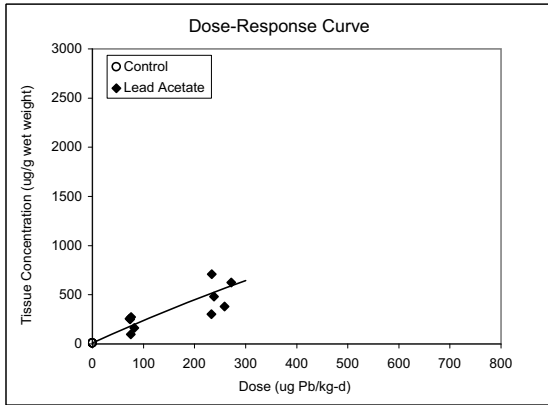
APPENDIX E

Figure 3b - All Data

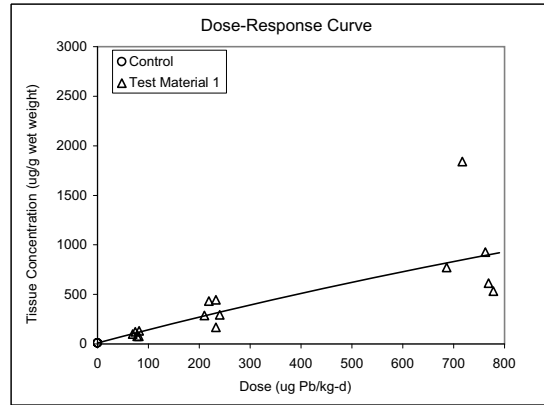
Phase II Experiment 3: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

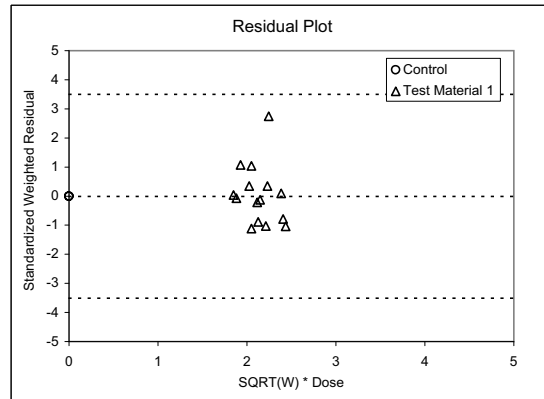
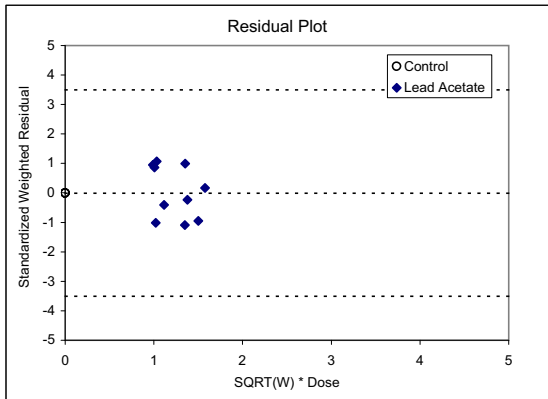
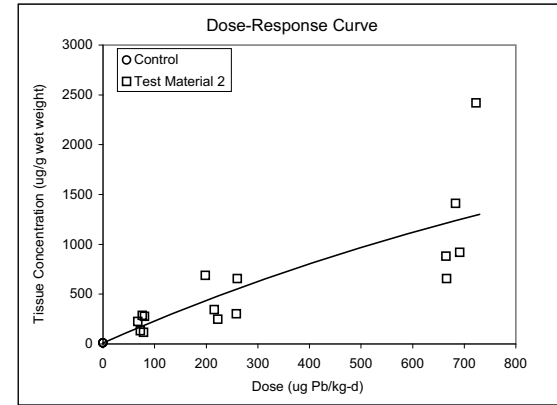
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.00E+01	3.16E+00
b	3.08E+03	2.88E+03
c1	7.70E-04	7.83E-04
c2	4.44E-04	4.51E-04
c3	7.46E-04	7.98E-04
Covariance (c1,c2)	0.9824	--
Covariance (c1,c3)	0.9828	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	52.252
p	< 0.001
Adjusted R ²	0.8333
AIC	534.270

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.58	0.97
Lower bound	?	?
Upper bound	?	?
Standard Error	0.110*	0.194*

* $g \geq 0.05$, estimate is uncertain

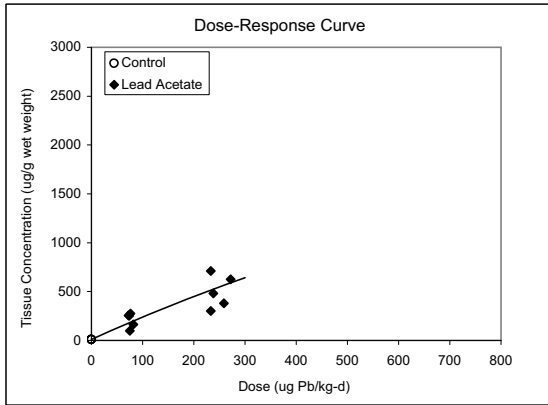
APPENDIX E

Figure 3c - All Data

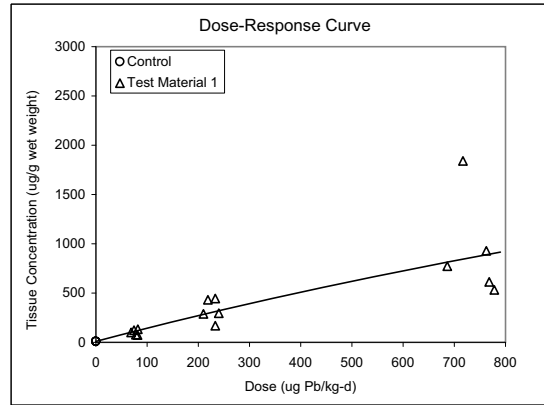
Phase II Experiment 3: Kidney

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

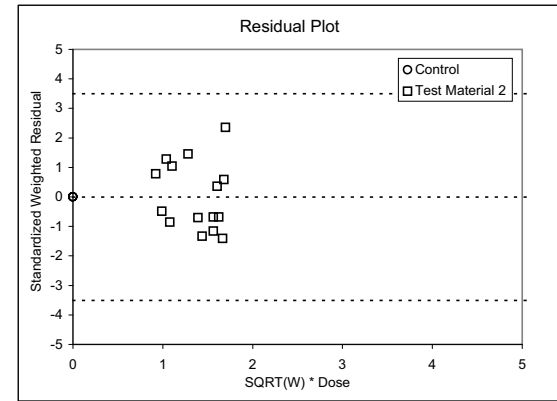
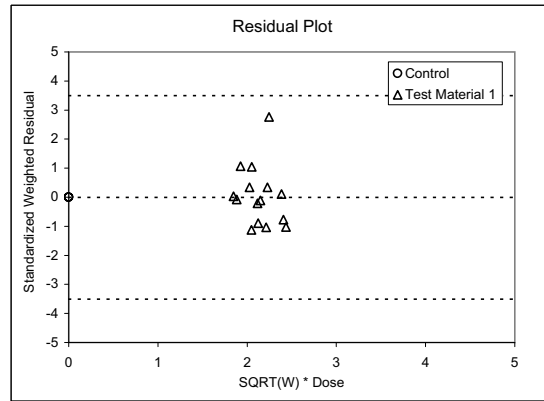
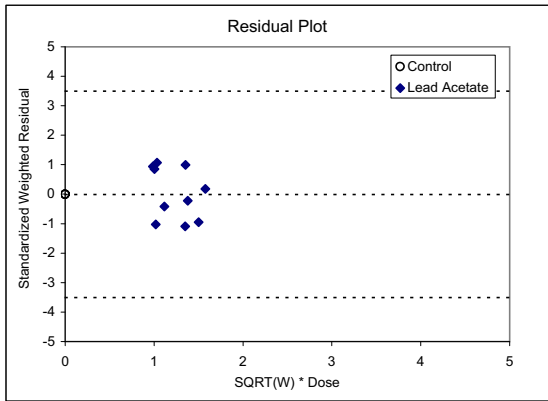
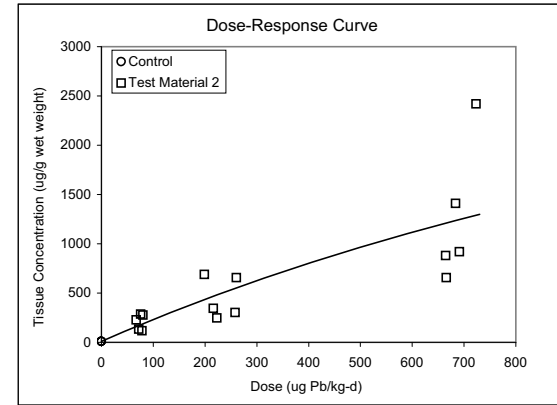
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.00E+01	3.16E+00
b	5.45E+03	5.36E+03
c1	2.29E+03	2.45E+03
c2	3.98E+03	4.24E+03
c3	2.36E+03	2.64E+03
Covariance (c1,c2)	0.9839	--
Covariance (c1,c3)	0.9844	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	52.312
p	< 0.001
Adjusted R ²	0.8335
AIC	534.219

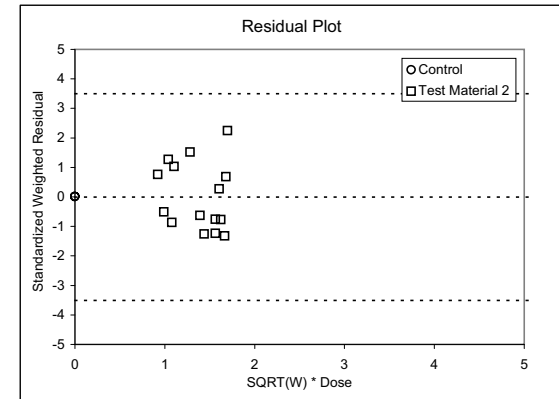
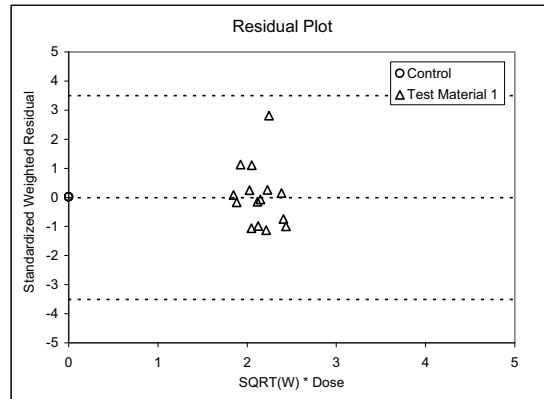
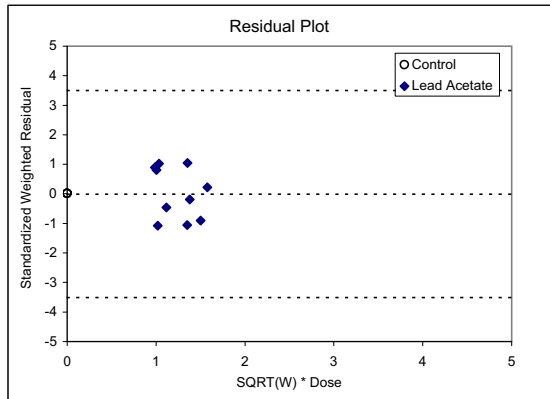
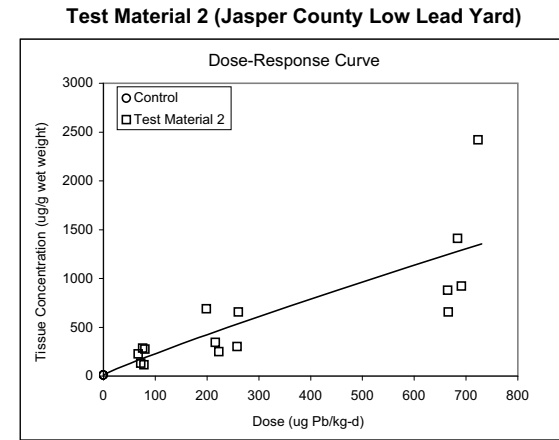
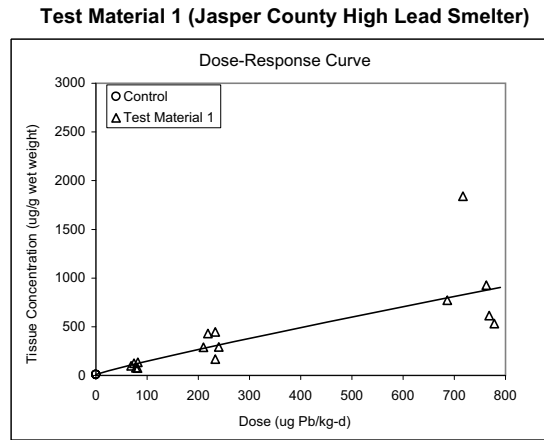
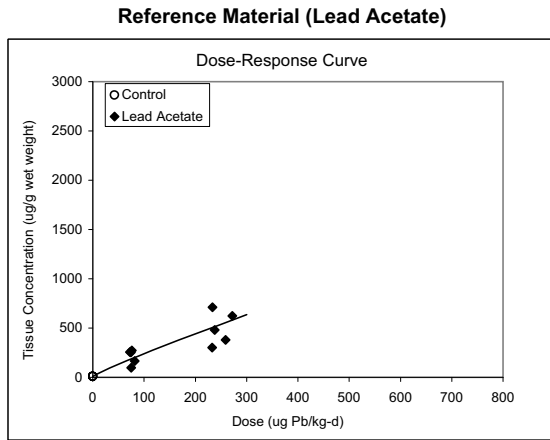
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.58	0.97
Lower bound	?	?
Upper bound	?	?
Standard Error	0.110*	0.194*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3d - All Data
Phase II Experiment 3: Kidney
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.94E+00	3.16E+00
b1	3.48E+00	1.53E+00
b2	2.06E+00	9.50E-01
b3	3.34E+00	1.59E+00
c	9.10E-01	8.26E-02
Covariance (b1,b2)	0.9216	--
Covariance (b1,b3)	0.9256	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	52.565
p	< 0.001
Adjusted R ²	0.8342
AIC	534.005

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.56	0.95
Lower bound	0.31	0.49
Upper bound	0.88	1.44
Standard Error	--	--

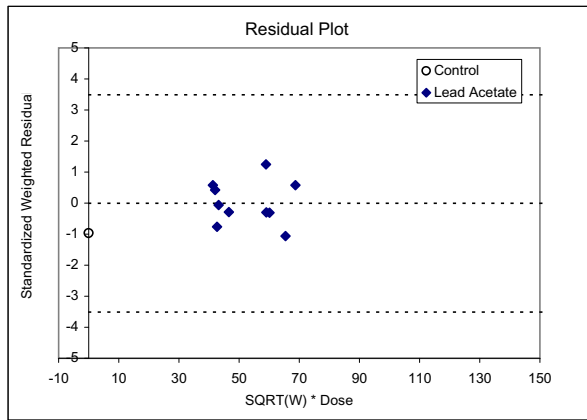
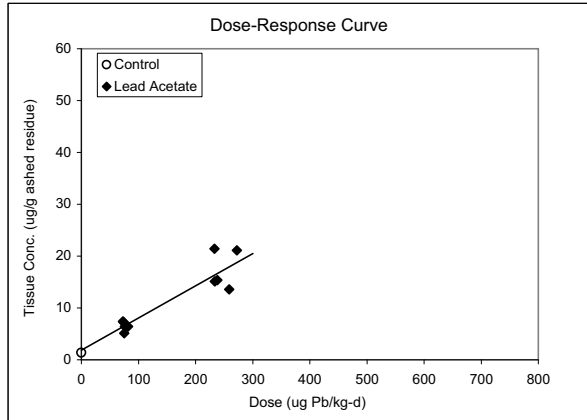
APPENDIX E

Figure 4a - All Data

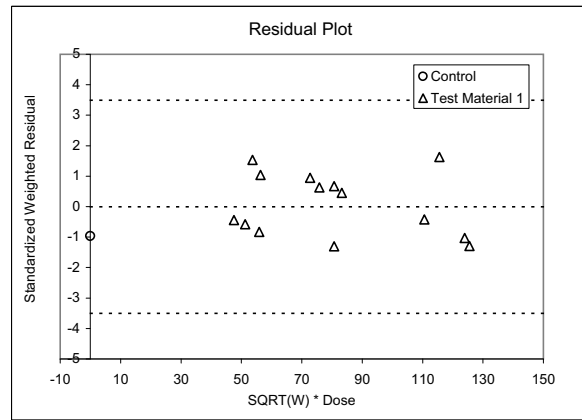
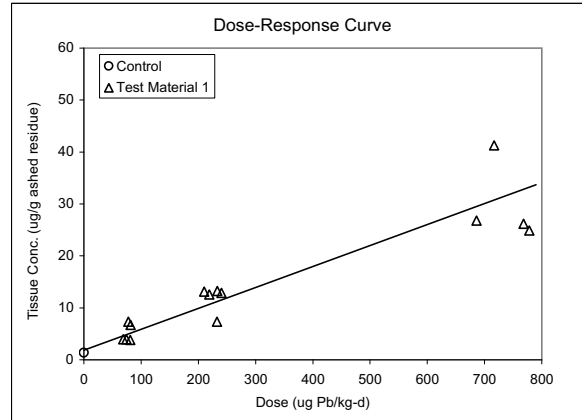
Phase II Experiment 3: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

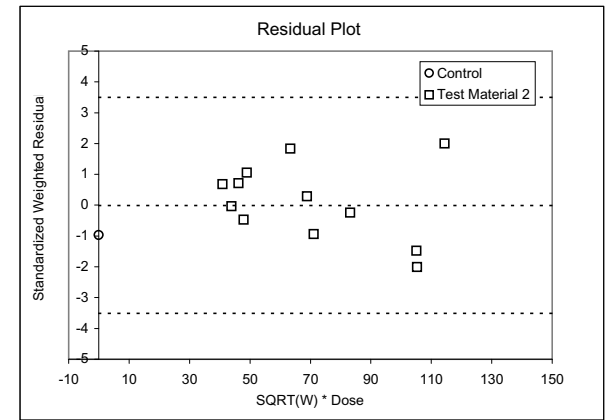
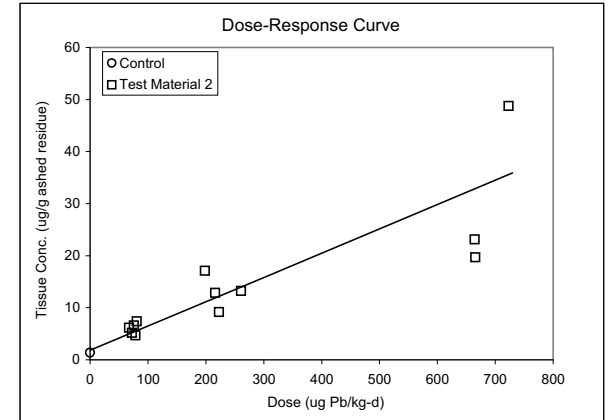
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.83E+00	3.96E-01
b1	6.21E-02	6.98E-03
b2	4.03E-02	3.75E-03
b3	4.66E-02	4.55E-03
Covariance (c1,c2)	0.1624	--
Covariance (c1,c3)	0.1457	--
Degrees of Freedom	33	--

Goodness of Fit

Statistic	Estimate
F	76.883
p	< 0.001
Adjusted R ²	0.8635
AIC	187.220

RBA and Uncertainty

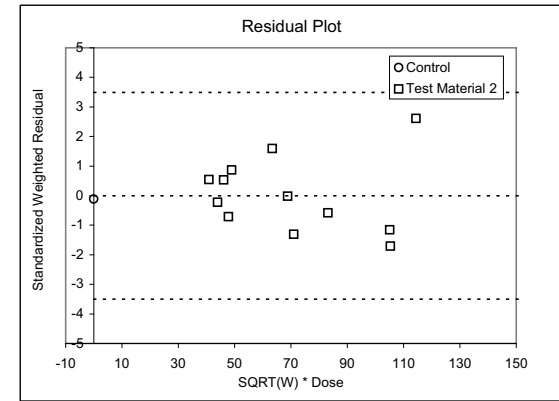
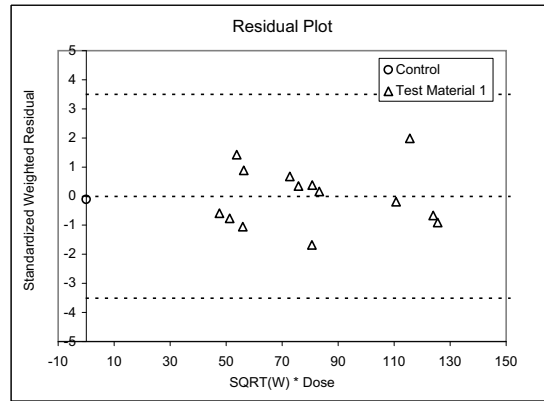
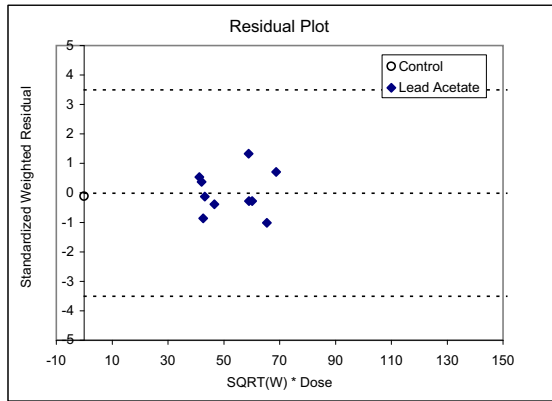
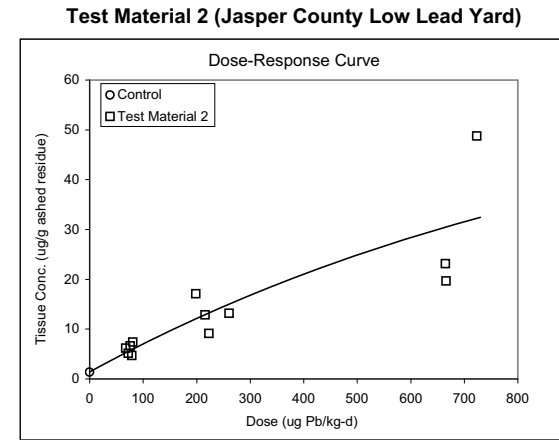
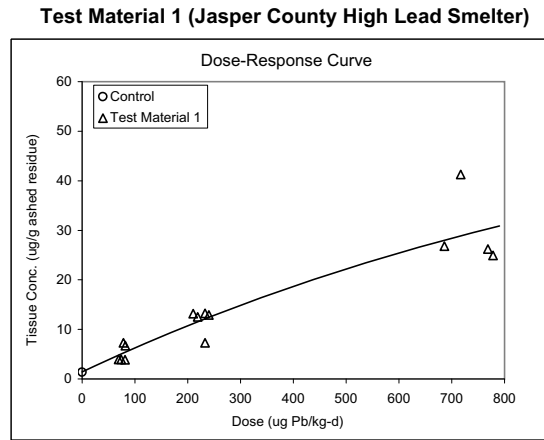
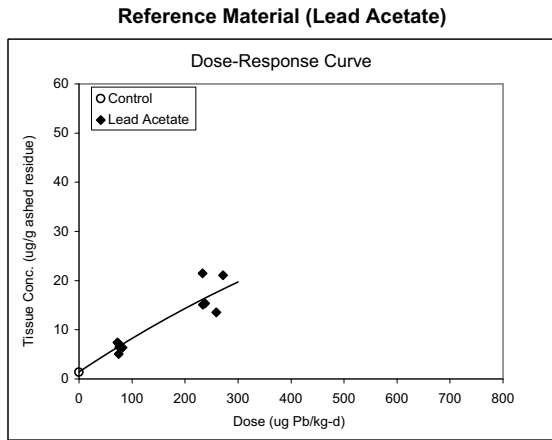
	Test Material 1	Test Material 2
RBA	0.65	0.75
Lower bound	0.52	0.60
Upper bound	0.82	0.95
Standard Error	0.087	0.103

APPENDIX E

Figure 4b - All Data

Phase II Experiment 3: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.41E+00	4.67E-01
b	6.20E+01	3.08E+01
c1	1.17E-03	6.92E-04
c2	8.17E-04	5.06E-04
c3	9.52E-04	5.93E-04
Covariance (c1,c2)	0.9723	--
Covariance (c1,c3)	0.9705	--
Degrees of Freedom	32	--

Goodness of Fit

Statistic	Estimate
F	61.268
p	< 0.001
Adjusted R ²	0.8701
AIC	186.192

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.70	0.81
Lower bound	4.82	7.47
Upper bound	2.28	2.25
Standard Error	0.101*	0.123*

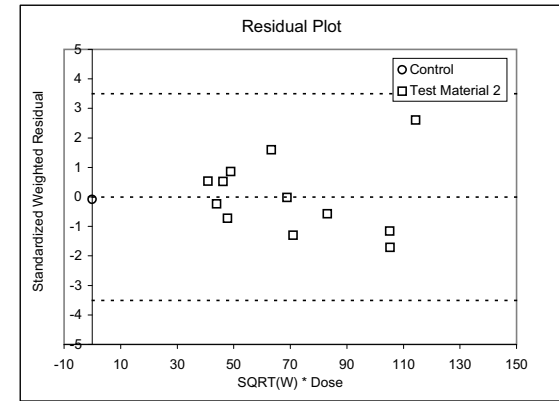
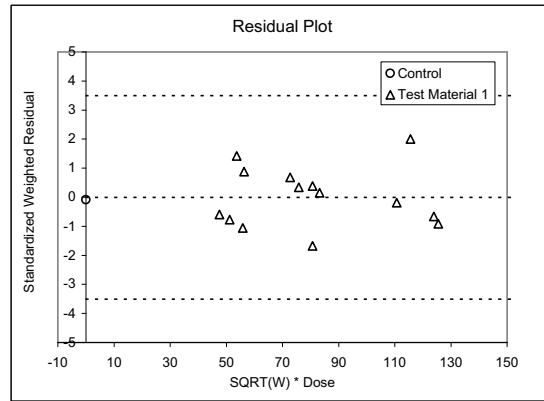
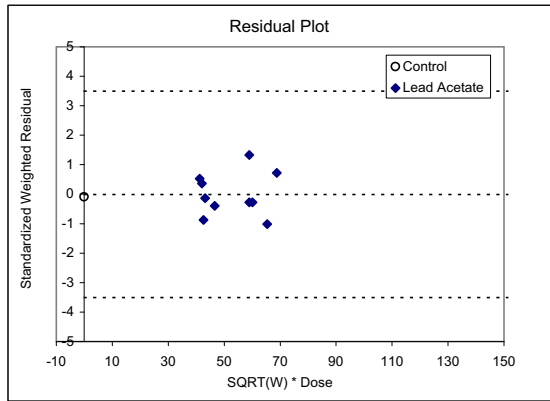
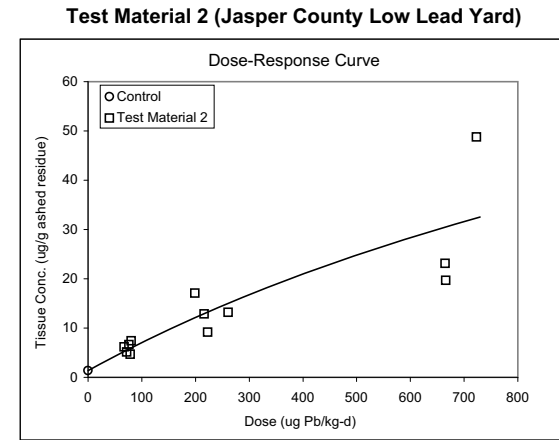
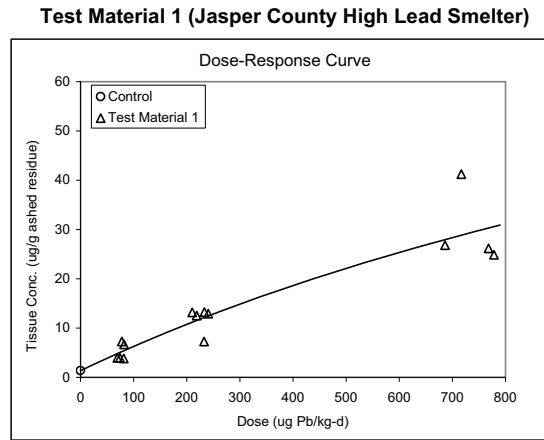
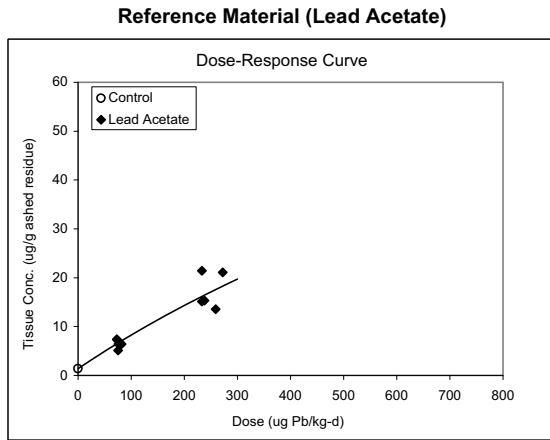
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4c - All Data

Phase II Experiment 3: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.39E+00	4.72E-01
b	1.09E+02	6.03E+01
c1	1.48E+03	9.77E+02
c2	2.13E+03	1.46E+03
c3	1.82E+03	1.26E+03
Covariance (c1,c2)	0.9775	--
Covariance (c1,c3)	0.9761	--
Degrees of Freedom	32	--

Goodness of Fit

Statistic	Estimate
F	61.359
p	< 0.001
Adjusted R ²	0.8702
AIC	186.145

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.70	0.81
Lower bound	?	?
Upper bound	?	?
Standard Error	0.101*	0.122*

* $g \geq 0.05$, estimate is uncertain

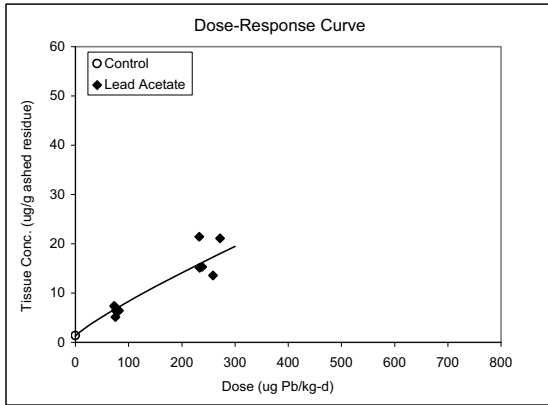
APPENDIX E

Figure 4d - All Data

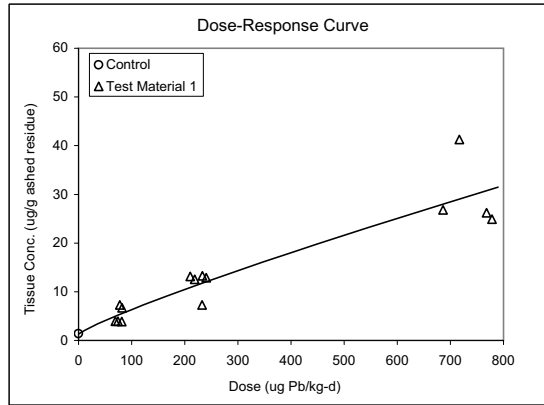
Phase II Experiment 3: Femur

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

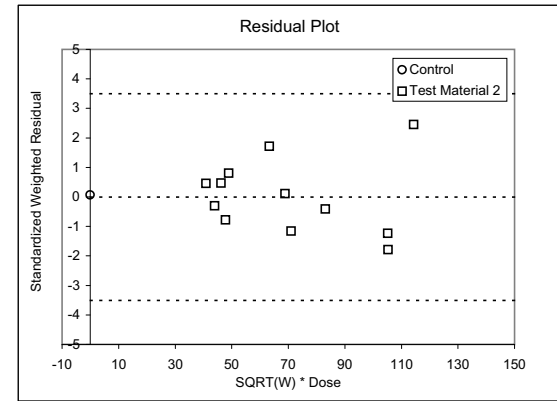
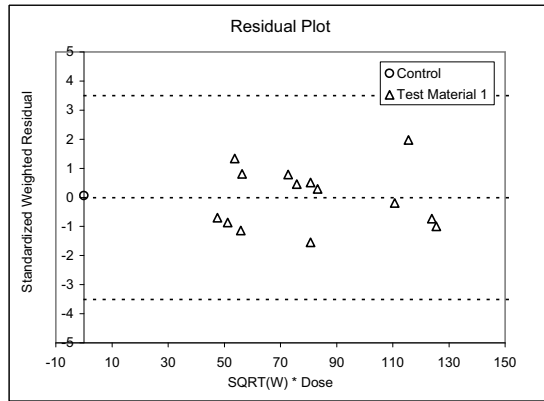
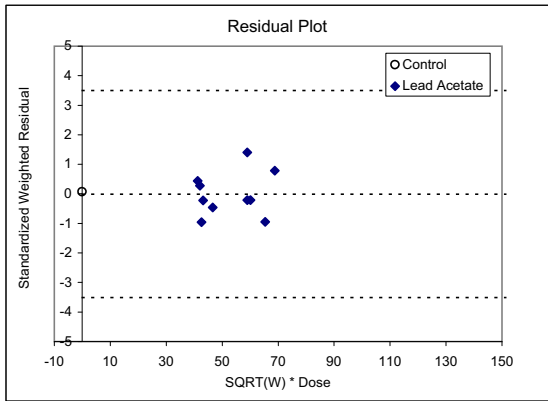
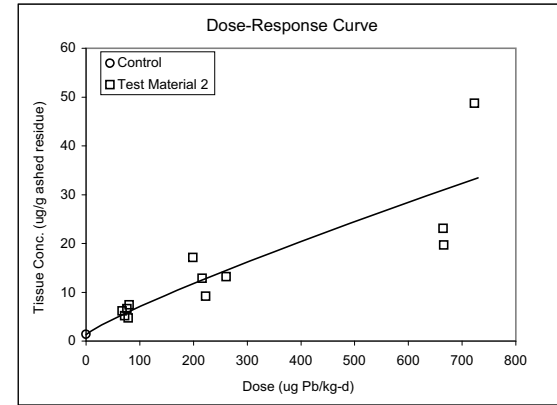
Reference Material (Lead Acetate)



Test Material 1 (Jasper County High Lead Smelter)



Test Material 2 (Jasper County Low Lead Yard)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.32E+00	4.98E-01
b1	1.29E-01	5.45E-02
b2	9.26E-02	4.31E-02
b3	1.06E-01	4.84E-02
c	8.67E-01	7.44E-02
Covariance (b1,b2)	0.9601	--
Covariance (b1,b3)	0.9575	--
Degrees of Freedom	32	--

Goodness of Fit

Statistic	Estimate
F	61.446
p	< 0.001
Adjusted R ²	0.8704
AIC	186.099

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.68	0.79
Lower bound	0.39	0.47
Upper bound	0.89	1.06
Standard Error	--	--

APPENDIX E

EXPERIMENT 4

Test Material 1: Murray Smelter Slag
Test Material 2: Jasper County High Lead Mill

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

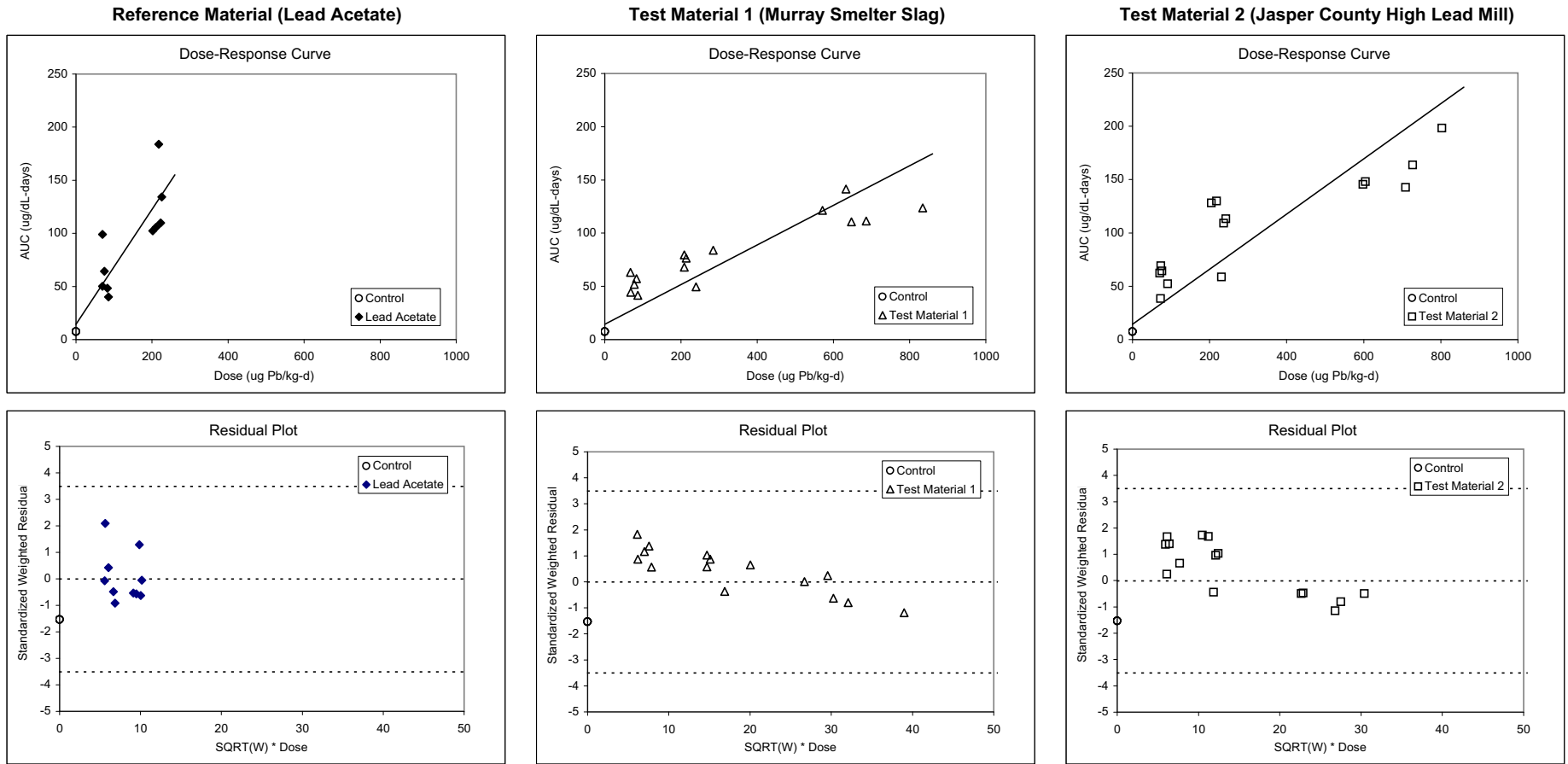
- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

Figure 1a - All Data

Phase II Experiment 4: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.43E+01	3.04E+00
b1	5.42E-01	7.80E-02
b2	1.86E-01	2.49E-02
b3	2.58E-01	3.04E-02
Covariance (c1,c2)	0.0818	--
Covariance (c1,c3)	0.0672	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	51.413
p	< 0.001
Adjusted R ²	0.7867
AIC	455.674

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.34	0.48
Lower bound	0.25	0.35
Upper bound	0.48	0.66
Standard Error	0.065*	0.086*

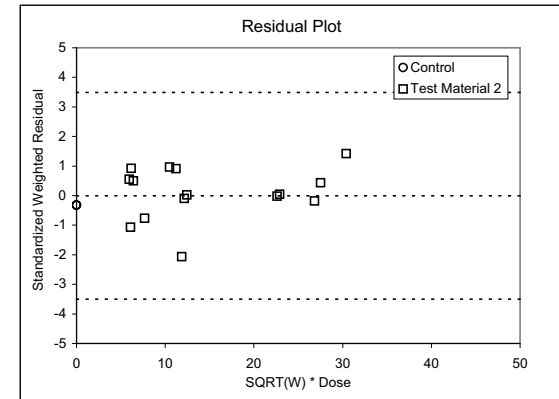
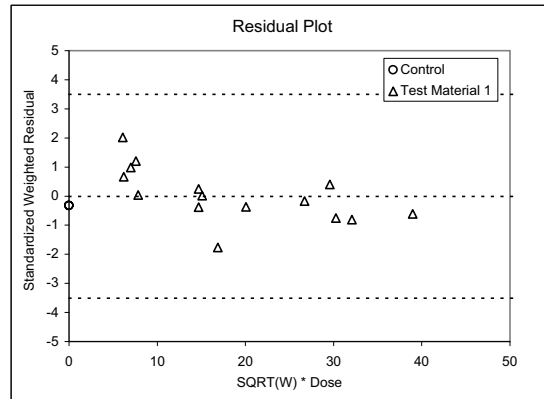
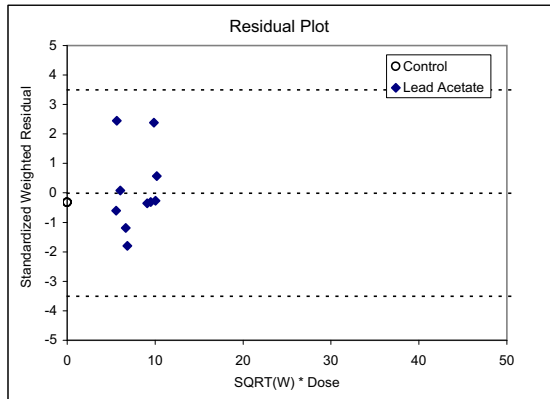
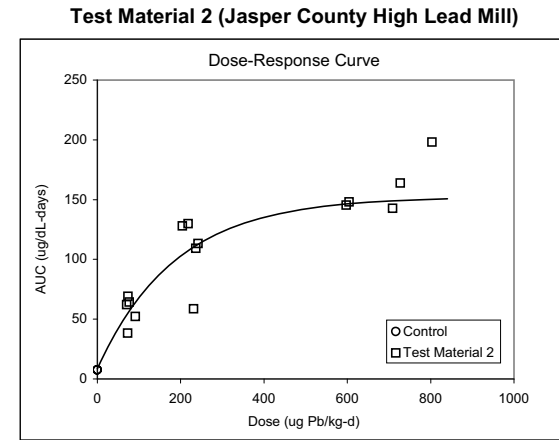
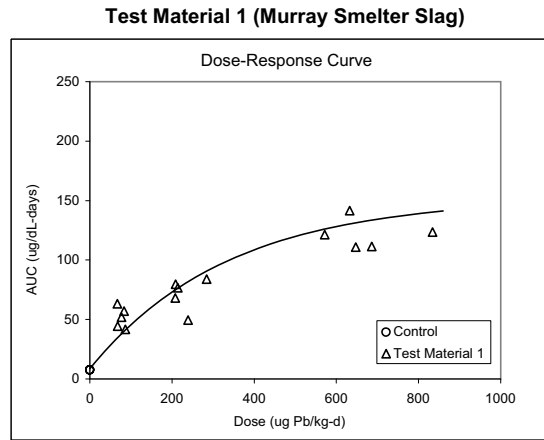
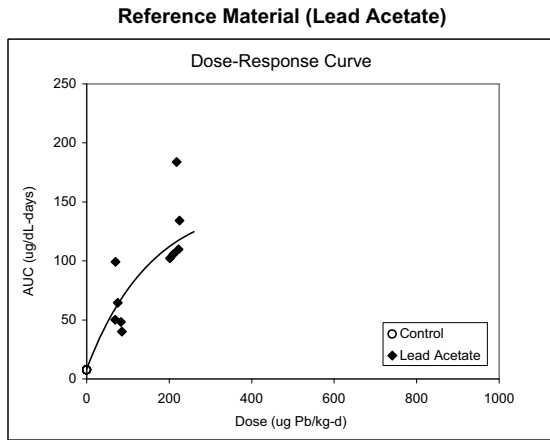
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1b - All Data

Phase II Experiment 4: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.52E+00	2.32E+00
b	1.44E+02	1.47E+01
c1	6.36E-03	1.40E-03
c2	2.98E-03	6.51E-04
c3	5.33E-03	1.20E-03
Covariance (c1,c2)	0.5953	--
Covariance (c1,c3)	0.5796	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	89.273
p	< 0.001
Adjusted R ²	0.8960
AIC	382.941

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.47	0.84
Lower bound	0.33	0.58
Upper bound	0.67	1.21
Standard Error	0.092*	0.171*

* $g \geq 0.05$, estimate is uncertain

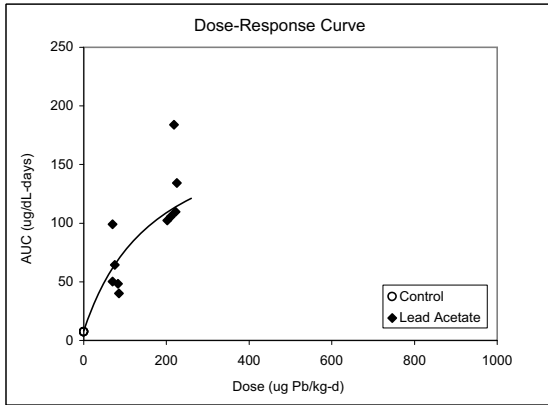
APPENDIX E

Figure 1c - All Data

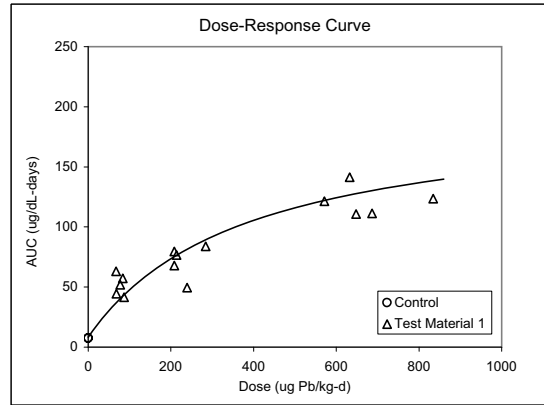
Phase II Experiment 4: Blood AUC

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

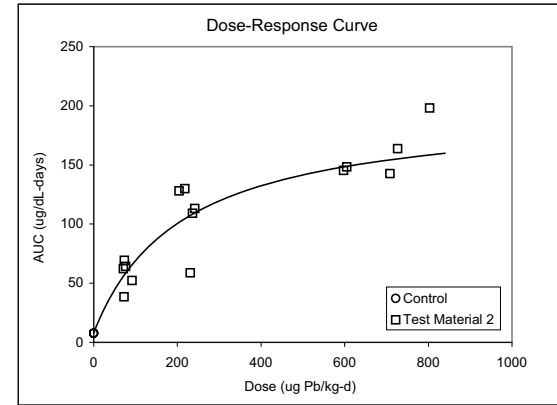
Reference Material (Lead Acetate)



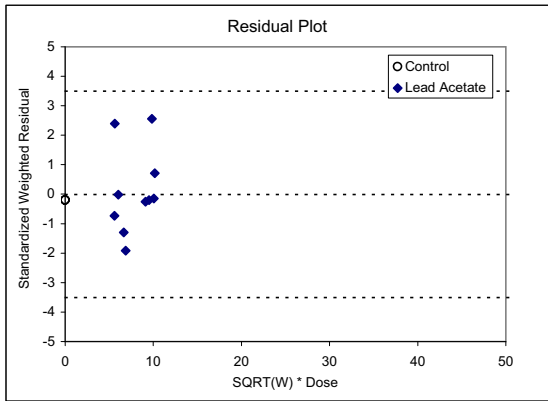
Test Material 1 (Murray Smelter Slag)



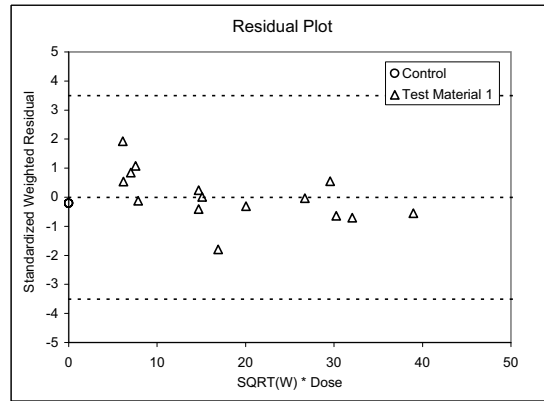
Test Material 2 (Jasper County High Lead Mill)



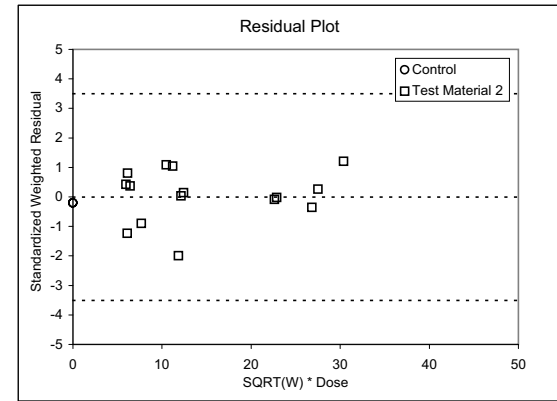
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.13E+00	2.28E+00
b	1.90E+02	2.47E+01
c1	1.77E+02	4.84E+01
c2	3.80E+02	1.03E+02
c3	2.11E+02	6.15E+01
Covariance (c1,c2)	0.7225	--
Covariance (c1,c3)	0.7236	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	94.291
p	< 0.001
Adjusted R ²	0.9010
AIC	379.665

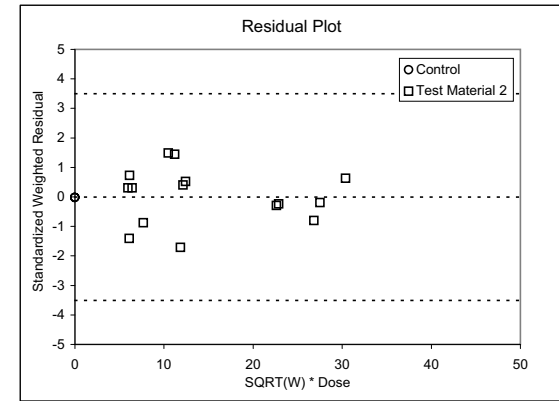
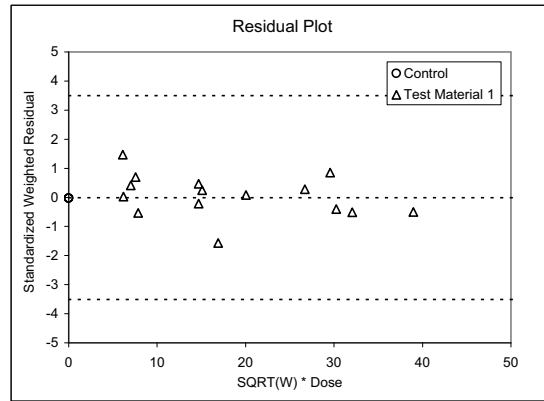
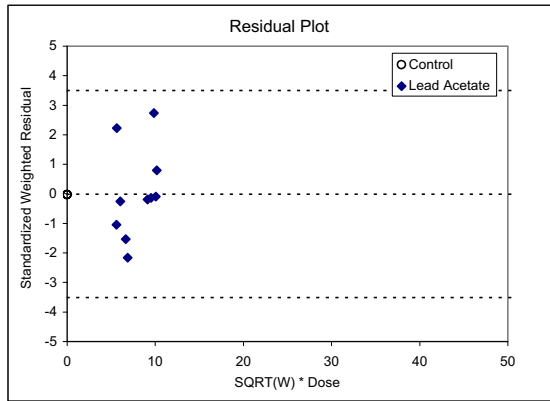
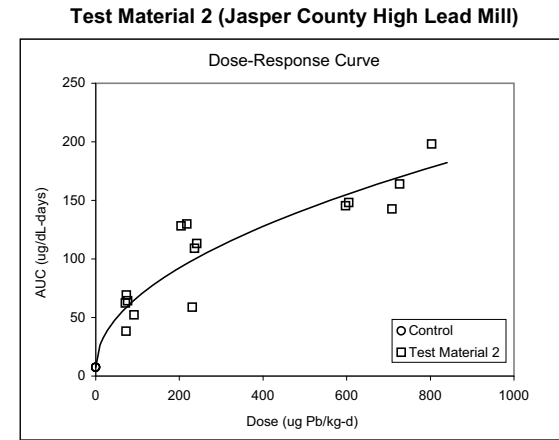
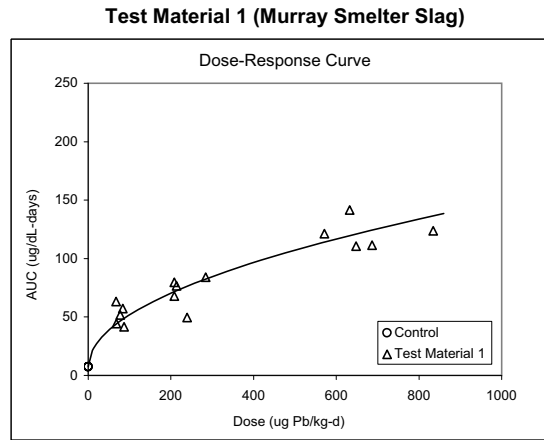
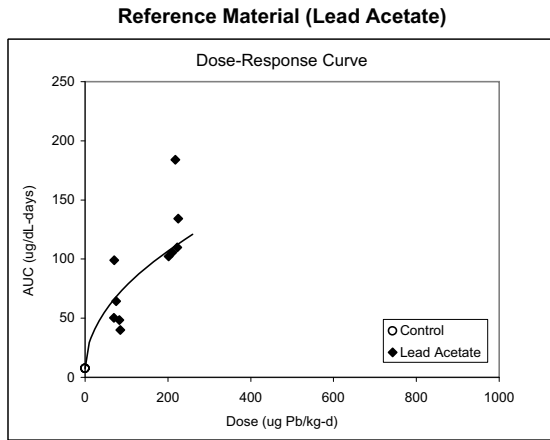
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.47	0.84
Lower bound	0.32	0.57
Upper bound	0.68	1.28
Standard Error	0.094*	0.177*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 4: Blood AUC
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.57E+00	2.20E+00
b1	6.88E+00	1.92E+00
b2	4.35E+00	1.41E+00
b3	5.87E+00	1.86E+00
c	5.04E-01	5.34E-02
Covariance (b1,b2)	0.9315	--
Covariance (b1,b3)	0.9341	--
Degrees of Freedom	37	--

Goodness of Fit

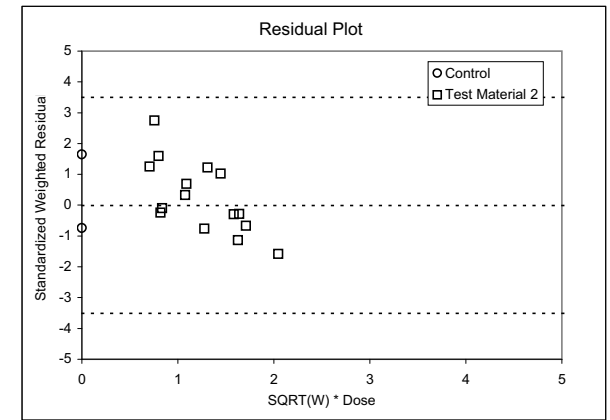
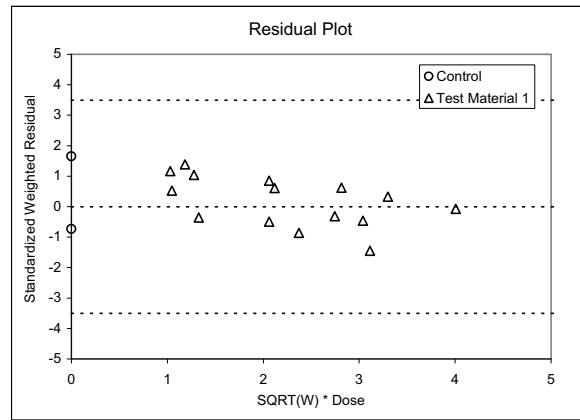
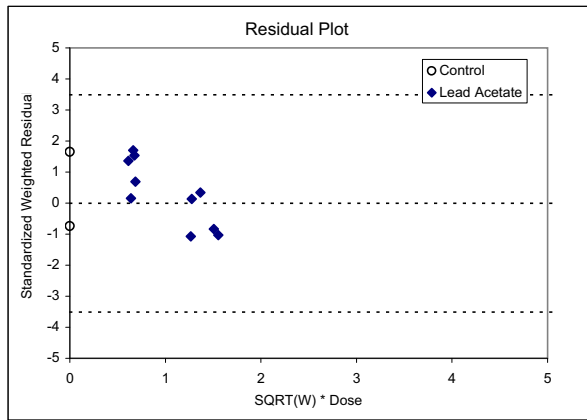
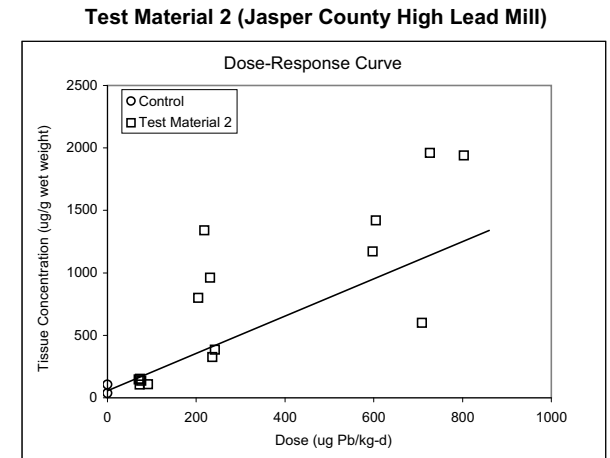
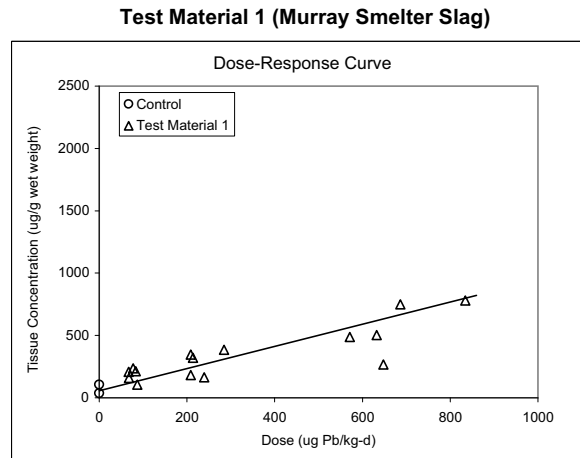
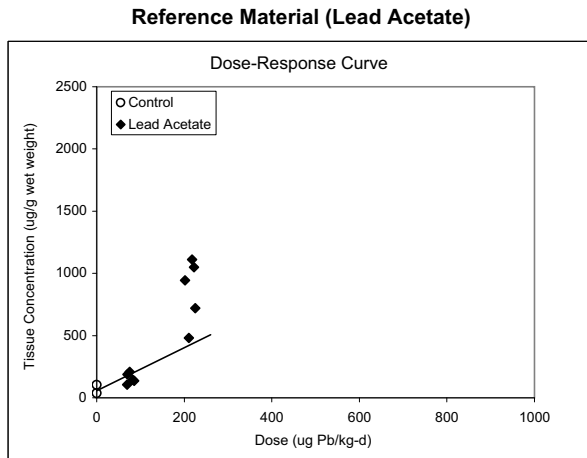
Statistic	Estimate
F	103.784
p	< 0.001
Adjusted R ²	0.9093
AIC	374.263

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.40	0.73
Lower bound	0.23	0.43
Upper bound	0.59	1.06
Standard Error	--	--

APPENDIX E

Figure 2a - All Data
Phase II Experiment 4: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.71E+01	1.77E+01
b1	1.73E+00	4.26E-01
b2	8.89E-01	1.50E-01
b3	1.49E+00	2.95E-01
Covariance (c1,c2)	0.1813	--
Covariance (c1,c3)	0.2399	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	18.693
p	< 0.001
Adjusted R ²	0.5642
AIC	558.553

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.51	0.86
Lower bound	0.33	0.54
Upper bound	0.88	1.47
Standard Error	0.140*	0.238*

* $g \geq 0.05$, estimate is uncertain

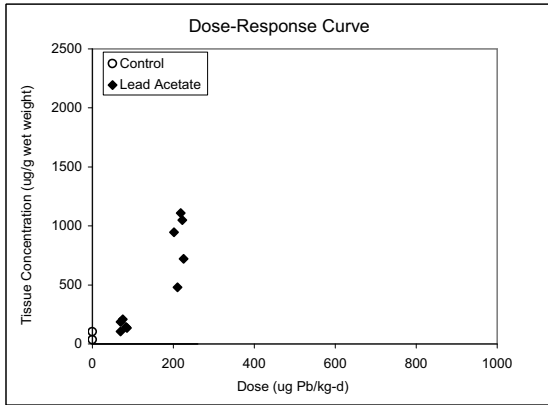
APPENDIX E

Figure 2b - All Data

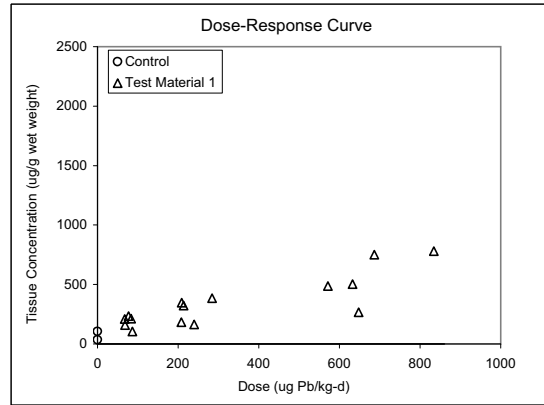
Phase II Experiment 4: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

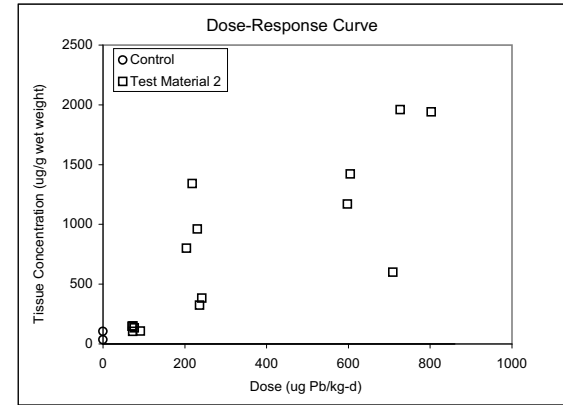
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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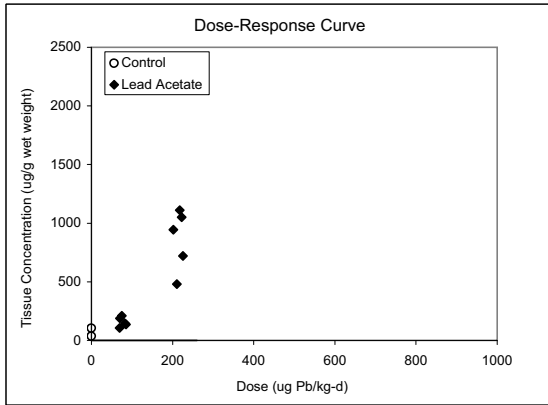
APPENDIX E

Figure 2c - All Data

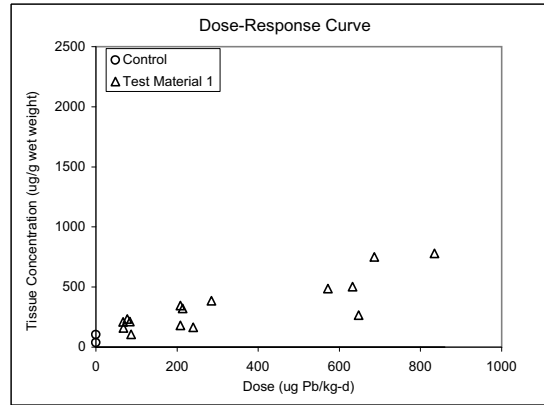
Phase II Experiment 4: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

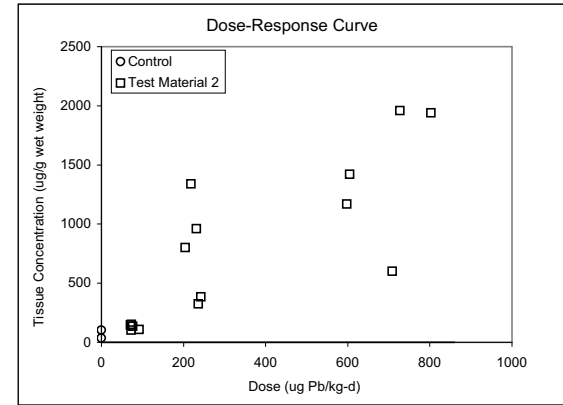
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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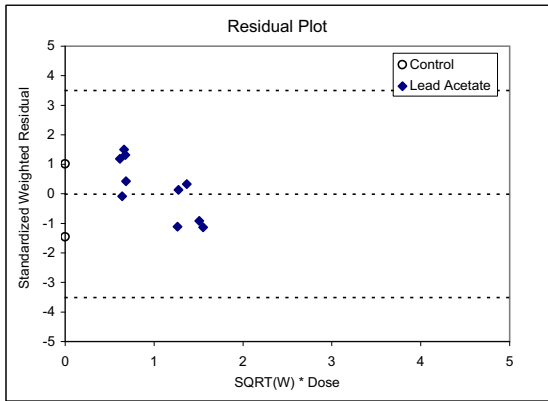
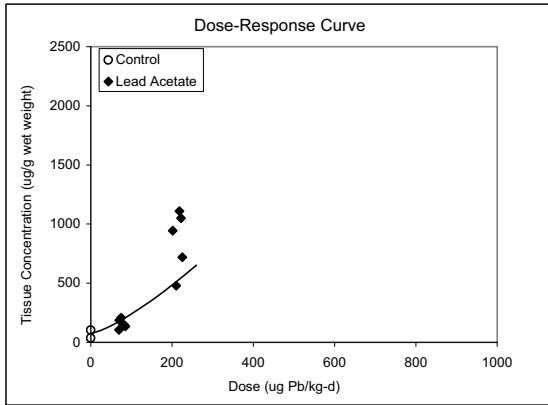
APPENDIX E

Figure 2d - All Data

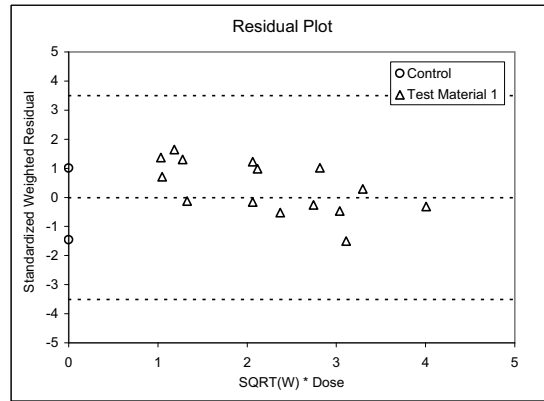
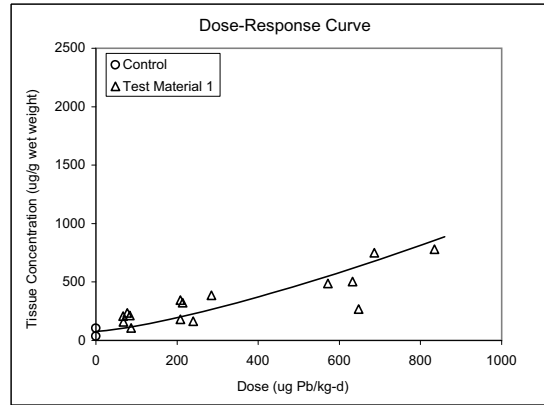
Phase II Experiment 4: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

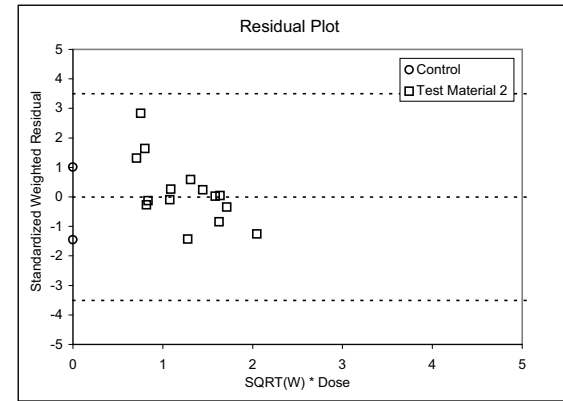
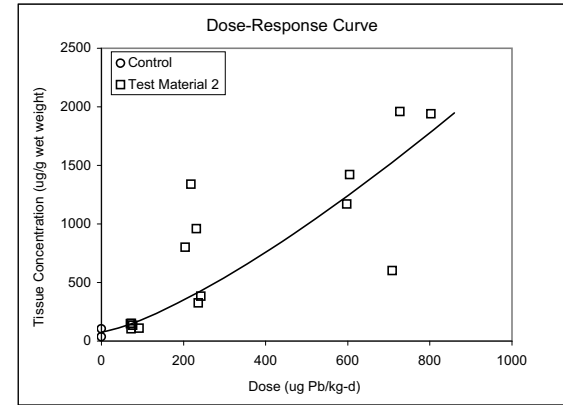
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.61E+01	1.98E+01
b1	3.76E-01	3.69E-01
b2	1.09E-01	1.34E-01
b3	2.52E-01	2.90E-01
c	1.32E+00	1.86E-01
Covariance (b1,b2)	0.9617	--
Covariance (b1,b3)	0.9615	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	15.495
p	< 0.001
Adjusted R ²	0.5858
AIC	555.816

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.39	0.74
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

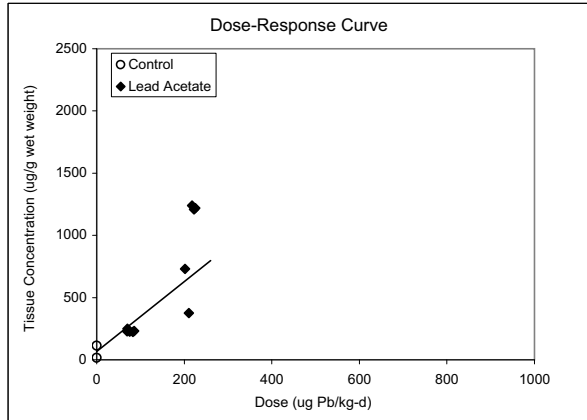
APPENDIX E

Figure 3a - All Data

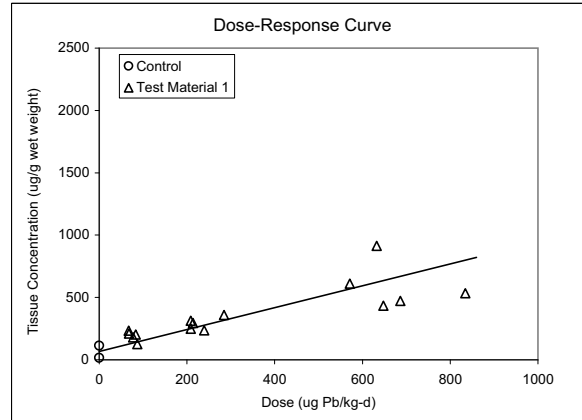
Phase II Experiment 4: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

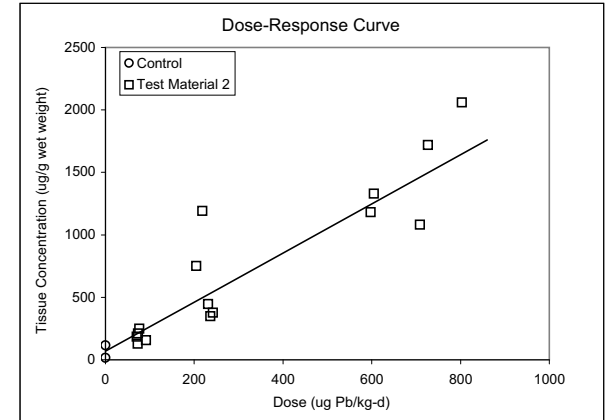
Reference Material (Lead Acetate)



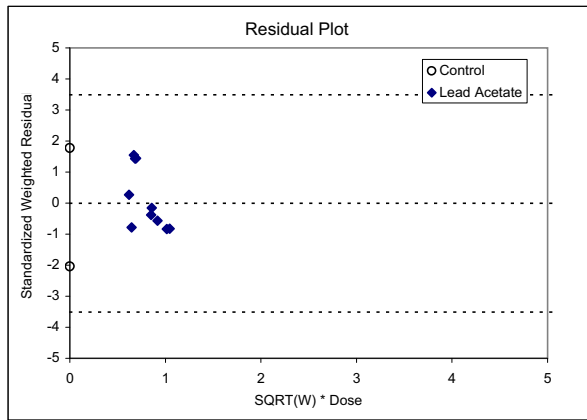
Test Material 1 (Murray Smelter Slag)



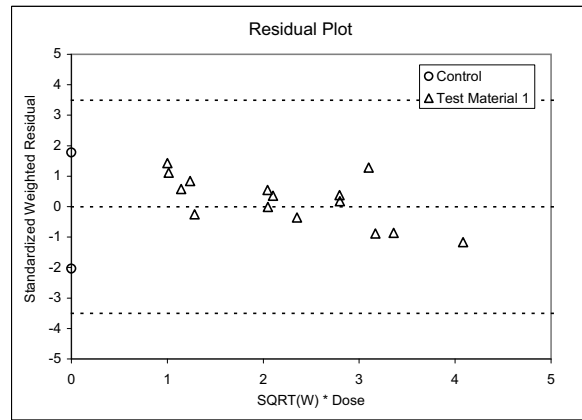
Test Material 2 (Jasper County High Lead Mill)



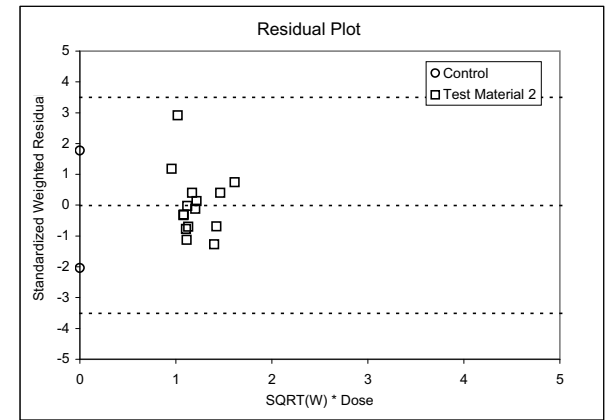
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.79E+01	1.62E+01
b1	2.80E+00	4.81E-01
b2	8.77E-01	1.34E-01
b3	1.97E+00	2.63E-01
Covariance (c1,c2)	0.1300	--
Covariance (c1,c3)	0.1213	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	35.326
p	< 0.001
Adjusted R ²	0.7152
AIC	550.107

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.31	0.70
Lower bound	0.22	0.50
Upper bound	0.46	1.02
Standard Error	0.067*	0.143*

* $g \geq 0.05$, estimate is uncertain

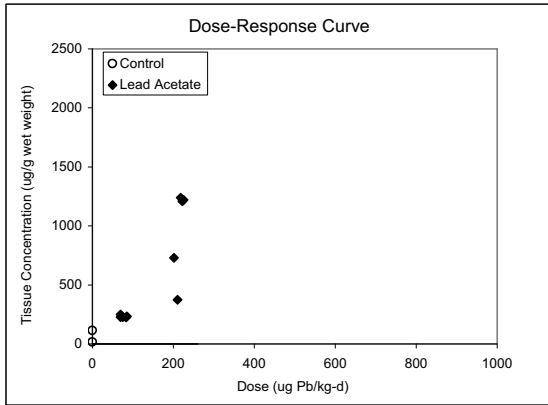
APPENDIX E

Figure 3b - All Data

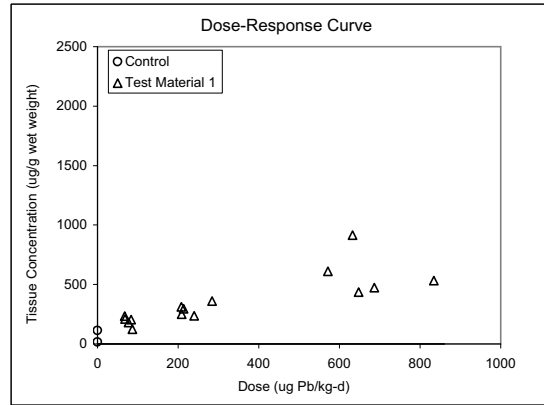
Phase II Experiment 4: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

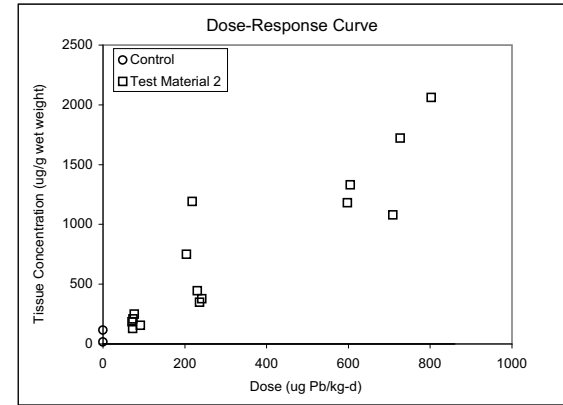
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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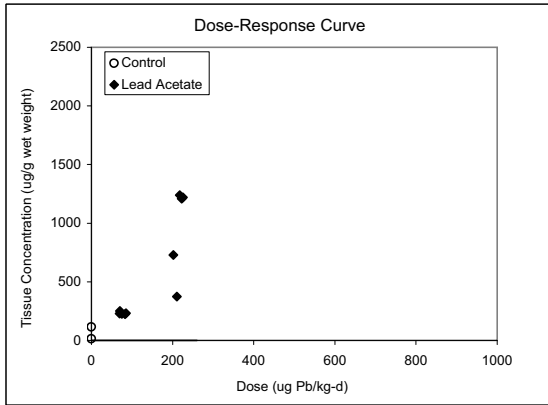
APPENDIX E

Figure 3c - All Data

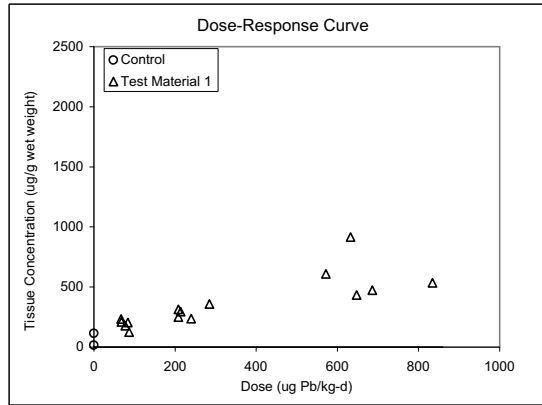
Phase II Experiment 4: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

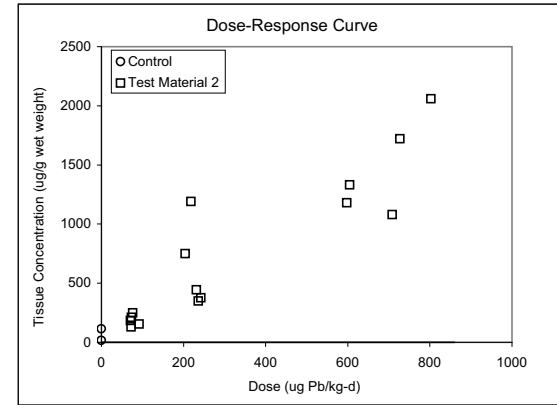
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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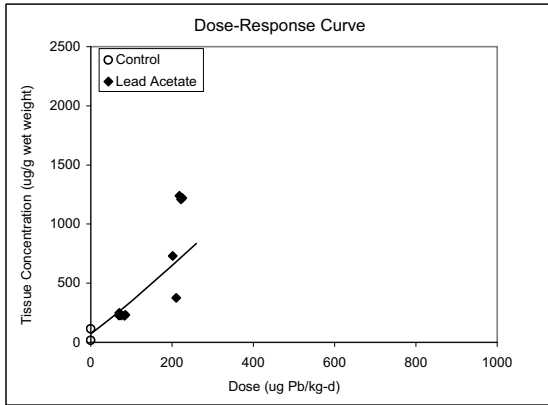
APPENDIX E

Figure 3d - All Data

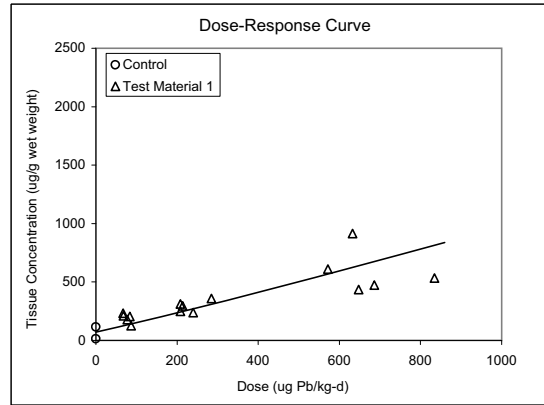
Phase II Experiment 4: Kidney

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

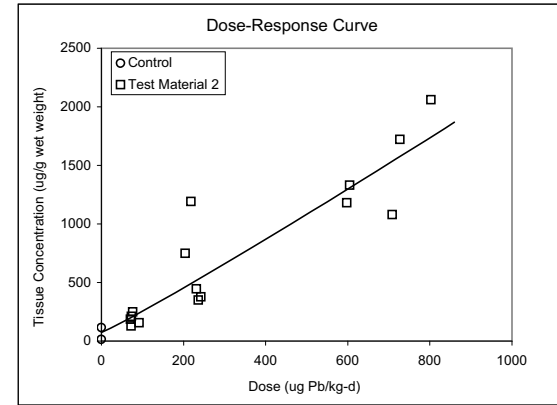
Reference Material (Lead Acetate)



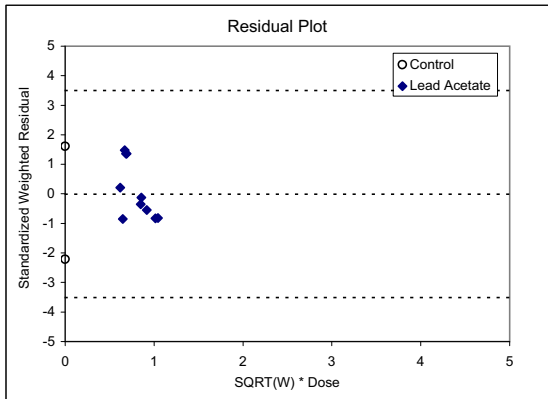
Test Material 1 (Murray Smelter Slag)



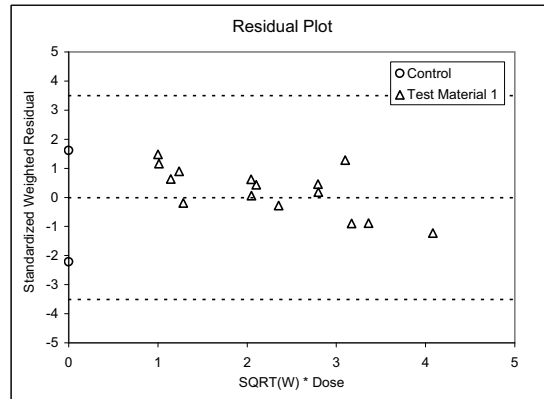
Test Material 2 (Jasper County High Lead Mill)



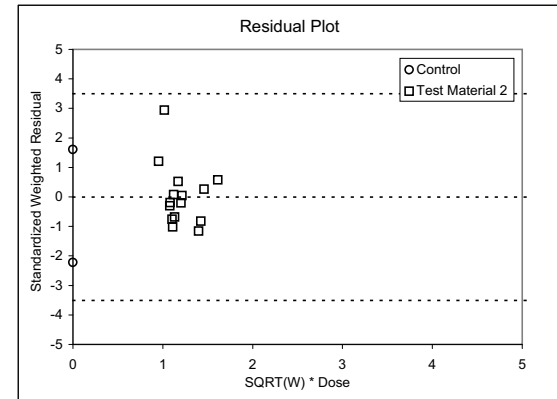
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.24E+01	1.86E+01
b1	2.09E+00	1.37E+00
b2	5.88E-01	4.86E-01
b3	1.38E+00	1.05E+00
c	1.06E+00	1.27E-01
Covariance (b1,b2)	0.9527	--
Covariance (b1,b3)	0.9542	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	25.994
p	< 0.001
Adjusted R ²	0.7092
AIC	551.821

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.30	0.68
Lower bound	0.69	?
Upper bound	0.50	?
Standard Error	--	--

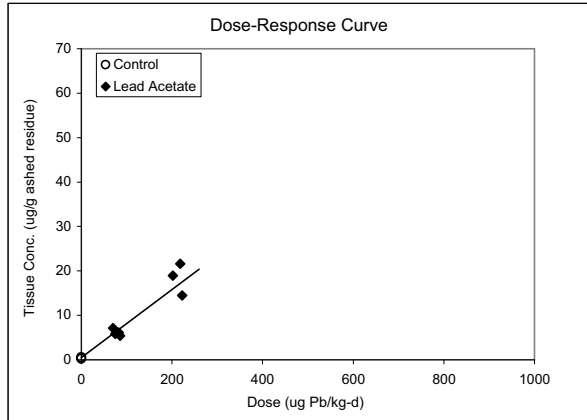
APPENDIX E

Figure 4a - All Data

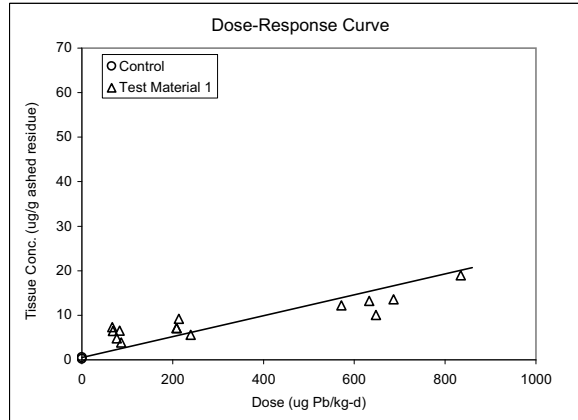
Phase II Experiment 4: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

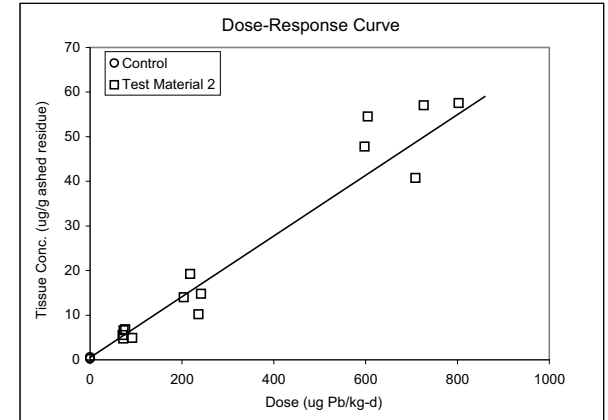
Reference Material (Lead Acetate)



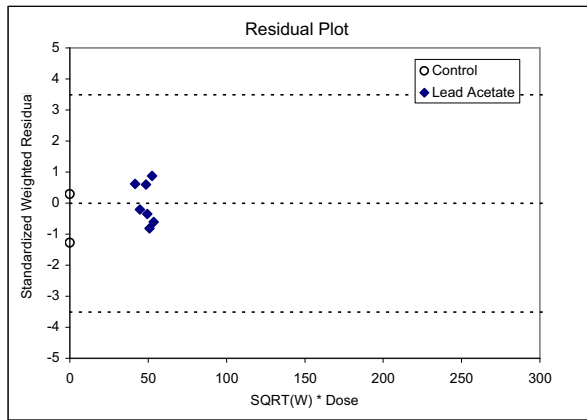
Test Material 1 (Murray Smelter Slag)



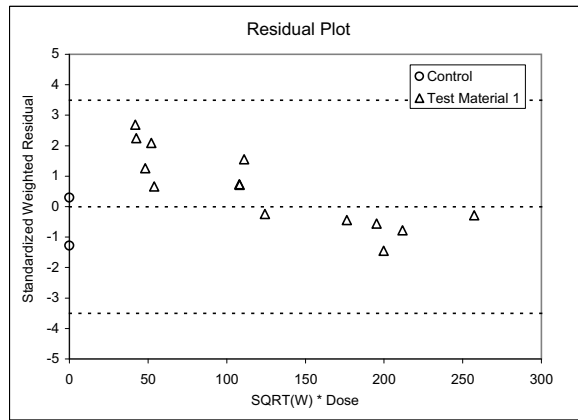
Test Material 2 (Jasper County High Lead Mill)



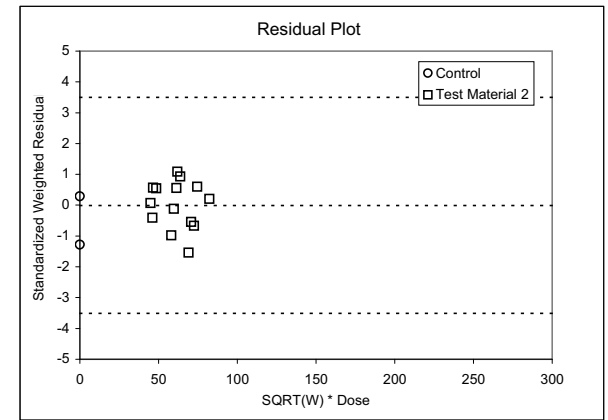
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.35E-01	1.64E-01
b1	7.65E-02	1.01E-02
b2	2.35E-02	2.47E-03
b3	6.80E-02	5.60E-03
Covariance (c1,c2)	0.0238	--
Covariance (c1,c3)	0.0207	--
Degrees of Freedom	33	--

Goodness of Fit

Statistic	Estimate
F	94.431
p	< 0.001
Adjusted R ²	0.8862
AIC	196.118

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.31	0.89
Lower bound	0.23	0.69
Upper bound	0.41	1.18
Standard Error	0.051*	0.137*

* $g \geq 0.05$, estimate is uncertain

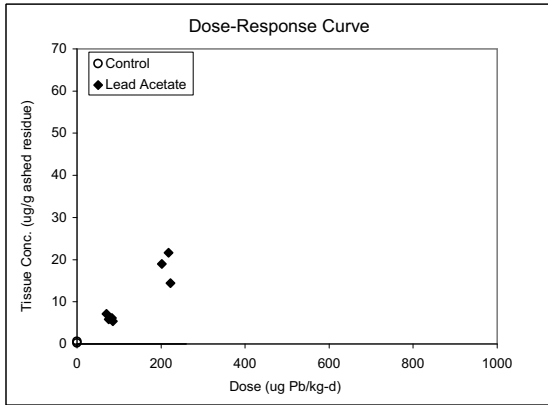
APPENDIX E

Figure 4b - All Data

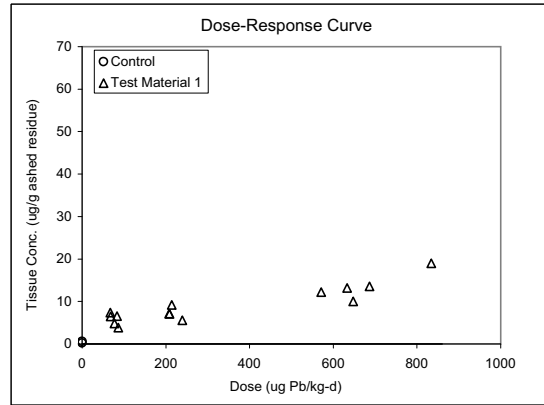
Phase II Experiment 4: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

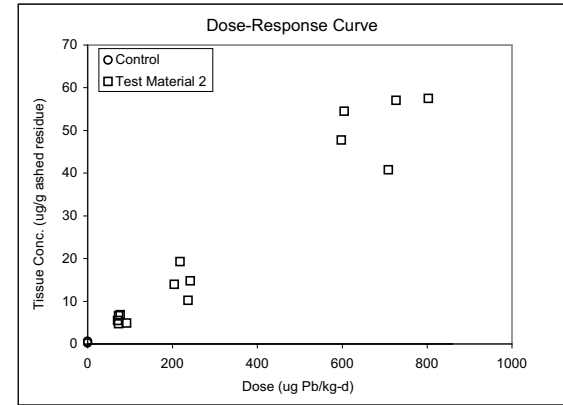
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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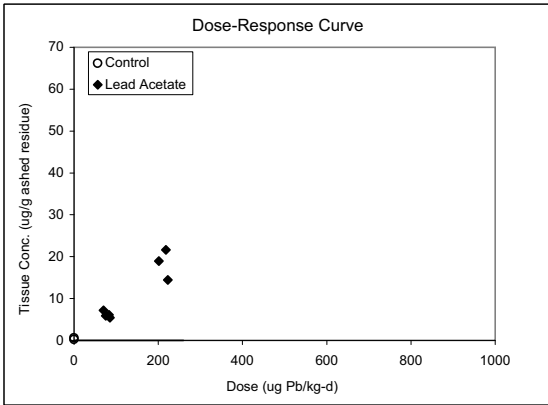
APPENDIX E

Figure 4c - All Data

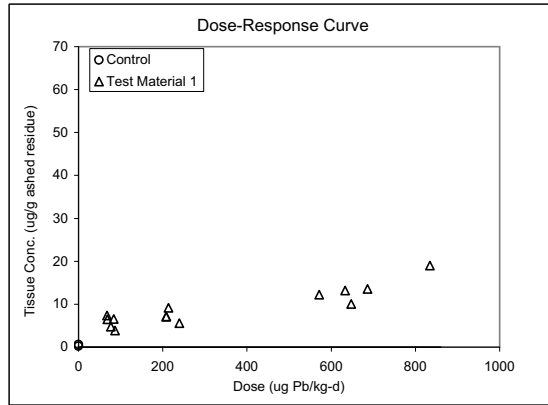
Phase II Experiment 4: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

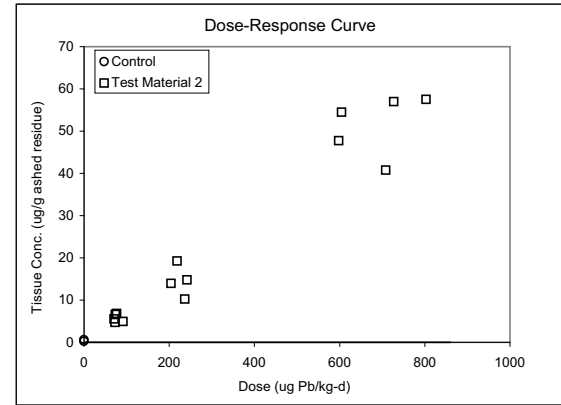
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Slag)



Test Material 2 (Jasper County High Lead Mill)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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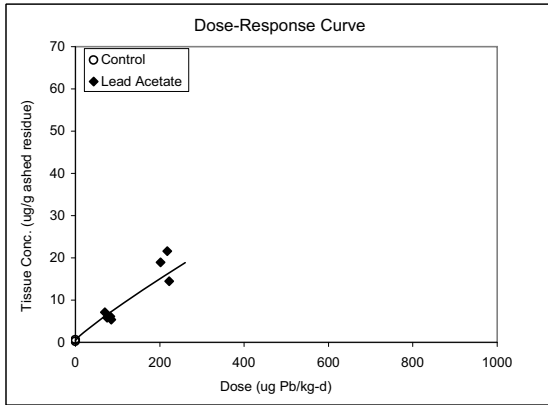
APPENDIX E

Figure 4d - All Data

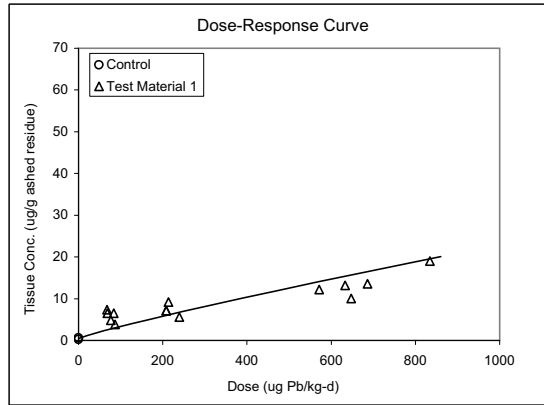
Phase II Experiment 4: Femur

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

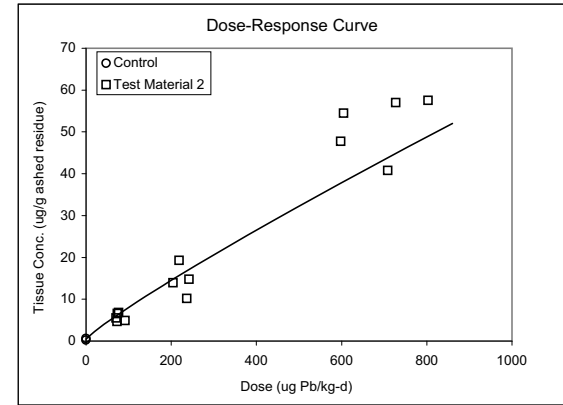
Reference Material (Lead Acetate)



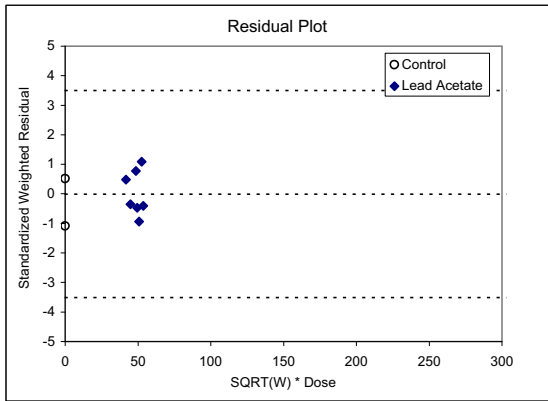
Test Material 1 (Murray Smelter Slag)



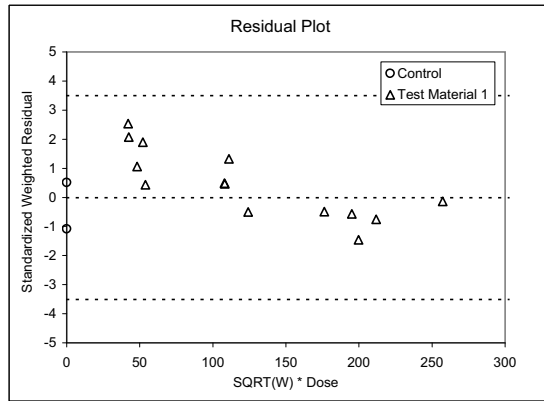
Test Material 2 (Jasper County High Lead Mill)



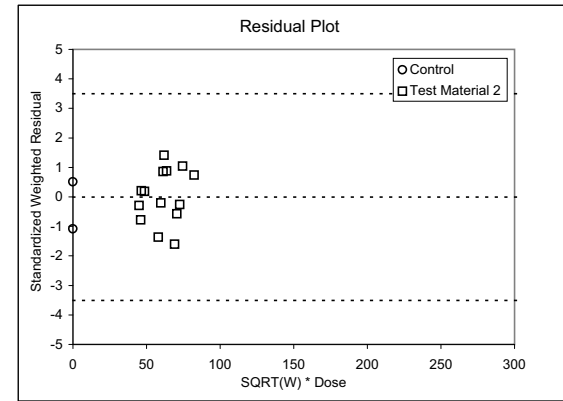
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.88E-01	1.66E-01
b1	1.29E-01	4.99E-02
b2	4.71E-02	2.26E-02
b3	1.24E-01	5.32E-02
c	8.92E-01	7.56E-02
Covariance (b1,b2)	0.9218	--
Covariance (b1,b3)	0.9254	--
Degrees of Freedom	32	--

Goodness of Fit

Statistic	Estimate
F	72.328
p	< 0.001
Adjusted R ²	0.8880
AIC	195.603

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.32	0.96
Lower bound	0.13	0.56
Upper bound	0.45	1.34
Standard Error	--	--

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APPENDIX E

EXPERIMENT 5

Test Material 1: Aspen Berm
Test Material 2: Aspen Residential

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

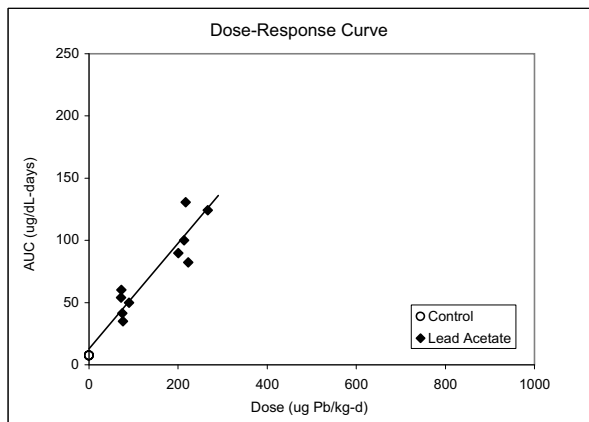
APPENDIX E

Figure 1a - All Data

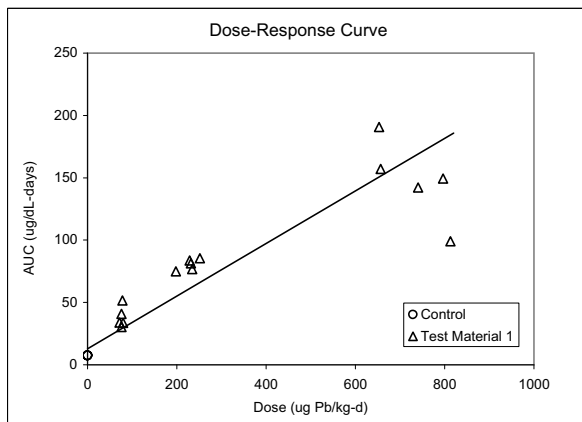
Phase II Experiment 5: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

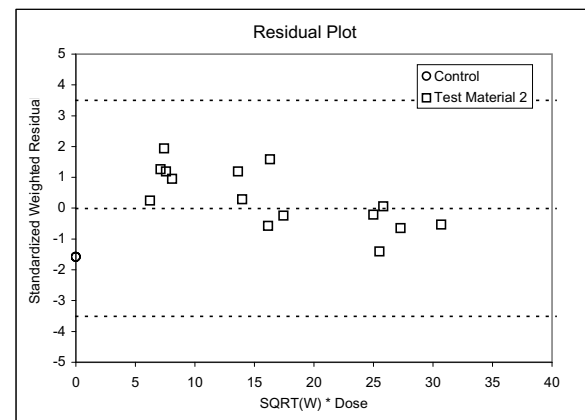
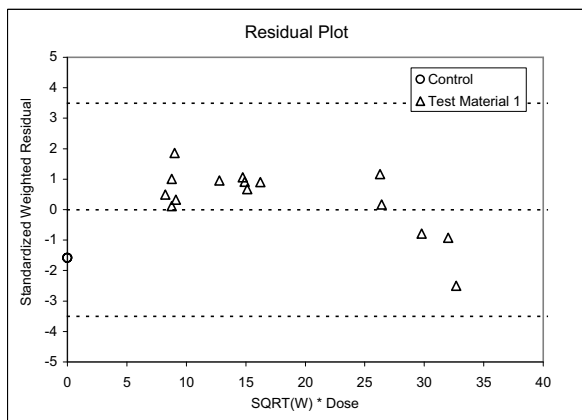
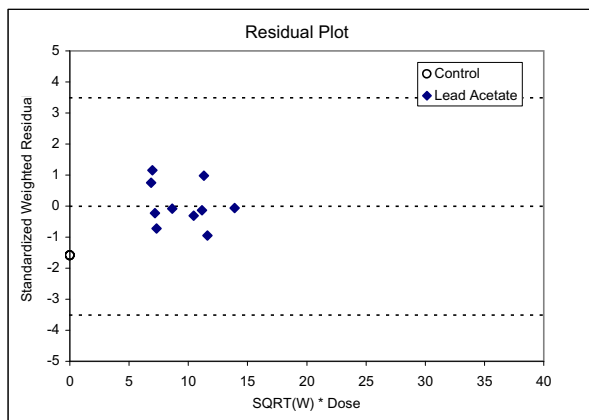
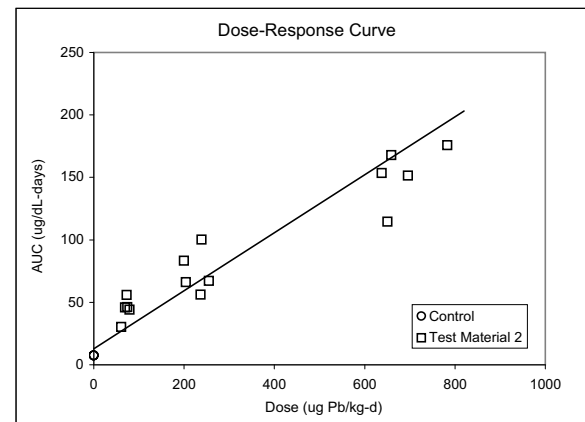
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.29E+01	2.19E+00
b1	4.25E-01	4.90E-02
b2	2.11E-01	1.99E-02
b3	2.32E-01	2.12E-02
Covariance (c1,c2)	0.0903	--
Covariance (c1,c3)	0.0880	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	87.459
p	< 0.001
Adjusted R ²	0.8635
AIC	385.030

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.50	0.55
Lower bound	0.39	0.43
Upper bound	0.64	0.70
Standard Error	0.071	0.077

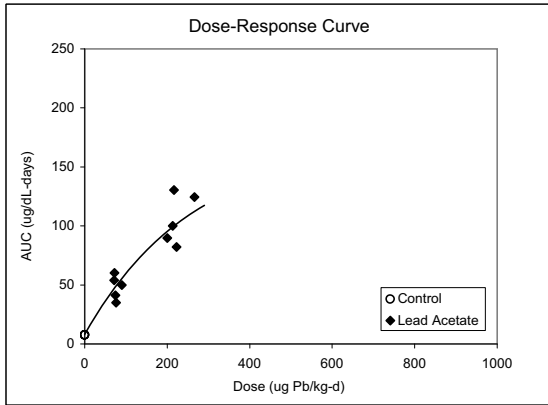
APPENDIX E

Figure 1b - All Data

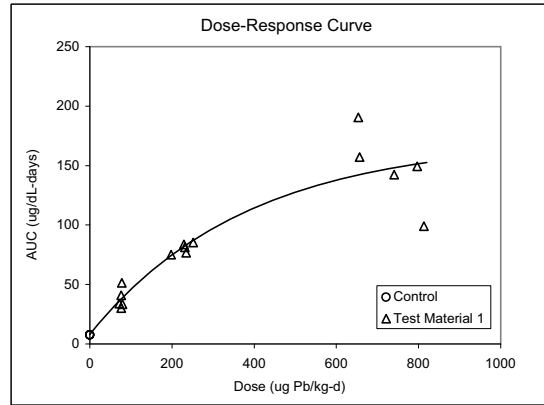
Phase II Experiment 5: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

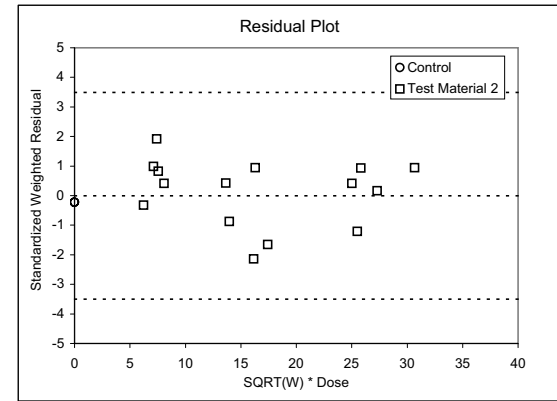
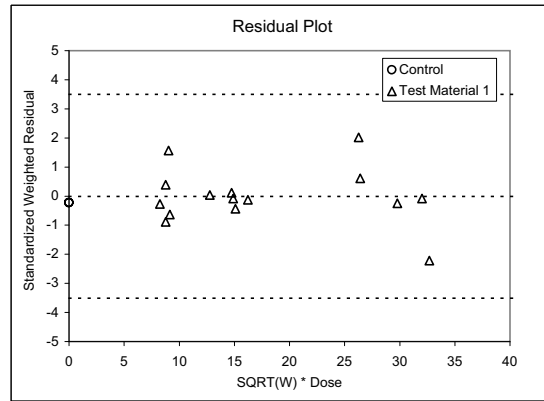
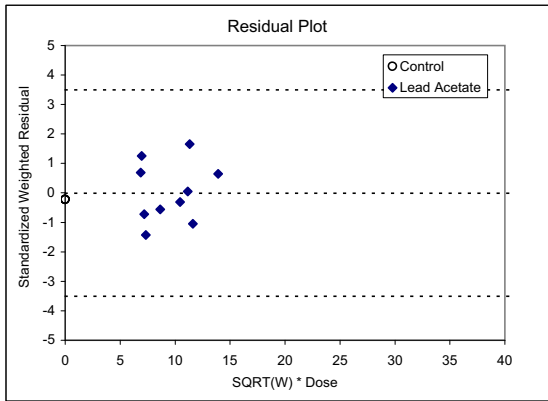
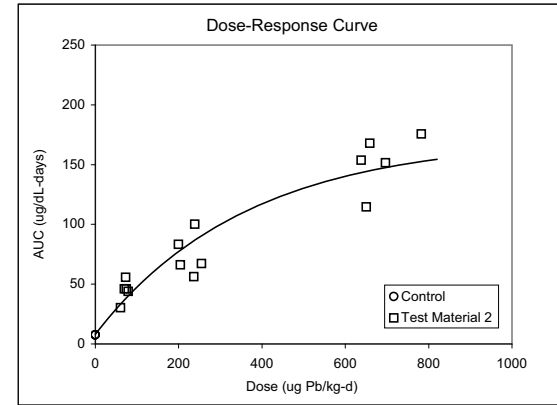
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.03E+00	1.72E+00
b	1.63E+02	1.69E+01
c1	3.82E-03	6.83E-04
c2	2.63E-03	4.97E-04
c3	2.76E-03	5.26E-04
Covariance (c1,c2)	0.7323	--
Covariance (c1,c3)	0.7322	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	143.955
p	< 0.001
Adjusted R ²	0.9331
AIC	345.170

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.69	0.72
Lower bound	0.54	0.56
Upper bound	0.87	0.91
Standard Error	0.093*	0.098*

* $g \geq 0.05$, estimate is uncertain

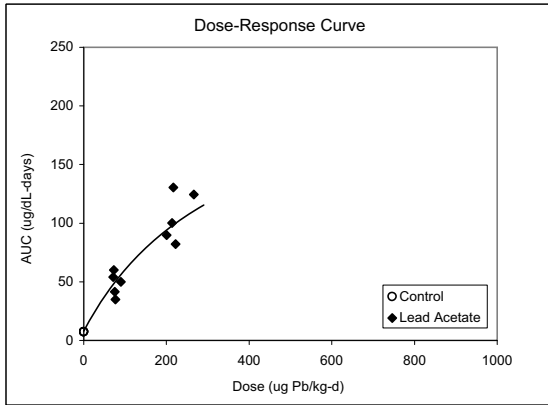
APPENDIX E

Figure 1c - All Data

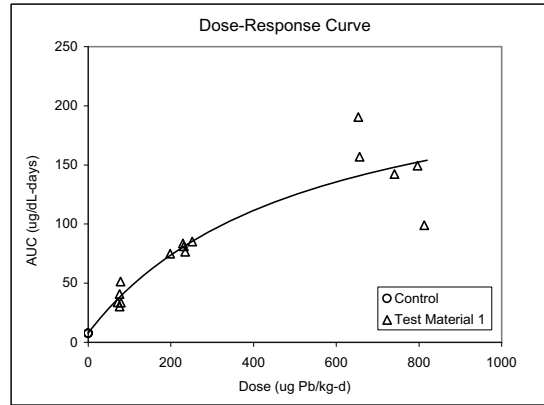
Phase II Experiment 5: Blood AUC

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

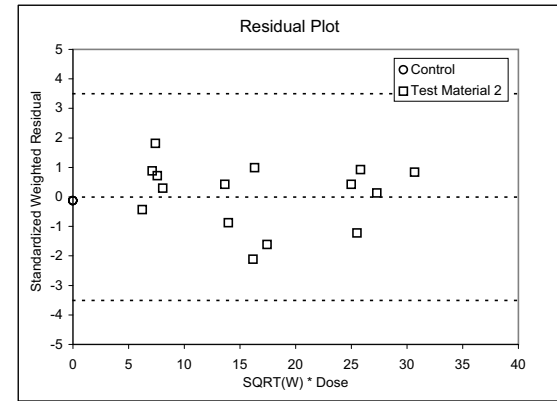
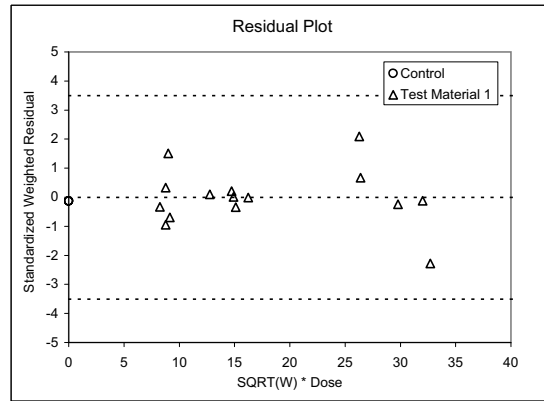
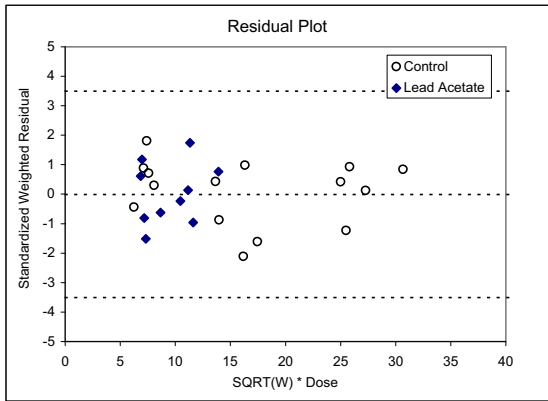
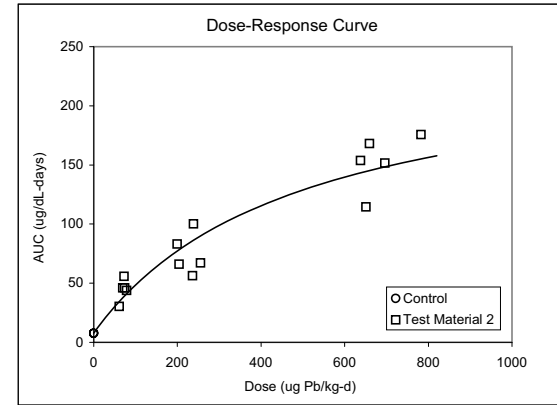
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.81E+00	1.73E+00
b	2.39E+02	3.23E+01
c1	3.55E+02	7.97E+01
c2	5.24E+02	1.24E+02
c3	4.89E+02	1.18E+02
Covariance (c1,c2)	0.8270	--
Covariance (c1,c3)	0.8275	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	145.720
p	< 0.001
Adjusted R ²	0.9339
AIC	344.735

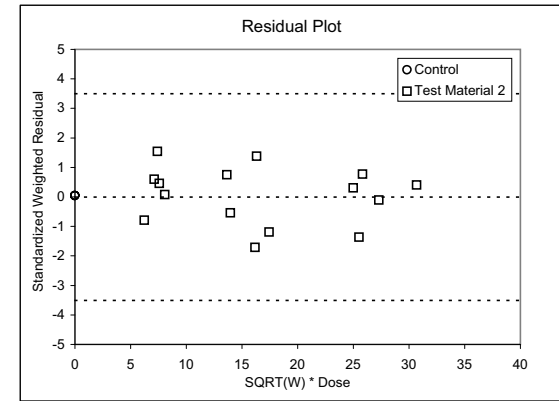
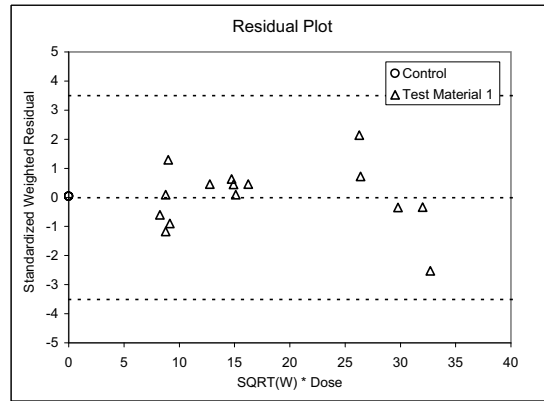
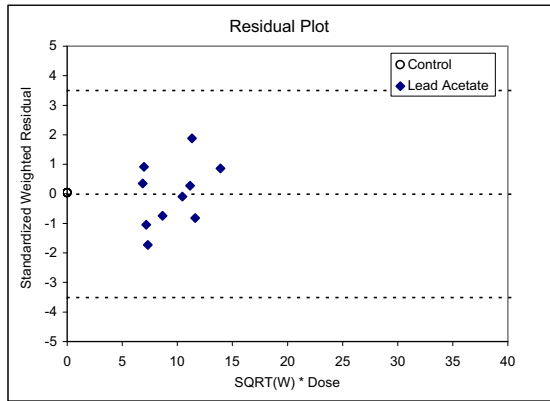
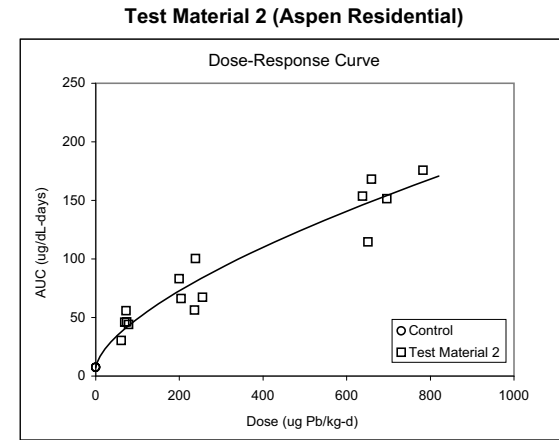
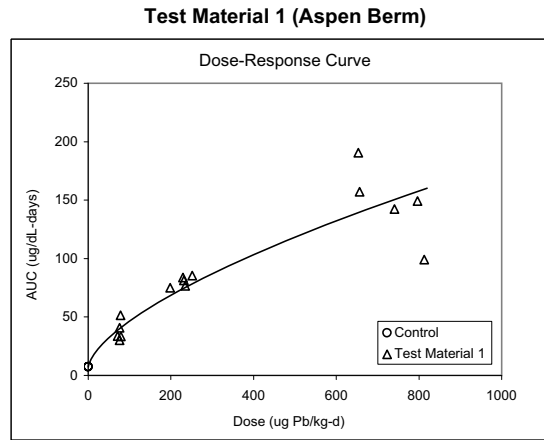
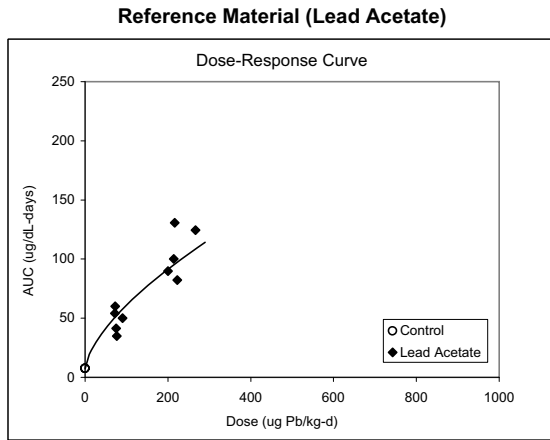
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.68	0.73
Lower bound	0.53	0.57
Upper bound	0.88	0.95
Standard Error	0.093*	0.100*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 5: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.41E+00	1.76E+00
b1	2.70E+00	6.67E-01
b2	1.97E+00	5.50E-01
b3	2.10E+00	5.84E-01
c	6.49E-01	4.56E-02
Covariance (b1,b2)	0.9387	--
Covariance (b1,b3)	0.9389	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	144.915
p	< 0.001
Adjusted R ²	0.9335
AIC	344.932

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.61	0.68
Lower bound	0.44	0.49
Upper bound	0.78	0.86
Standard Error	--	--

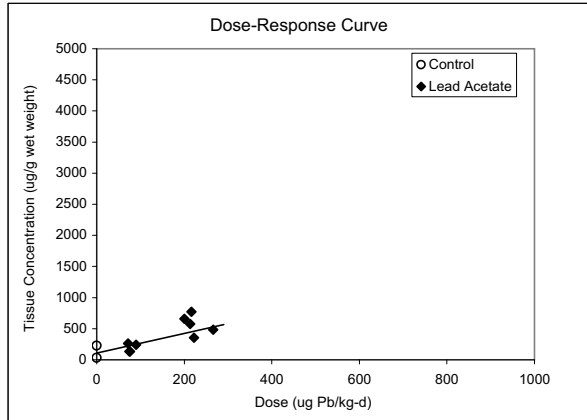
APPENDIX E

Figure 2a - All Data

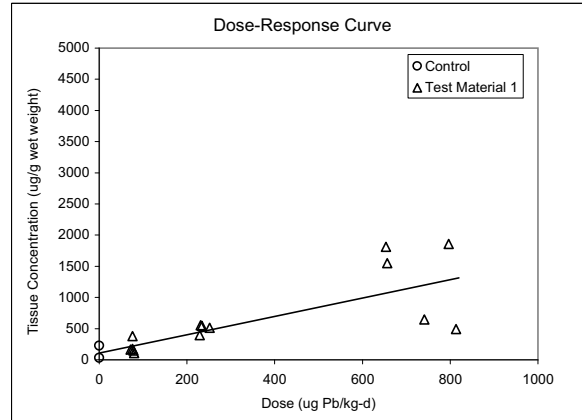
Phase II Experiment 5: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

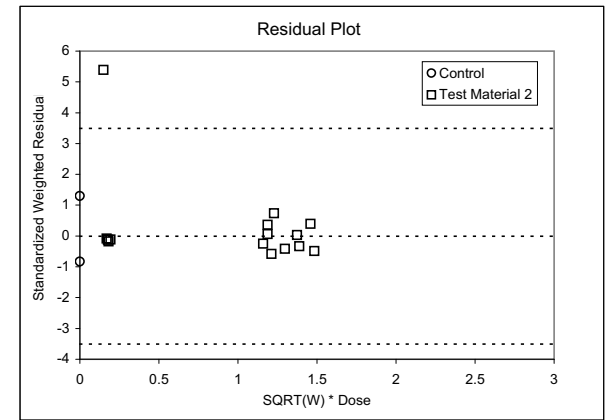
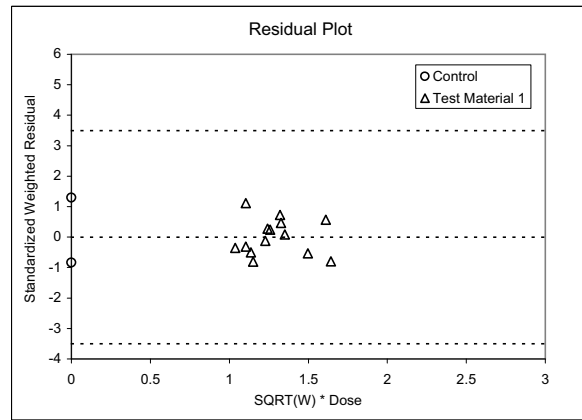
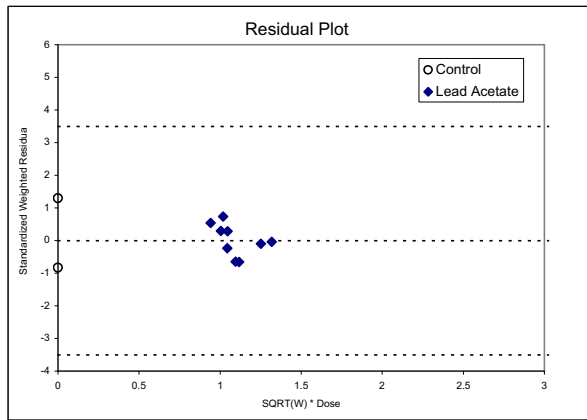
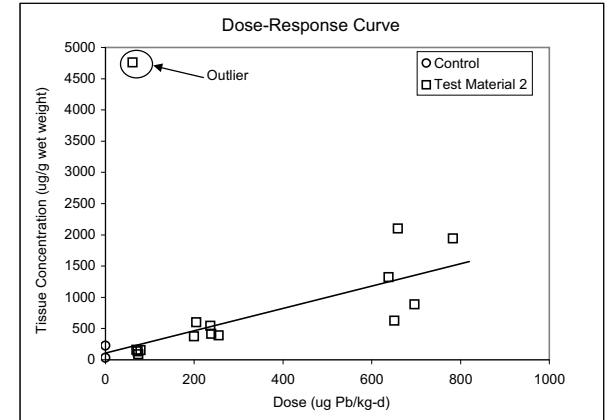
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.07E+02	5.09E+01
b1	1.58E+00	7.86E-01
b2	1.47E+00	5.19E-01
b3	1.79E+00	5.47E-01
Covariance (c1,c2)	0.2781	--
Covariance (c1,c3)	0.1555	--
Degrees of Freedom	36	--

Goodness of Fit

Statistic	Estimate
F	5.754
p	0.0025
Adjusted R ²	0.2678
AIC	674.409

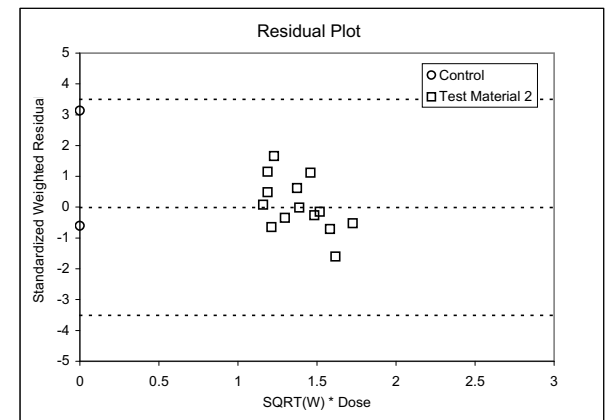
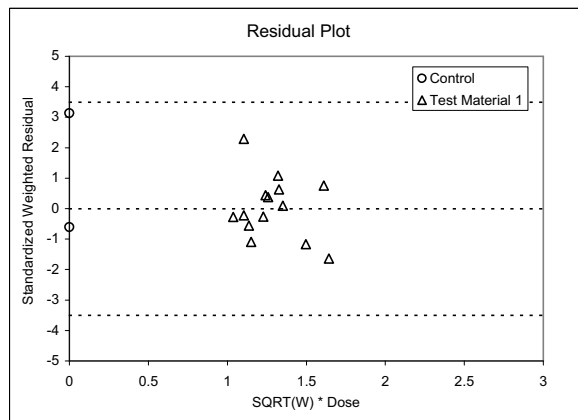
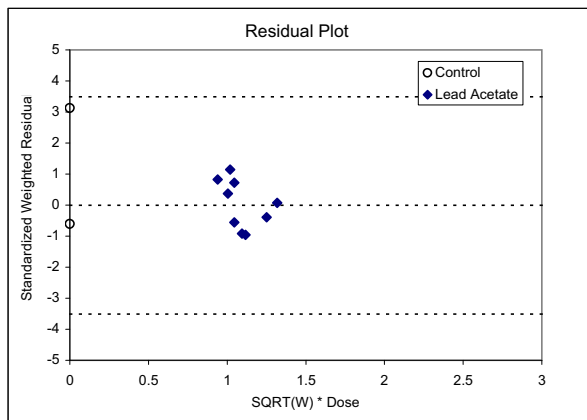
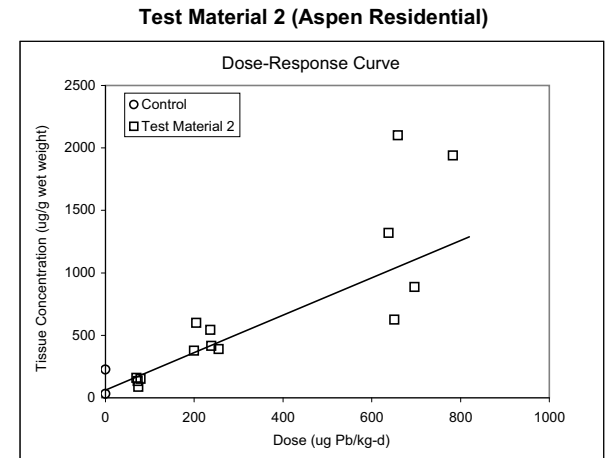
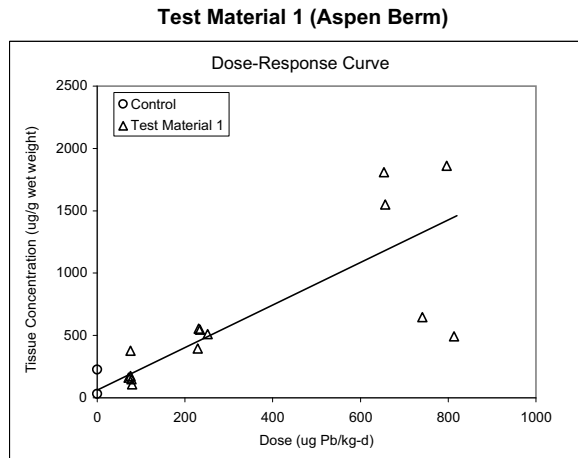
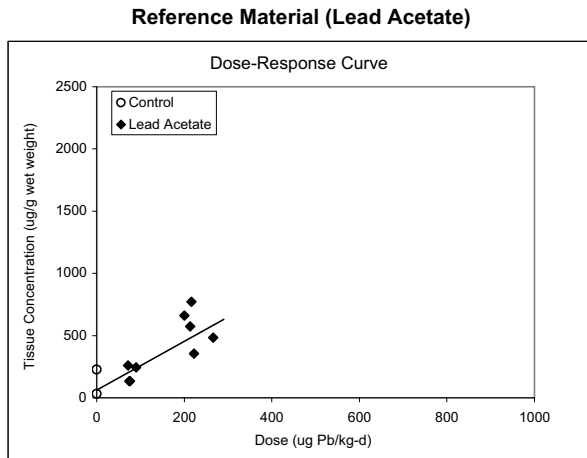
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.93	1.13
Lower bound	0.38	0.48
Upper bound	5.14	6.78
Standard Error	0.490*	0.616*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 5: Liver
Linear Model: $y = a + b_1*x_1 + b_2*x_2 + b_3*x_3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.21E+01	2.46E+01
b1	1.96E+00	4.29E-01
b2	1.71E+00	2.85E-01
b3	1.50E+00	2.92E-01
Covariance (c1,c2)	0.2174	--
Covariance (c1,c3)	0.2847	--
Degrees of Freedom	35	--

Goodness of Fit

Statistic	Estimate
F	18.566
p	< 0.001
Adjusted R ²	0.5810
AIC	526.951

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.87	0.77
Lower bound	0.58	0.50
Upper bound	1.39	1.21
Standard Error	0.214*	0.190*

* $g \geq 0.05$, estimate is uncertain

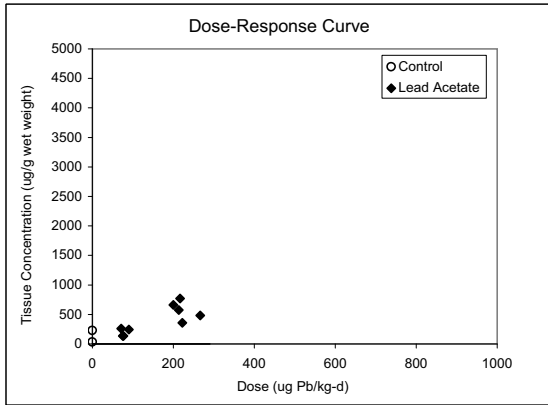
APPENDIX E

Figure 2b - All Data

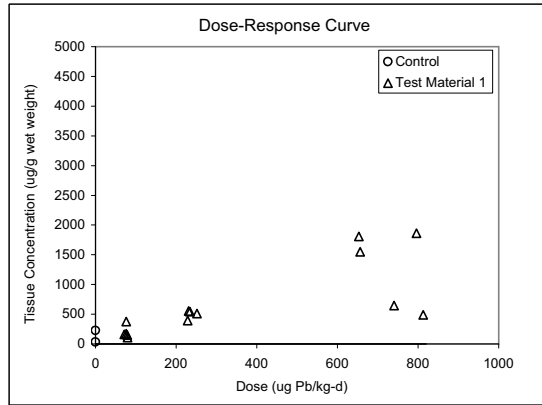
Phase II Experiment 5: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

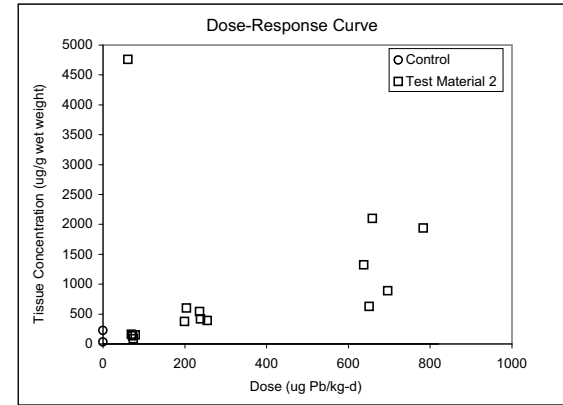
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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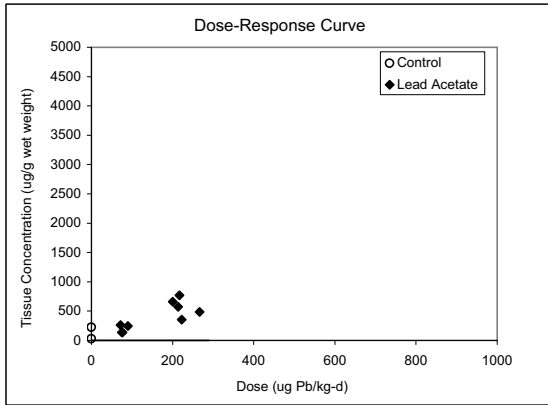
APPENDIX E

Figure 2c - All Data

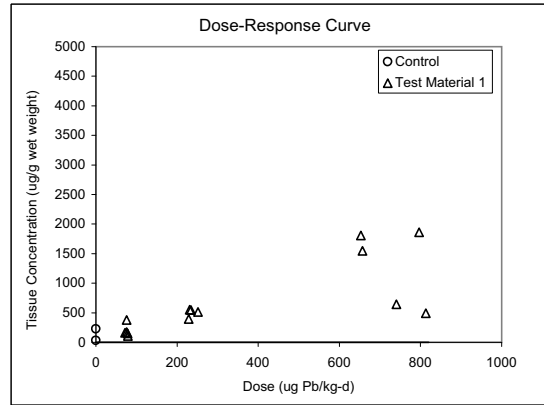
Phase II Experiment 5: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

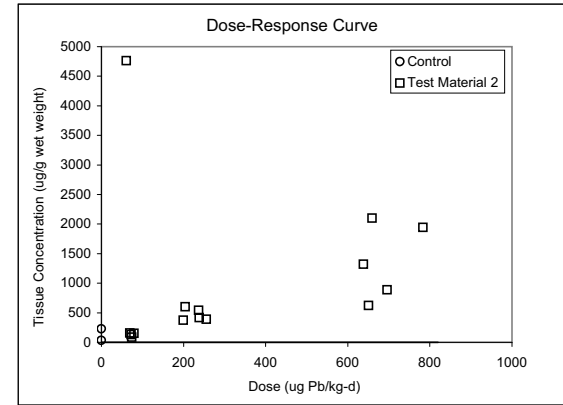
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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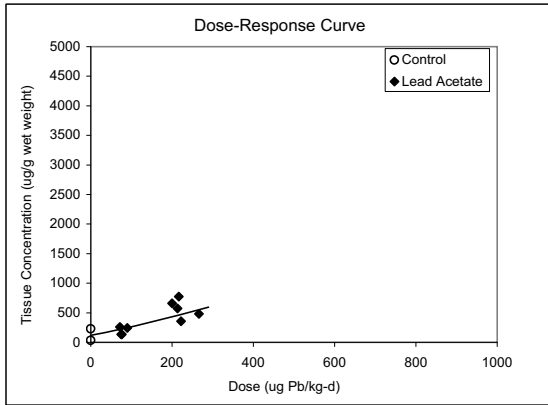
APPENDIX E

Figure 2d - All Data

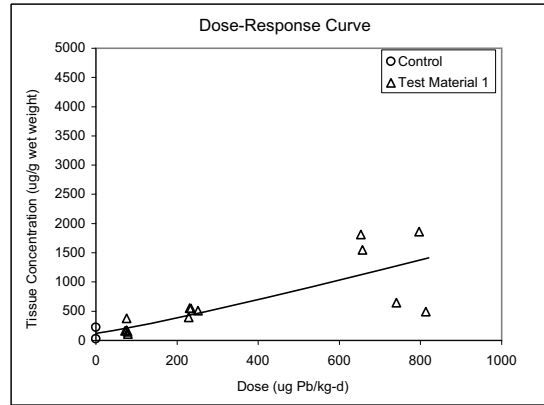
Phase II Experiment 5: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

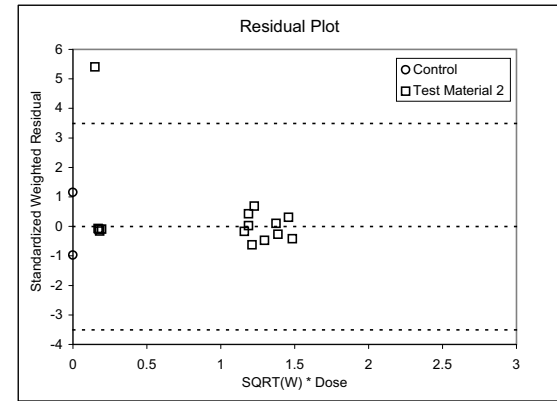
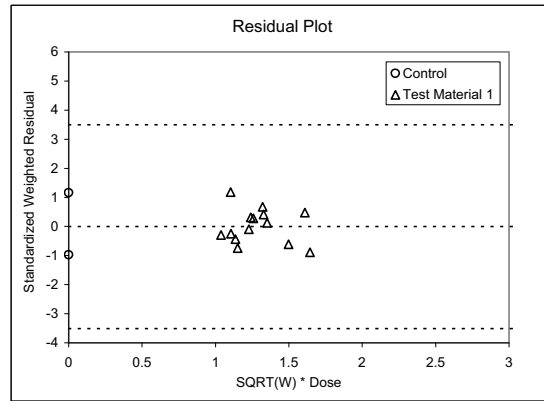
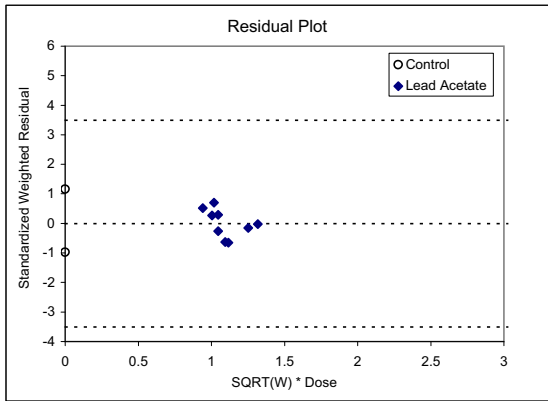
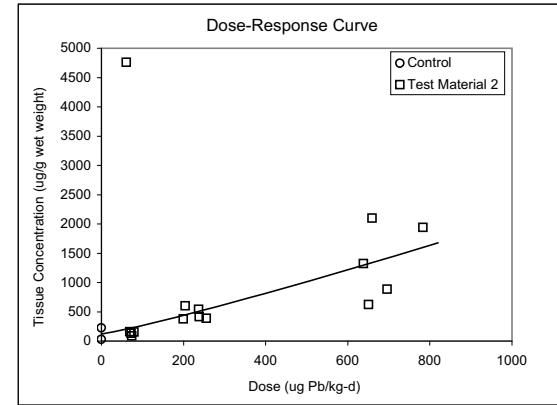
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.20E+02	6.37E+01
b1	8.19E-01	1.73E+00
b2	6.98E-01	1.63E+00
b3	8.39E-01	1.93E+00
c	1.12E+00	3.67E-01
Covariance (b1,b2)	0.9666	--
Covariance (b1,b3)	0.9647	--
Degrees of Freedom	35	--

Goodness of Fit

Statistic	Estimate
F	4.240
p	0.0067
Adjusted R ²	0.2494
AIC	675.820

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.87	1.02
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

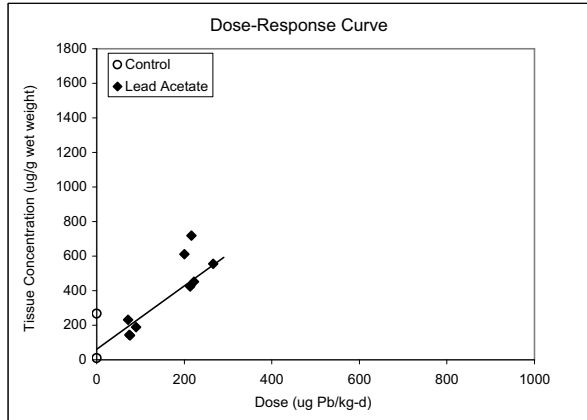
APPENDIX E

Figure 3a - All Data

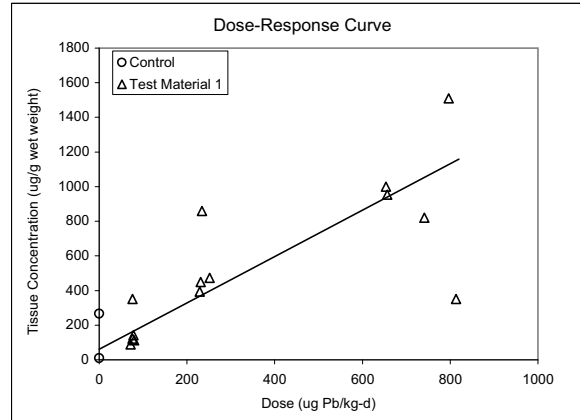
Phase II Experiment 5: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

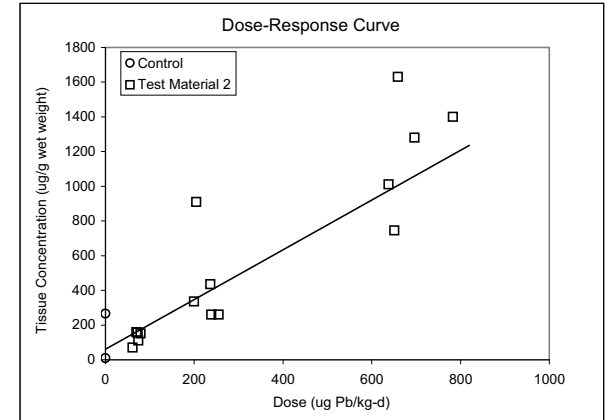
Reference Material (Lead Acetate)



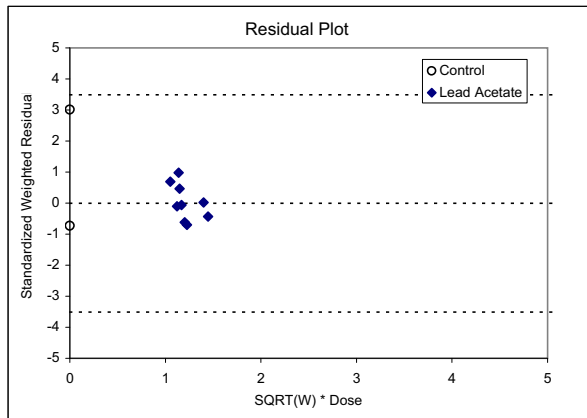
Test Material 1 (Aspen Berm)



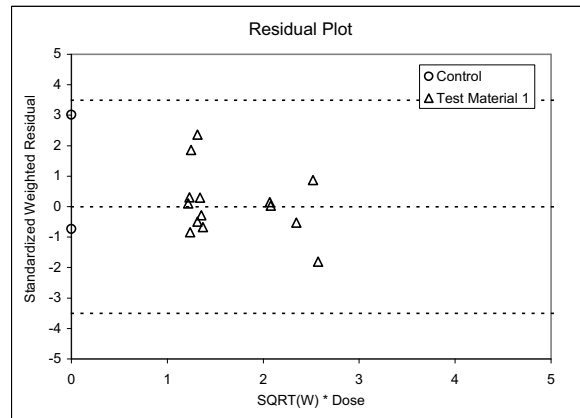
Test Material 2 (Aspen Residential)



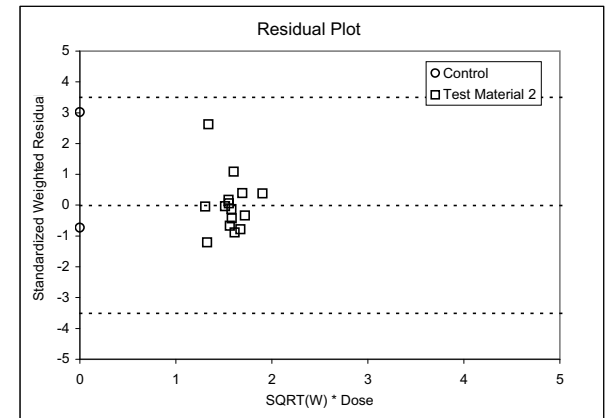
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.02E+01	2.63E+01
b1	1.84E+00	4.56E-01
b2	1.34E+00	2.50E-01
b3	1.43E+00	2.92E-01
Covariance (c1,c2)	0.2137	--
Covariance (c1,c3)	0.2775	--
Degrees of Freedom	36	--

Goodness of Fit

Statistic	Estimate
F	15.575
p	< 0.001
Adjusted R ²	0.5286
AIC	547.820

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.73	0.78
Lower bound	0.46	0.49
Upper bound	1.26	1.33
Standard Error	0.202*	0.214*

* $g \geq 0.05$, estimate is uncertain

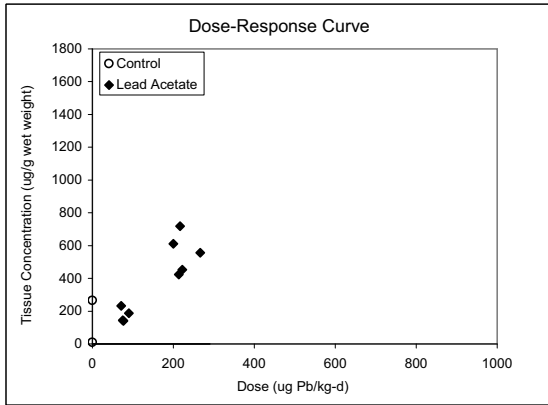
APPENDIX E

Figure 3b - All Data

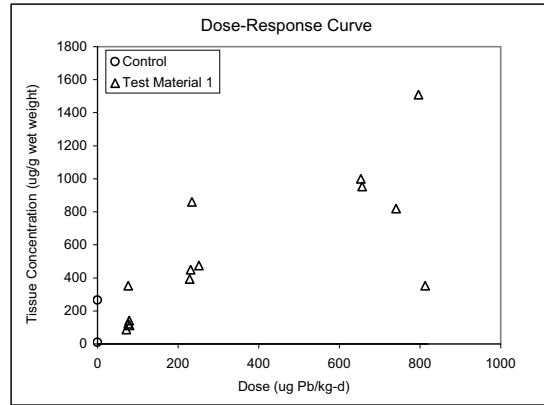
Phase II Experiment 5: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

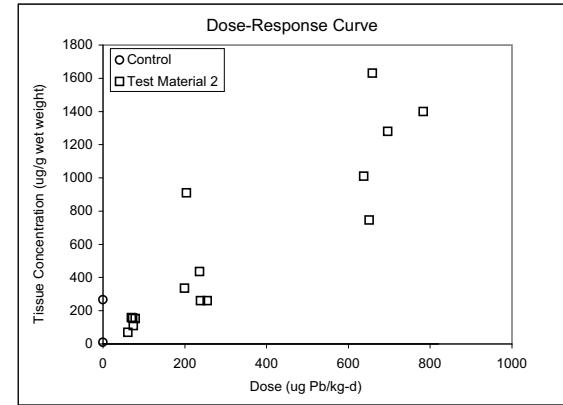
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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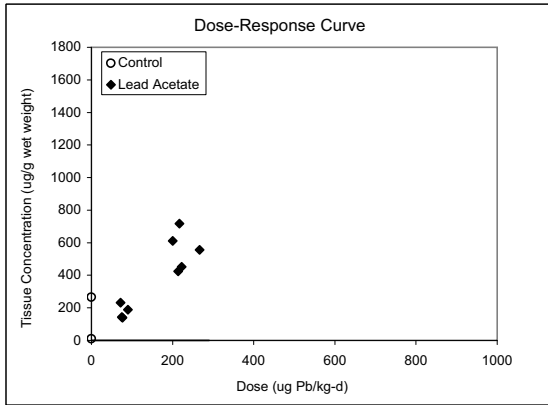
APPENDIX E

Figure 3c - All Data

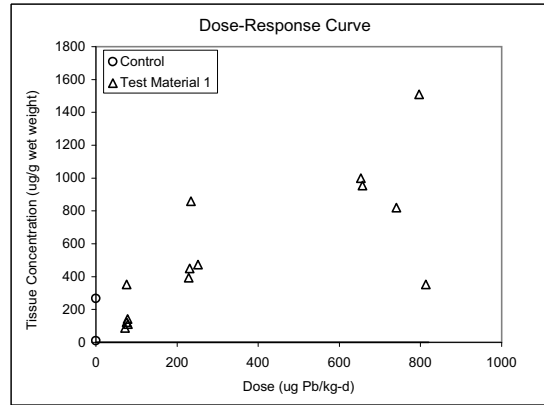
Phase II Experiment 5: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

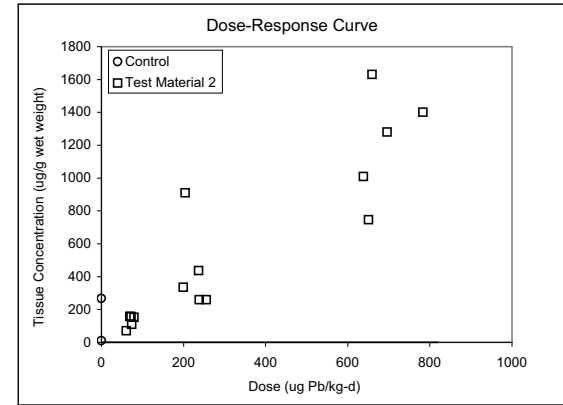
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



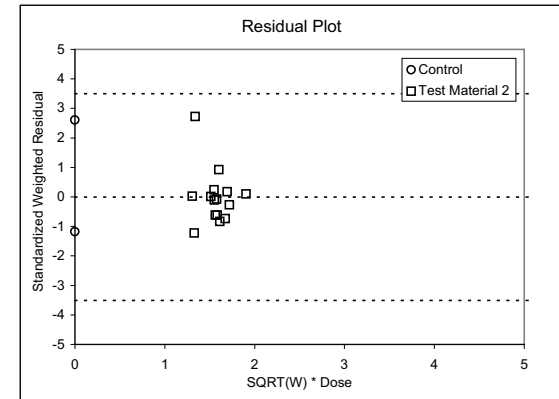
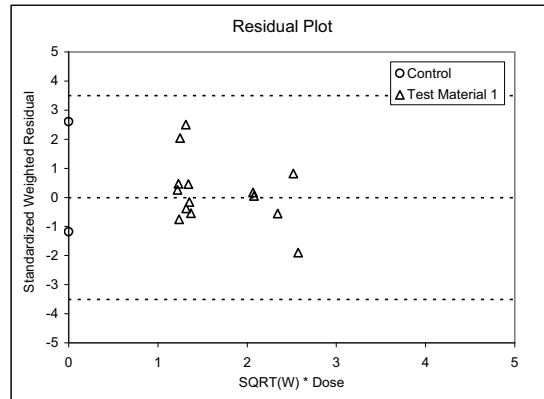
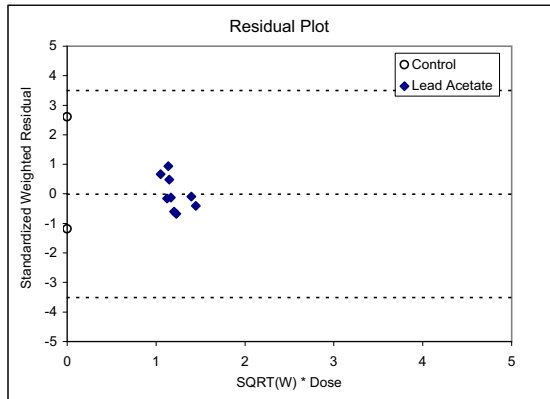
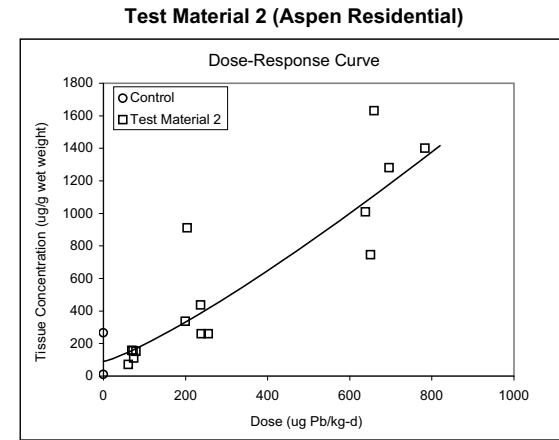
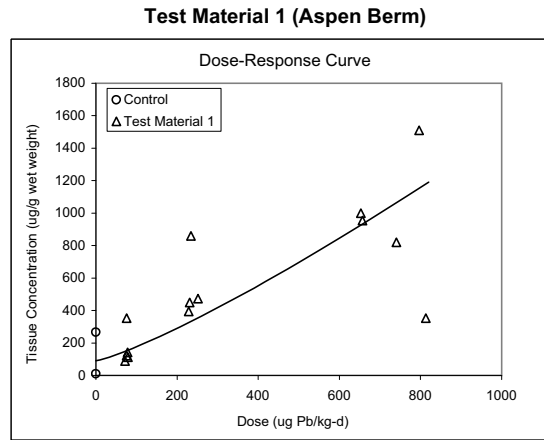
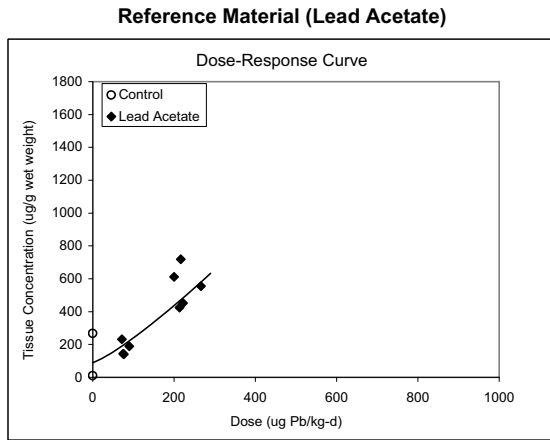
NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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APPENDIX E

Figure 3d - All Data
Phase II Experiment 5: Kidney
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.99E+01	4.32E+01
b1	5.81E-01	9.47E-01
b2	3.36E-01	6.35E-01
b3	4.05E-01	7.34E-01
c	1.21E+00	2.85E-01
Covariance (b1,b2)	0.9831	--
Covariance (b1,b3)	0.9834	--
Degrees of Freedom	35	--

Goodness of Fit

Statistic	Estimate
F	11.844
p	< 0.001
Adjusted R ²	0.5266
AIC	548.008

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.64	0.74
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

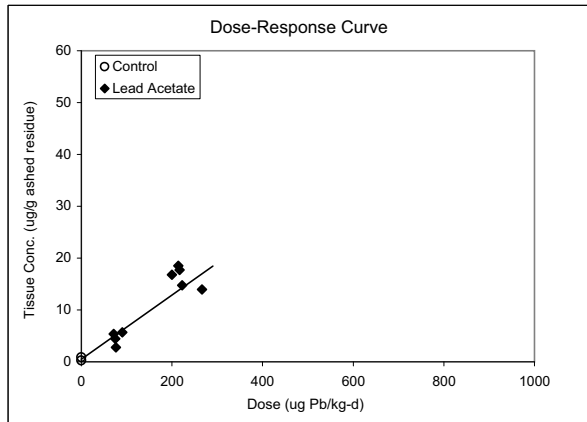
APPENDIX E

Figure 4a - All Data

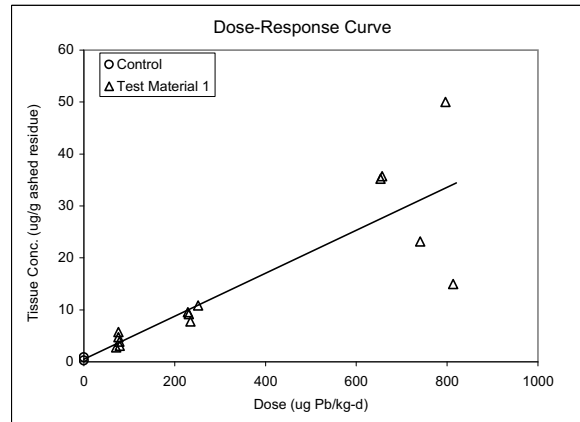
Phase II Experiment 5: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

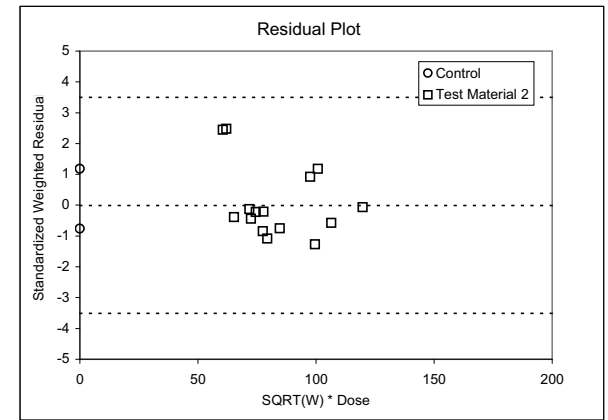
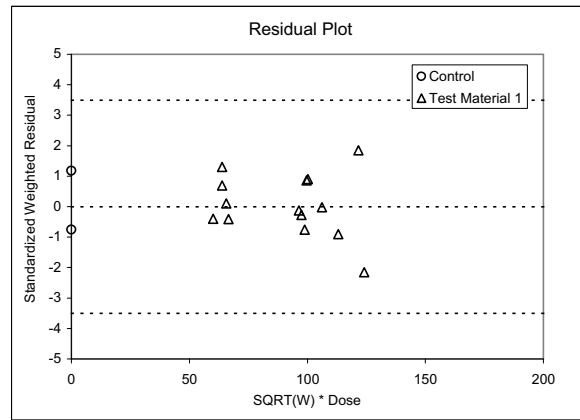
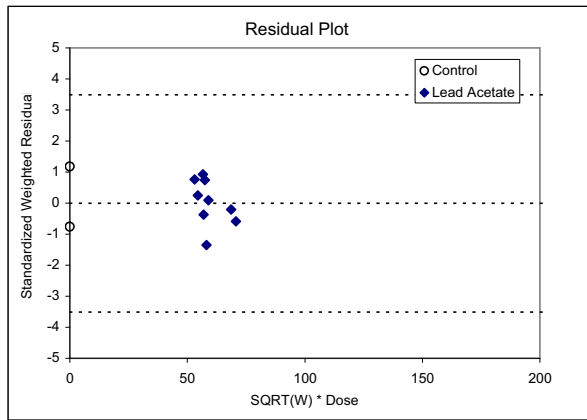
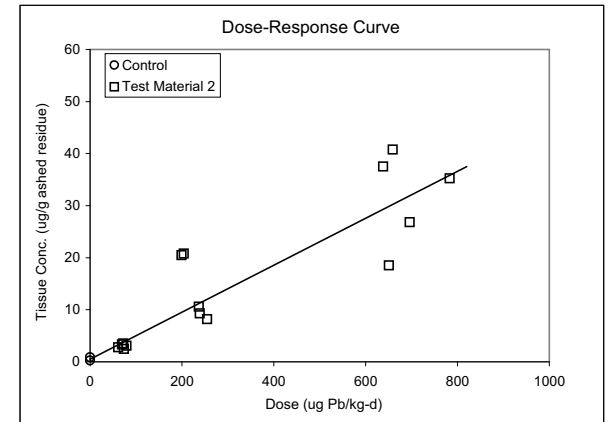
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.85E-01	2.13E-01
b1	6.19E-02	8.12E-03
b2	4.14E-02	4.15E-03
b3	4.51E-02	4.47E-03
Covariance (c1,c2)	0.0463	--
Covariance (c1,c3)	0.0555	--
Degrees of Freedom	36	--

Goodness of Fit

Statistic	Estimate
F	78.581
p	< 0.001
Adjusted R ²	0.8565
AIC	221.181

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.67	0.73
Lower bound	0.51	0.56
Upper bound	0.89	0.97
Standard Error	0.108	0.117

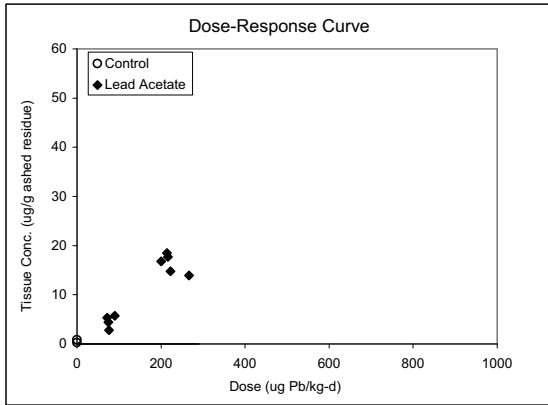
APPENDIX E

Figure 4b - All Data

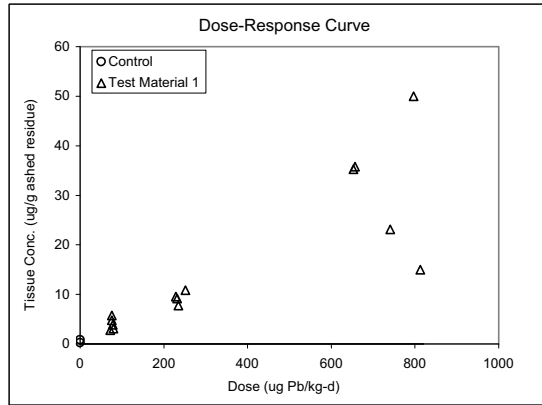
Phase II Experiment 5: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

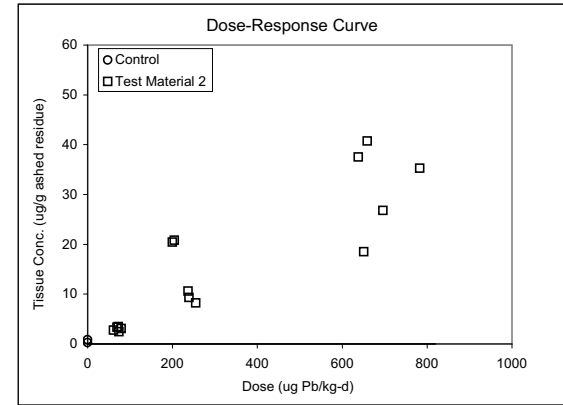
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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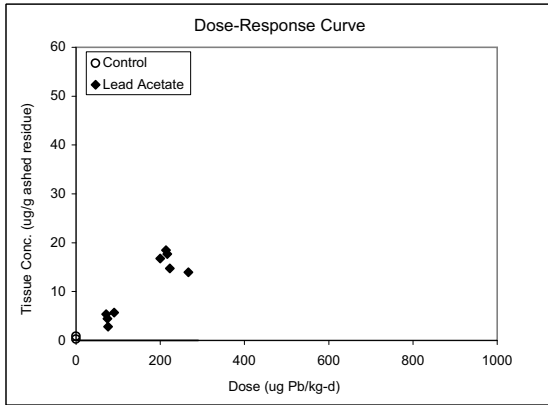
APPENDIX E

Figure 4c - All Data

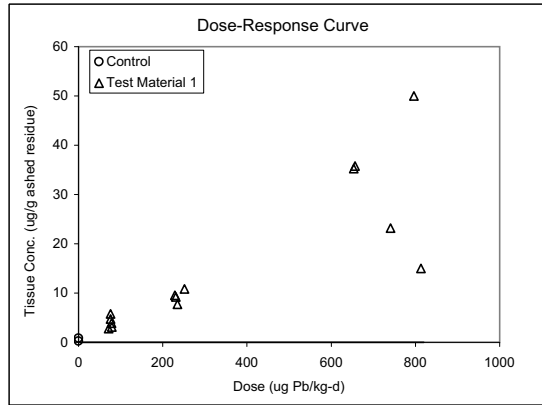
Phase II Experiment 5: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

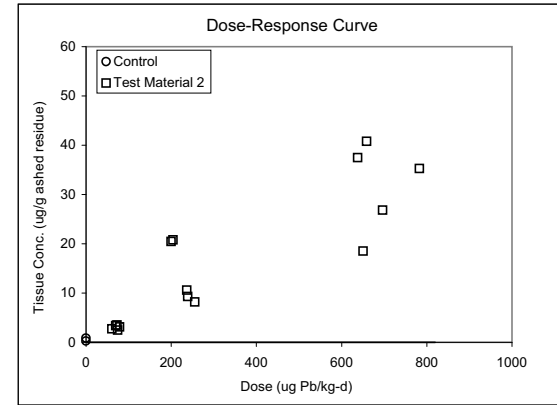
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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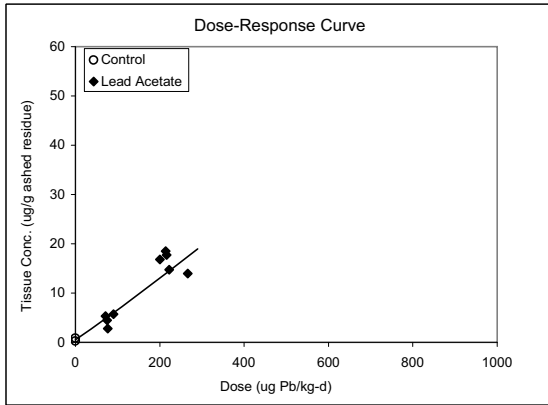
APPENDIX E

Figure 4d - All Data

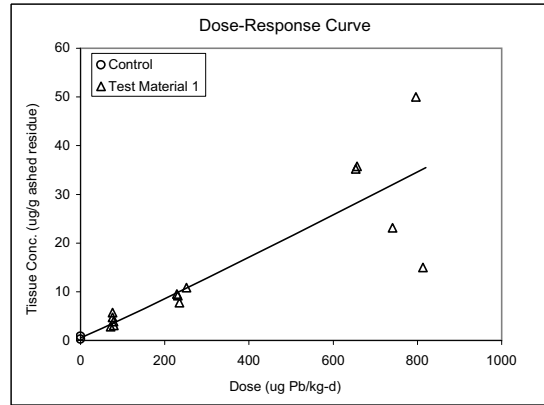
Phase II Experiment 5: Femur

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

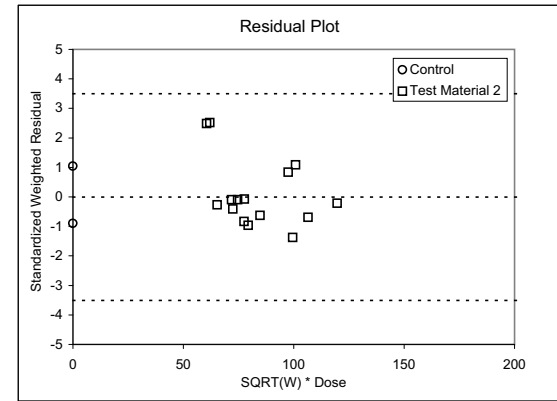
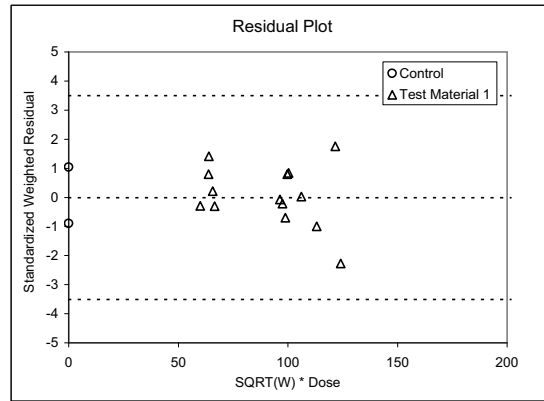
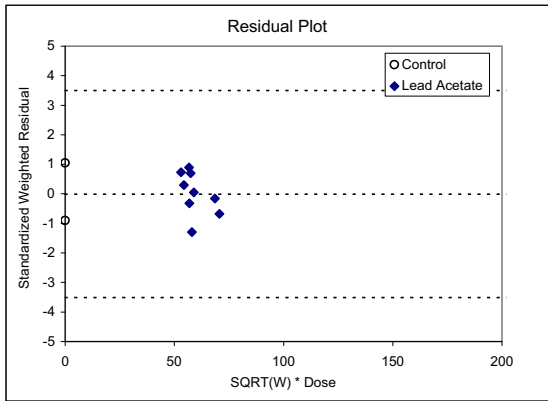
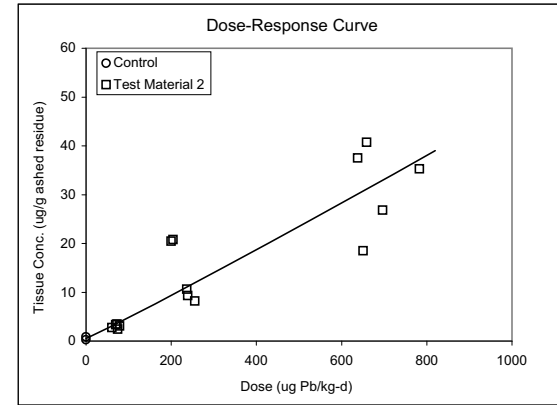
Reference Material (Lead Acetate)



Test Material 1 (Aspen Berm)



Test Material 2 (Aspen Residential)



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.28E-01	2.29E-01
b1	5.00E-02	2.14E-02
b2	3.21E-02	1.57E-02
b3	3.53E-02	1.69E-02
c	1.04E+00	7.94E-02
Covariance (b1,b2)	0.9327	--
Covariance (b1,b3)	0.9328	--
Degrees of Freedom	35	--

Goodness of Fit

Statistic	Estimate
F	57.870
p	< 0.001
Adjusted R ²	0.8536
AIC	222.558

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.65	0.72
Lower bound	0.33	0.39
Upper bound	0.88	0.97
Standard Error	--	--

APPENDIX E

EXPERIMENT 6

Test Material 1: Midvale Slag

Test Material 2: Butte Soil

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model (All Data)
- Figure 3a Kidney - Linear Model (Outlier Excluded)
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

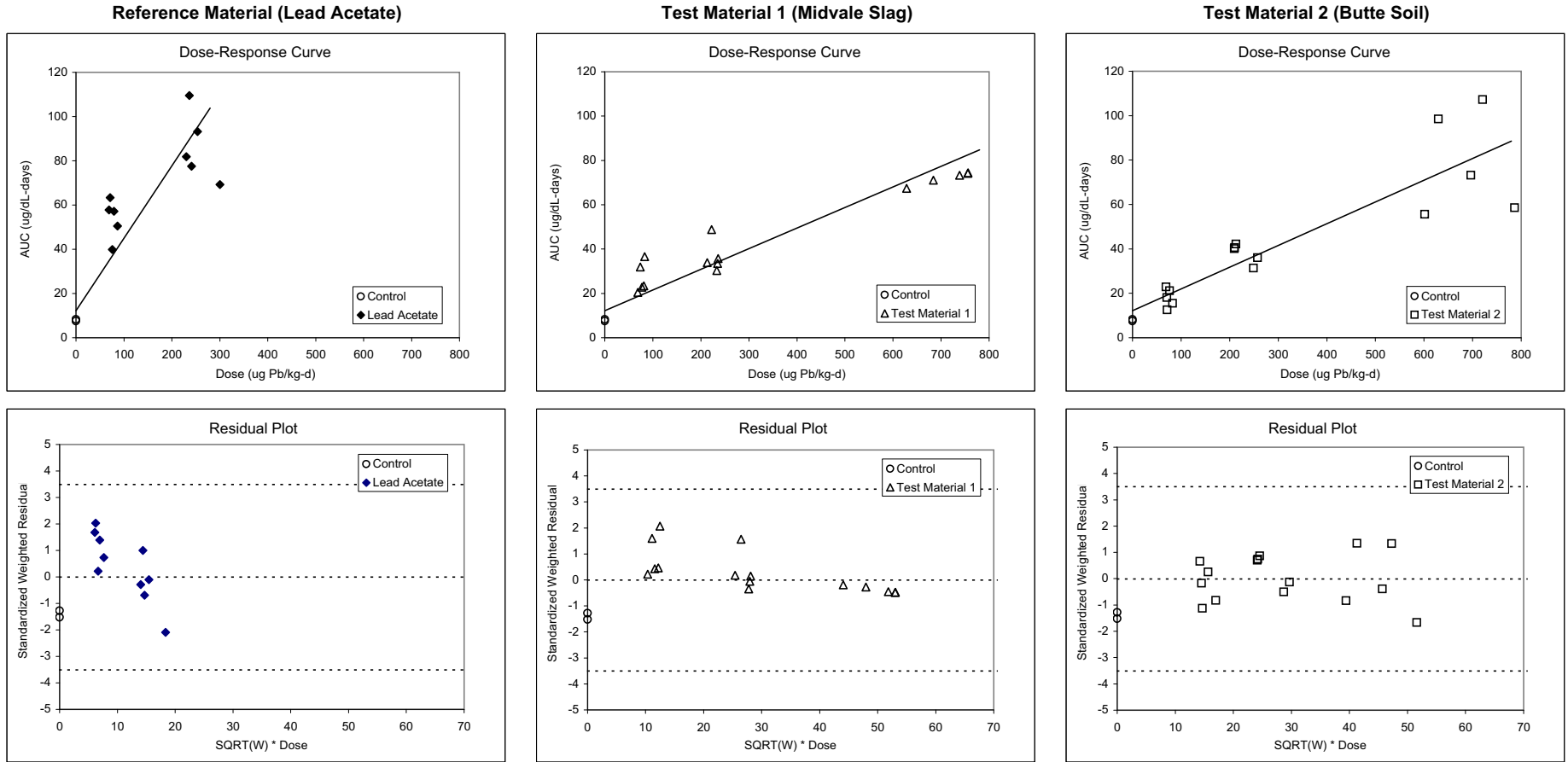
- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

Figure 1a - All Data

Phase II Experiment 6: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.22E+01	1.66E+00
b1	3.27E-01	3.47E-02
b2	9.31E-02	1.06E-02
b3	9.78E-02	1.15E-02
Covariance (c1,c2)	0.1007	--
Covariance (c1,c3)	0.1127	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	63.445
p	< 0.001
Adjusted R ²	0.8204
AIC	333.585

RBA and Uncertainty

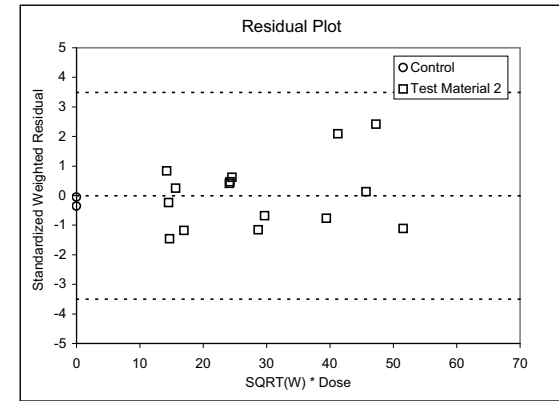
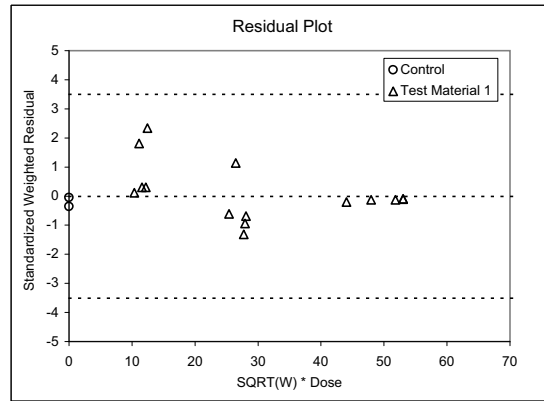
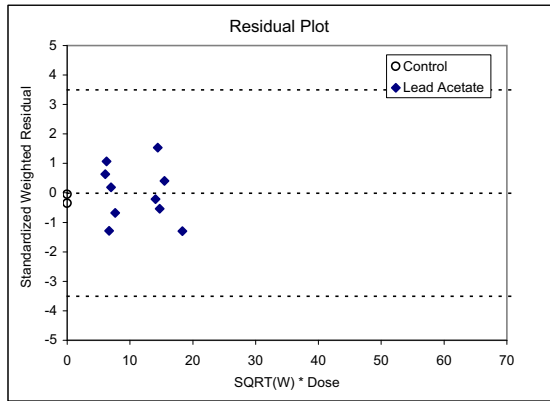
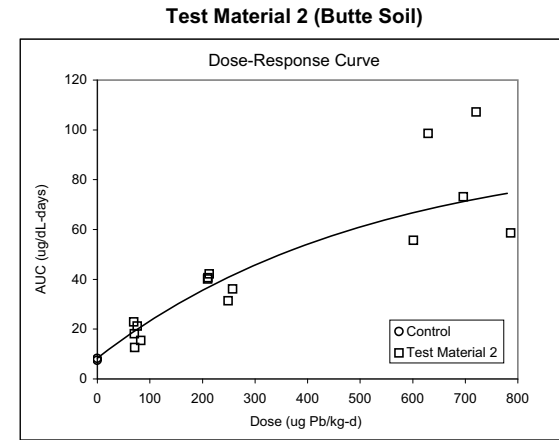
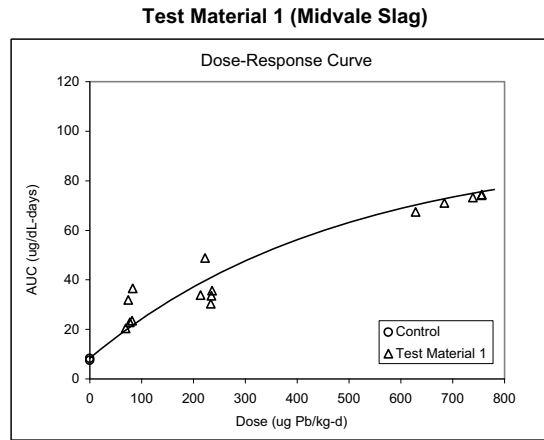
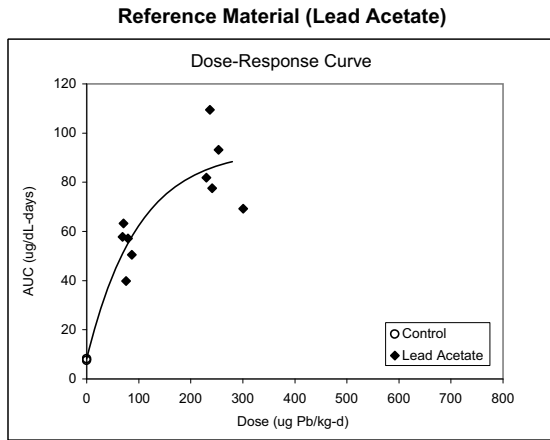
	Test Material 1	Test Material 2
RBA	0.28	0.30
Lower bound	0.22	0.23
Upper bound	0.36	0.38
Standard Error	0.042	0.045

APPENDIX E

Figure 1b - All Data

Phase II Experiment 6: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.37E+00	1.61E+00
b	8.51E+01	9.89E+00
c1	1.01E-02	2.83E-03
c2	2.06E-03	4.66E-04
c3	1.93E-03	4.28E-04
Covariance (c1,c2)	0.7145	--
Covariance (c1,c3)	0.7021	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	81.898
p	< 0.001
Adjusted R ²	0.8875
AIC	311.830

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.21	0.19
Lower bound	0.15	0.14
Upper bound	0.31	0.29
Standard Error	0.041*	0.039*

* $g \geq 0.05$, estimate is uncertain

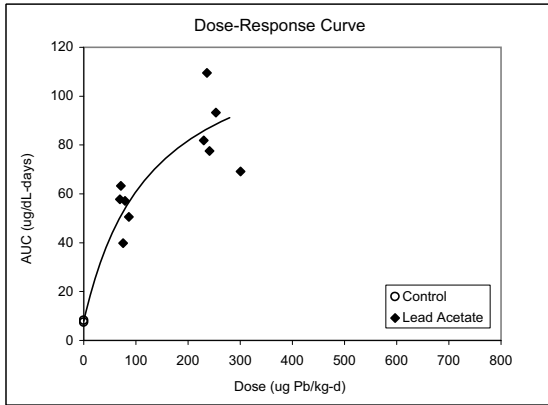
APPENDIX E

Figure 1c - All Data

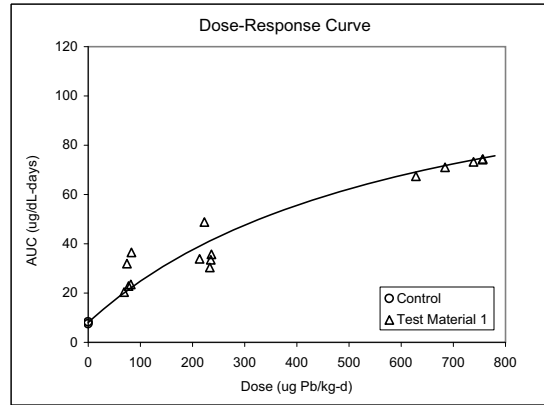
Phase II Experiment 6: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

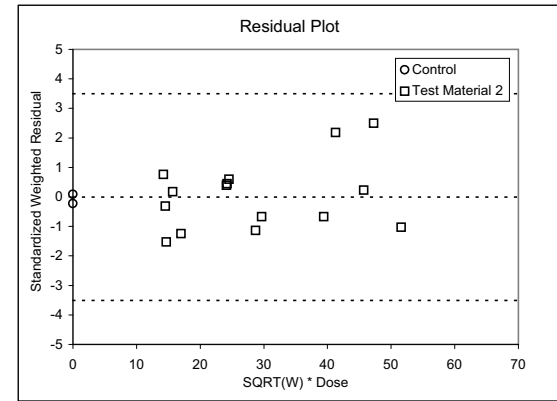
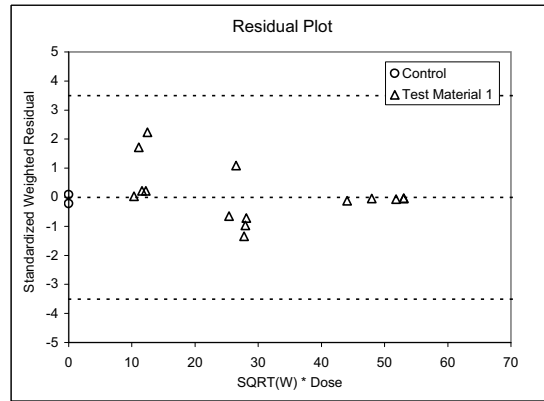
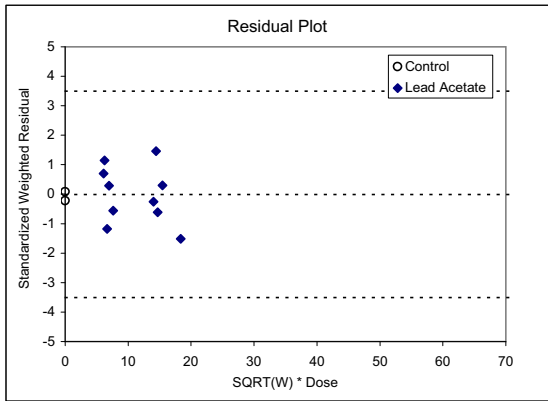
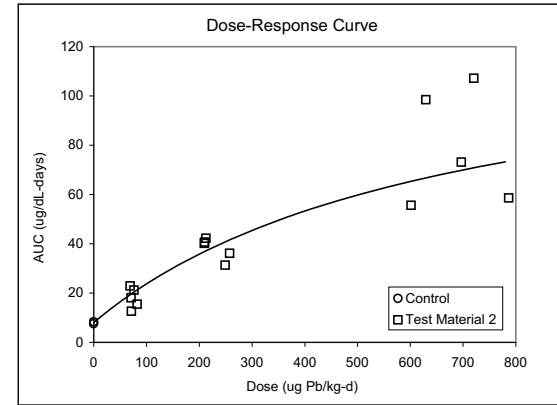
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.05E+00	1.68E+00
b	1.22E+02	2.01E+01
c1	1.31E+02	4.96E+01
c2	6.26E+02	1.91E+02
c3	6.79E+02	2.01E+02
Covariance (c1,c2)	0.8466	--
Covariance (c1,c3)	0.8359	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	80.706
p	< 0.001
Adjusted R ²	0.8861
AIC	312.322

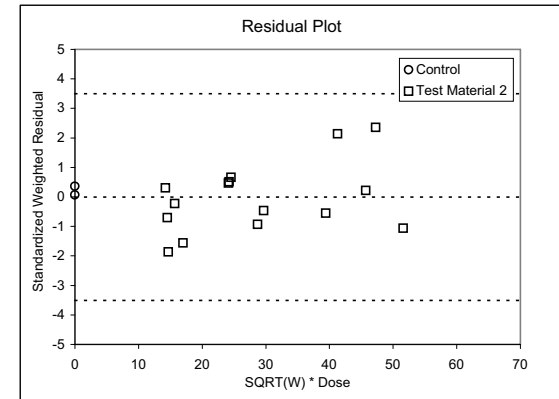
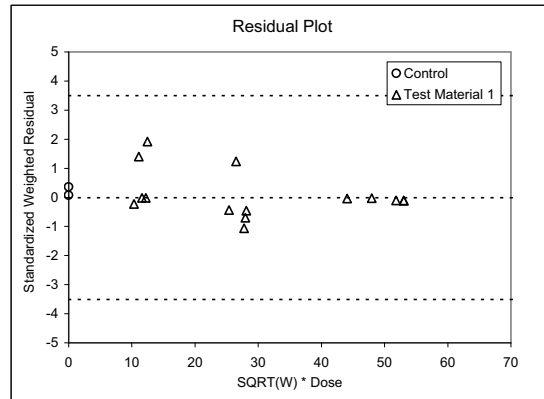
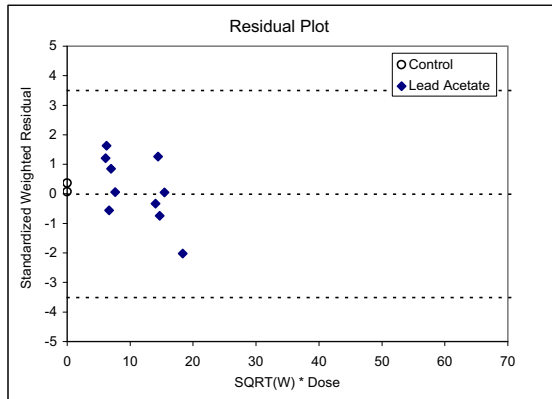
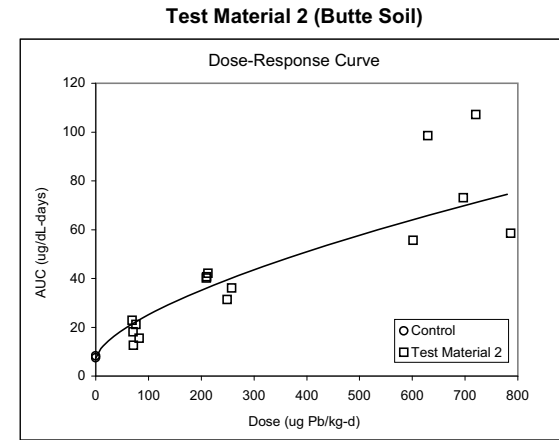
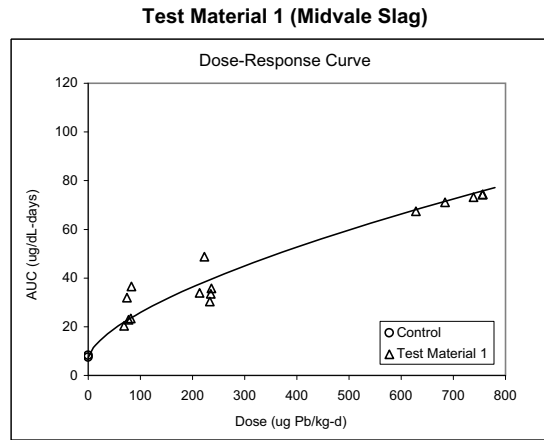
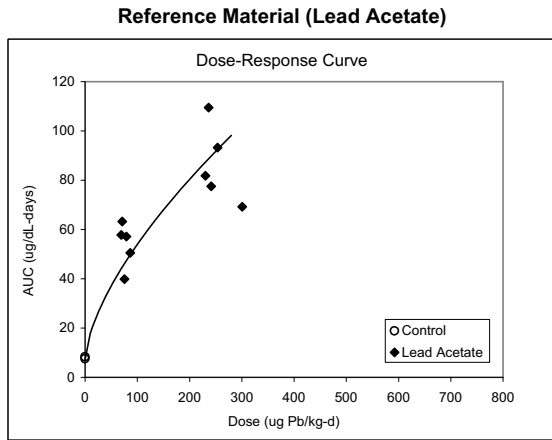
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.21	0.19
Lower bound	0.12	0.11
Upper bound	0.29	0.27
Standard Error	0.042*	0.040*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 6: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.32E+00	1.88E+00
b1	2.38E+00	8.92E-01
b2	9.43E-01	4.10E-01
b3	9.06E-01	3.88E-01
c	6.47E-01	6.78E-02
Covariance (b1,b2)	0.9646	--
Covariance (b1,b3)	0.9617	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	72.563
p	< 0.001
Adjusted R ²	0.8747
AIC	316.066

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.24	0.23
Lower bound	0.12	0.12
Upper bound	0.32	0.30
Standard Error	--	--

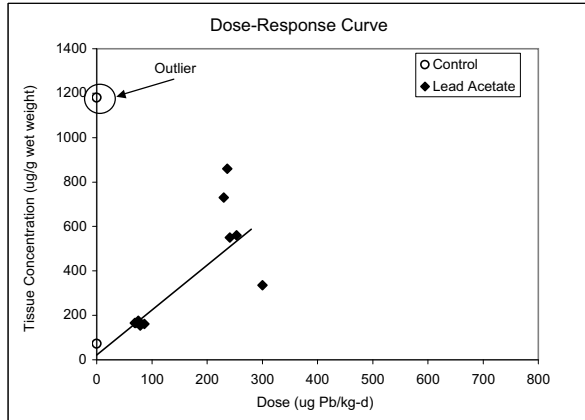
APPENDIX E

Figure 2a - All Data

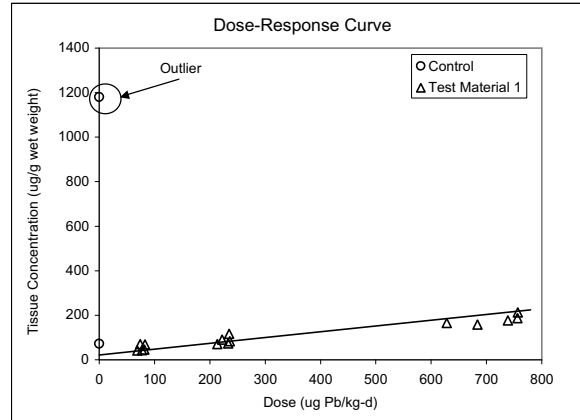
Phase II Experiment 6: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

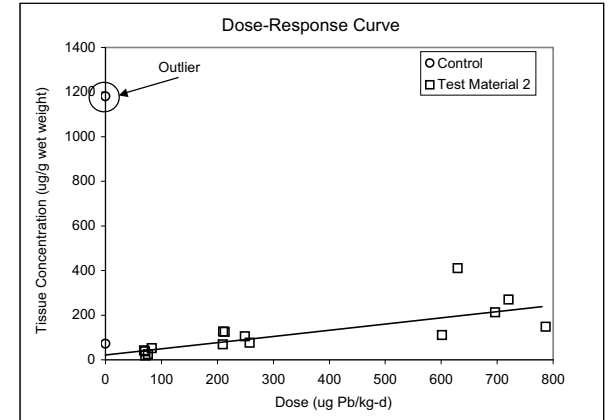
Reference Material (Lead Acetate)



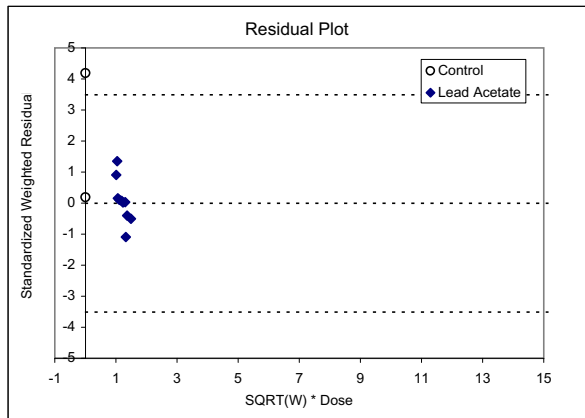
Test Material 1 (Midvale Slag)



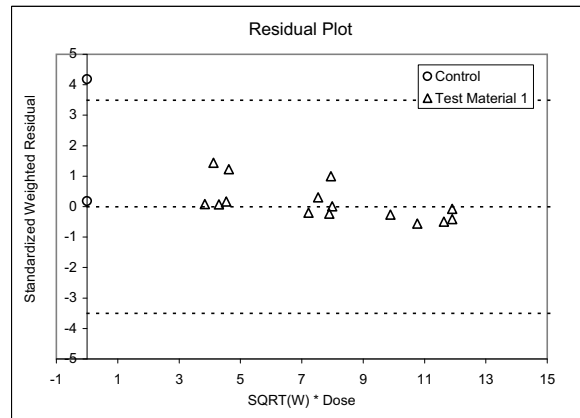
Test Material 2 (Butte Soil)



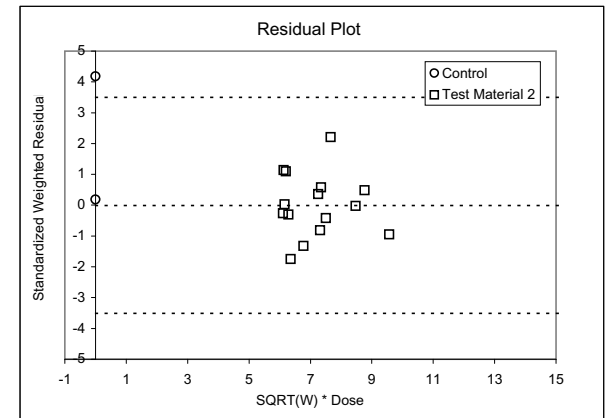
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	2.13E+01	6.97E+00
b1	2.02E+00	3.28E-01
b2	2.60E-01	4.52E-02
b3	2.78E-01	5.87E-02
Covariance (c1,c2)	0.1005	--
Covariance (c1,c3)	0.1298	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	23.514
p	< 0.001
Adjusted R ²	0.6223
AIC	468.374

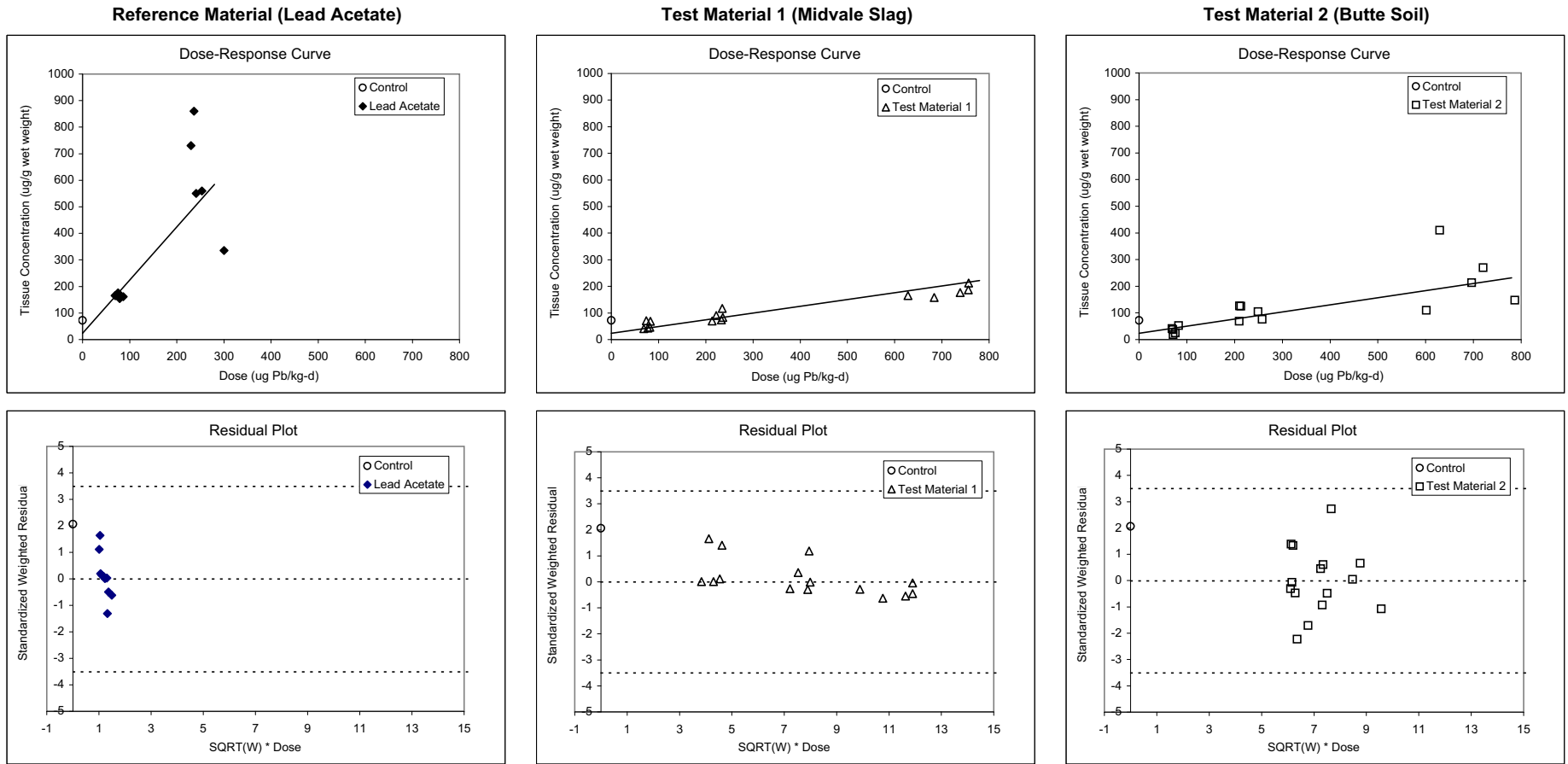
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.13	0.14
Lower bound	0.09	0.09
Upper bound	0.19	0.21
Standard Error	0.029*	0.034*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 6: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	2.33E+01	5.58E+00
b1	2.00E+00	2.69E-01
b2	2.54E-01	3.69E-02
b3	2.67E-01	4.77E-02
Covariance (c1,c2)	0.0962	--
Covariance (c1,c3)	0.1248	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	34.108
p	< 0.001
Adjusted R ²	0.7129
AIC	430.977

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.13	0.13
Lower bound	0.09	0.09
Upper bound	0.17	0.19
Standard Error	0.024*	0.028*

* $g \geq 0.05$, estimate is uncertain

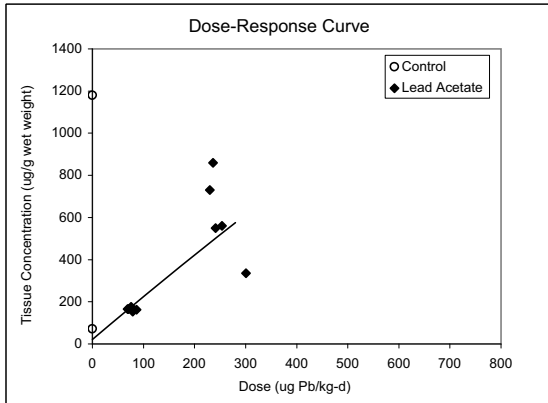
APPENDIX E

Figure 2b - All Data

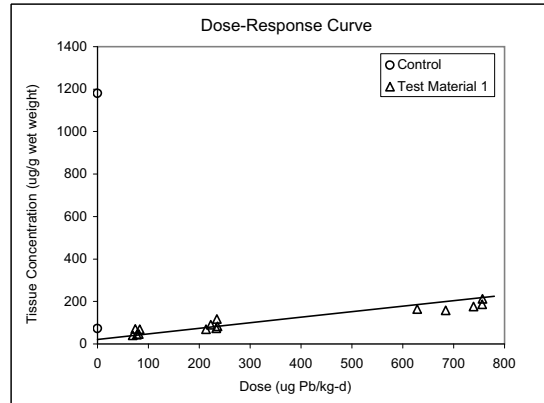
Phase II Experiment 6: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

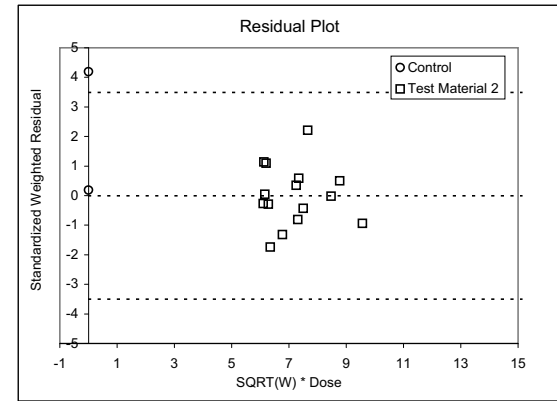
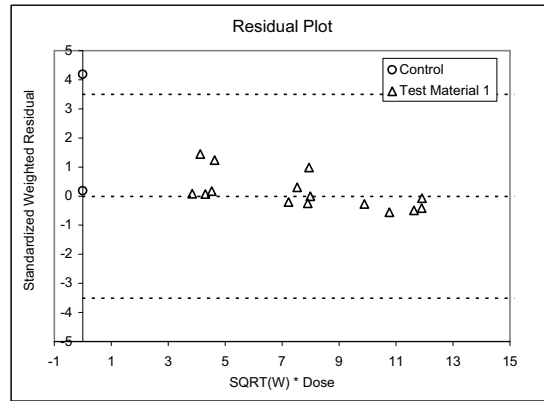
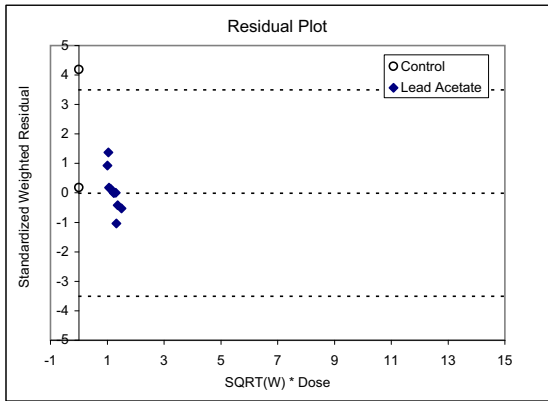
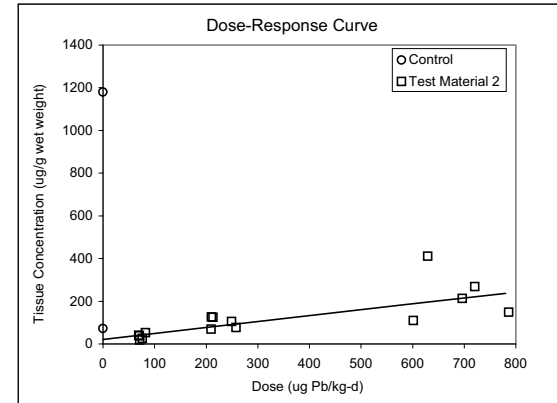
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	2.10E+01	8.24E+00
b	6.21E+03	6.55E+04
c1	3.33E-04	3.63E-03
c2	4.26E-05	4.60E-04
c3	4.55E-05	4.91E-04
Covariance (c1,c2)	0.9998	--
Covariance (c1,c3)	0.9997	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	17.178
p	< 0.001
Adjusted R ²	0.6121
AIC	470.359

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.13	0.14
Lower bound	?	?
Upper bound	?	?
Standard Error	0.031*	0.039*

* $g \geq 0.05$, estimate is uncertain

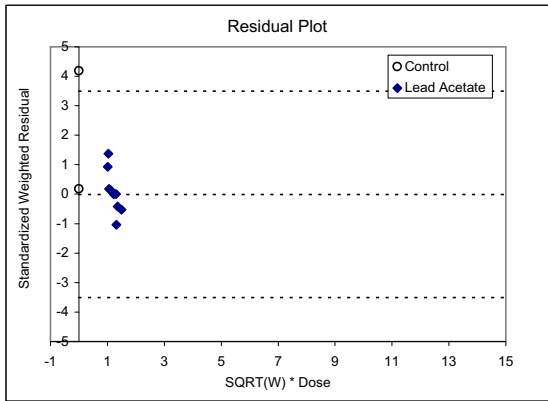
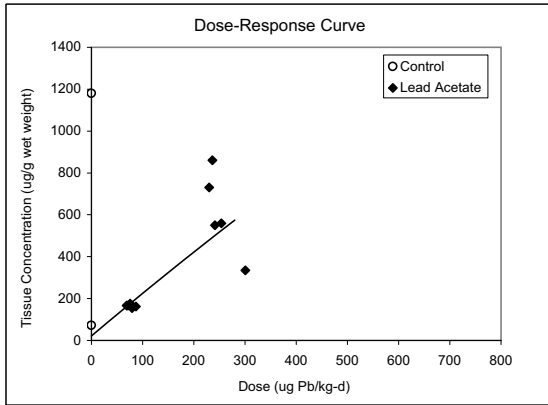
APPENDIX E

Figure 2c - All Data

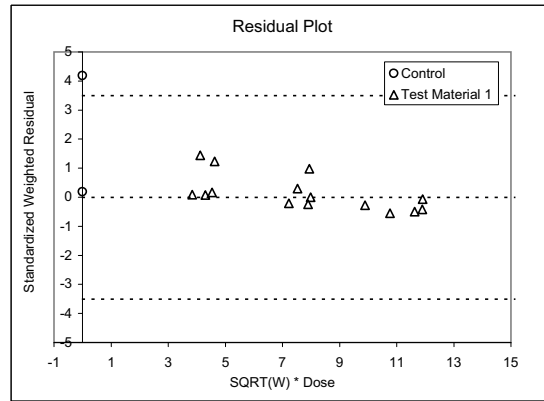
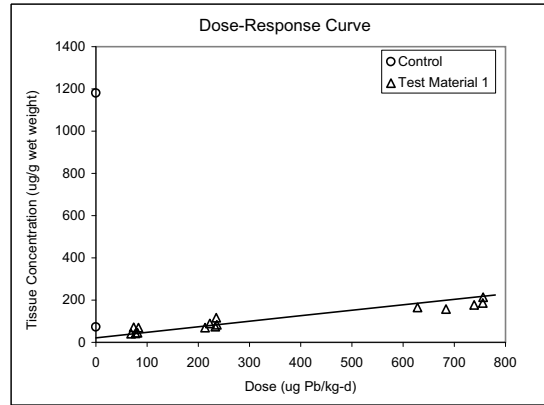
Phase II Experiment 6: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

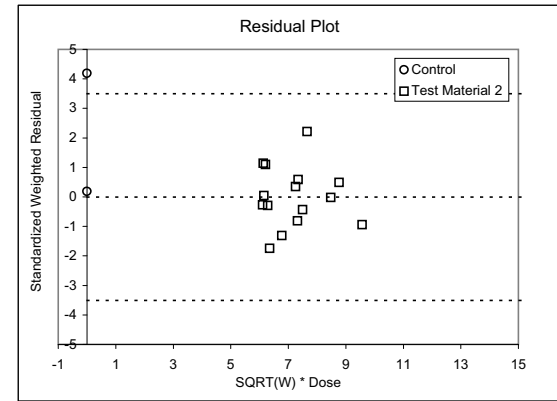
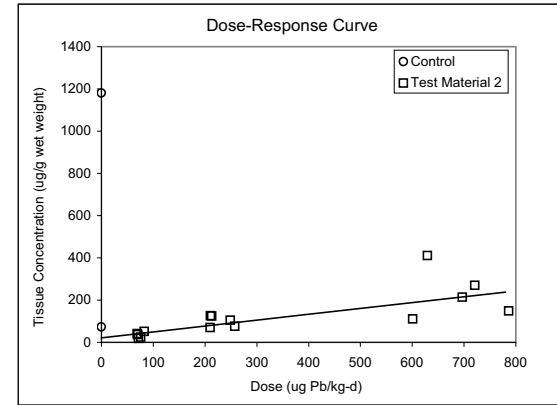
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	2.09E+01	8.29E+00
b	1.21E+04	1.27E+05
c1	5.82E+03	6.29E+04
c2	4.55E+04	4.86E+05
c3	4.27E+04	4.57E+05
Covariance (c1,c2)	0.9998	--
Covariance (c1,c3)	0.9997	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	17.178
p	< 0.001
Adjusted R ²	0.6122
AIC	470.359

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.13	0.14
Lower bound	?	?
Upper bound	?	?
Standard Error	0.031*	0.039*

* $g \geq 0.05$, estimate is uncertain

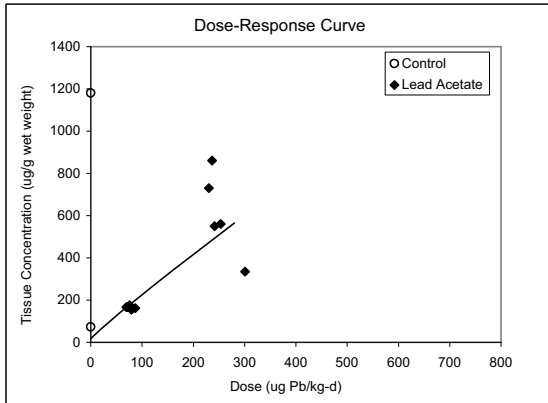
APPENDIX E

Figure 2d - All Data

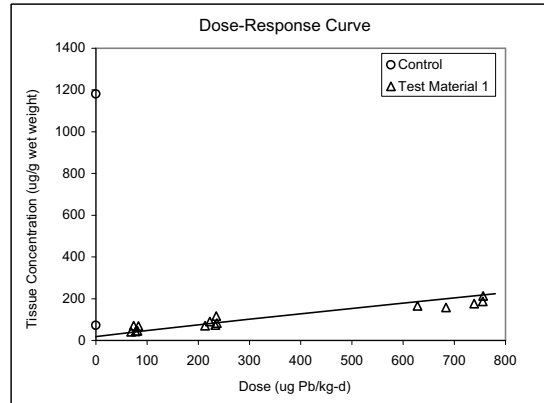
Phase II Experiment 6: Liver

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

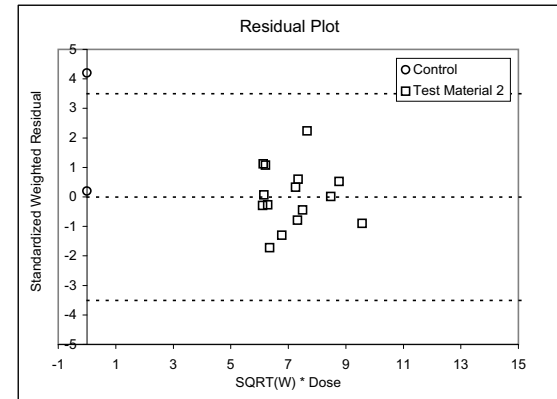
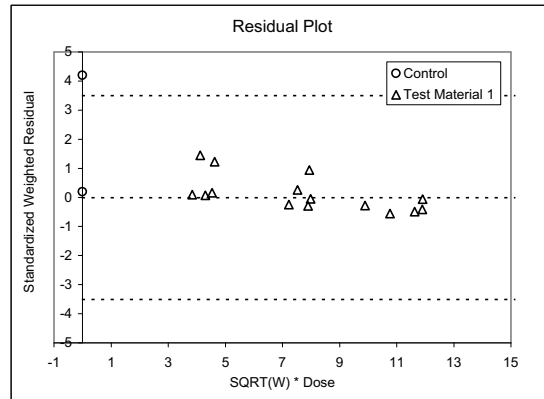
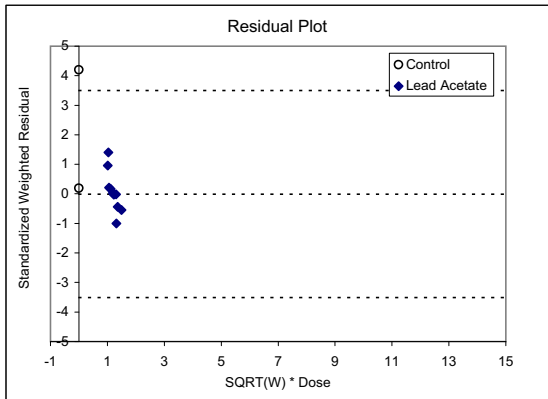
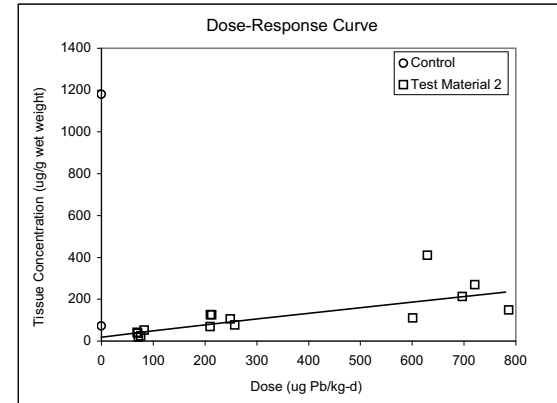
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.81E+01	1.76E+01
b1	2.70E+00	3.63E+00
b2	3.86E-01	6.87E-01
b3	4.05E-01	7.20E-01
c	9.43E-01	2.62E-01
Covariance (b1,b2)	0.9893	--
Covariance (b1,b3)	0.9877	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	17.205
p	< 0.001
Adjusted R ²	0.6126
AIC	470.299

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.13	0.13
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

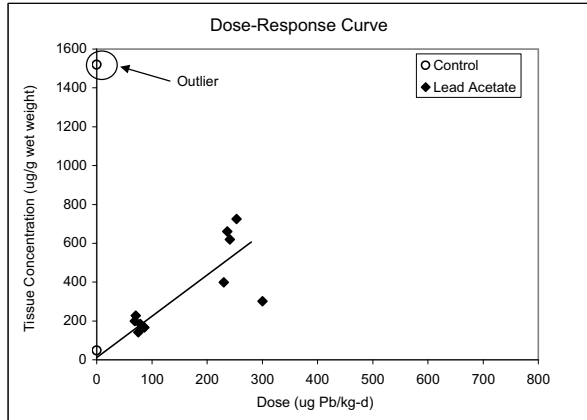
APPENDIX E

Figure 3a - All Data

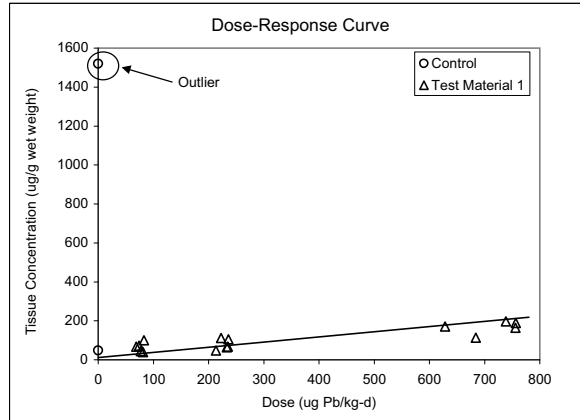
Phase II Experiment 6: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

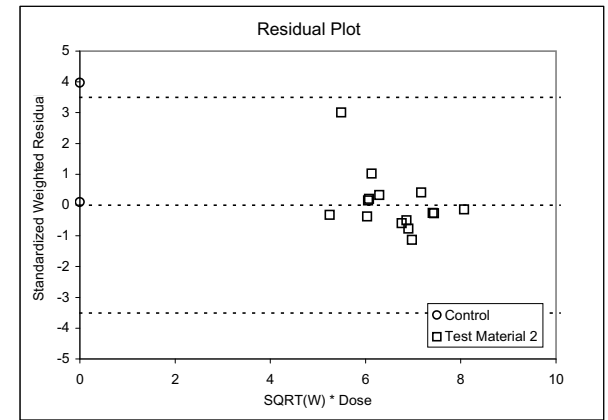
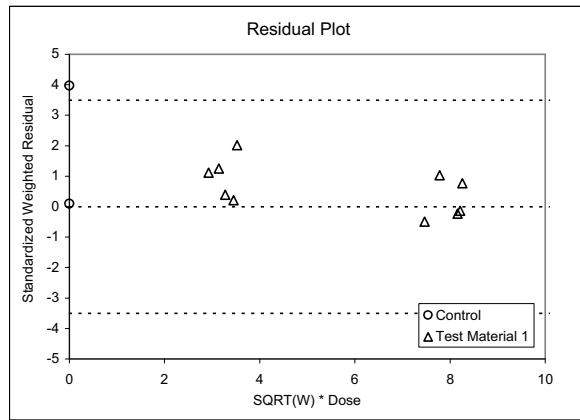
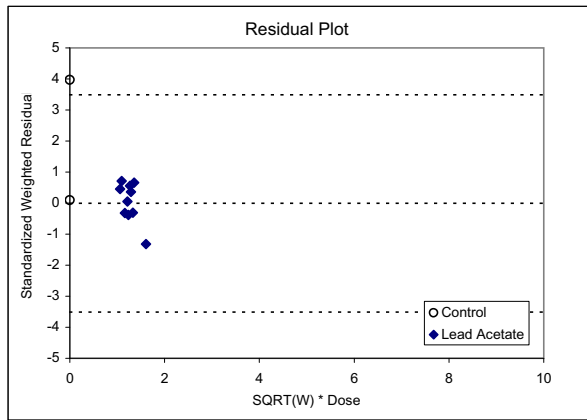
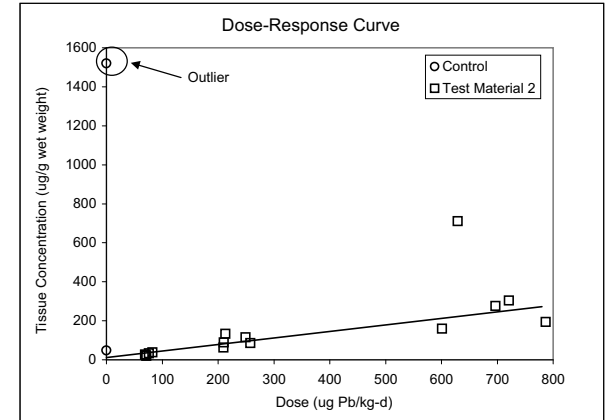
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.15E+01	9.29E+00
b1	2.12E+00	3.83E-01
b2	2.64E-01	5.24E-02
b3	3.34E-01	8.87E-02
Covariance (c1,c2)	0.0947	--
Covariance (c1,c3)	0.1423	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	17.831
p	< 0.001
Adjusted R ²	0.5519
AIC	500.260

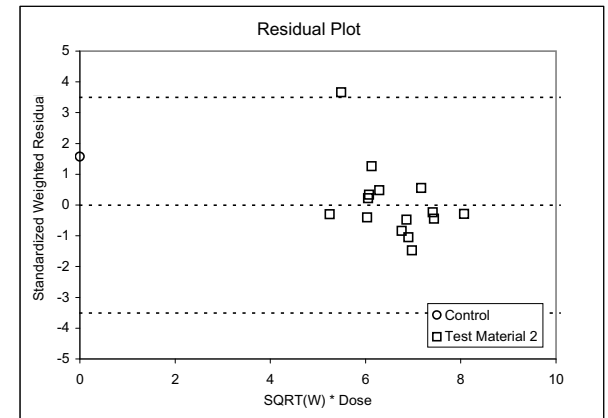
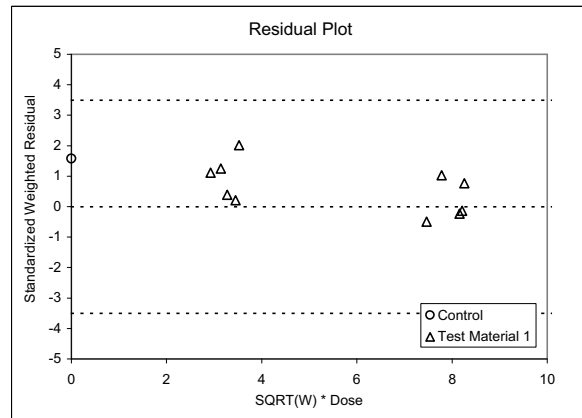
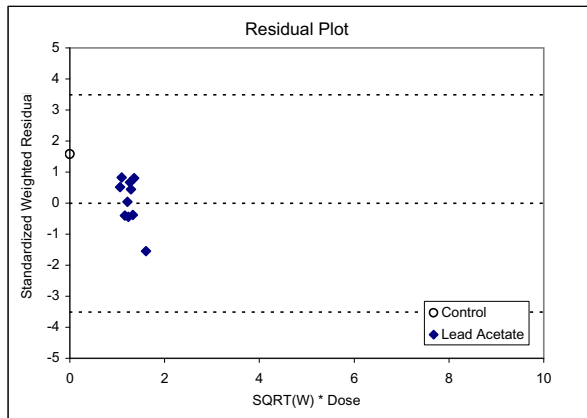
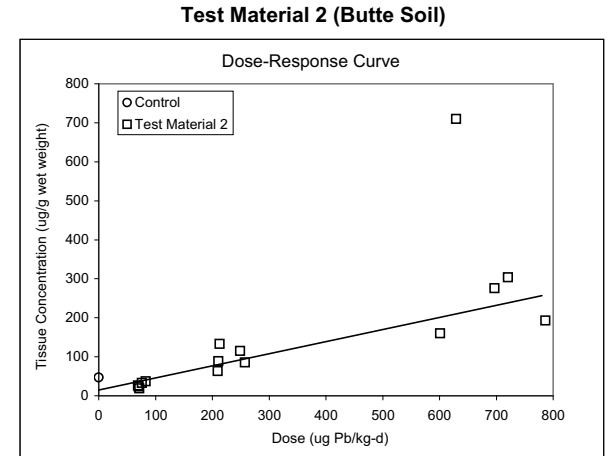
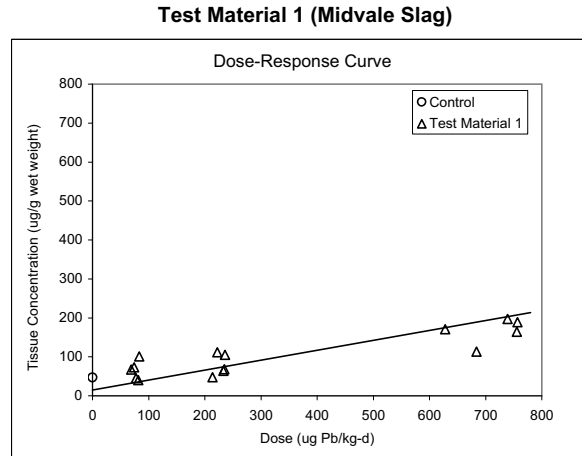
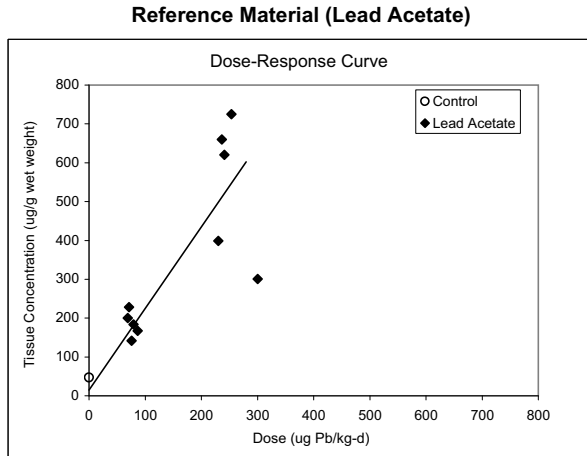
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.12	0.16
Lower bound	0.08	0.09
Upper bound	0.19	0.25
Standard Error	0.032*	0.047*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3a - Outlier Excluded
Phase II Experiment 6: Kidney
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.49E+01	7.31E+00
b1	2.10E+00	3.19E-01
b2	2.55E-01	4.32E-02
b3	3.10E-01	7.17E-02
Covariance (c1,c2)	0.0853	--
Covariance (c1,c3)	0.1306	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	25.046
p	< 0.001
Adjusted R ²	0.6433
AIC	454.018

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.12	0.15
Lower bound	0.08	0.09
Upper bound	0.18	0.22
Standard Error	0.026*	0.038*

*g ≥ 0.05, estimate is uncertain

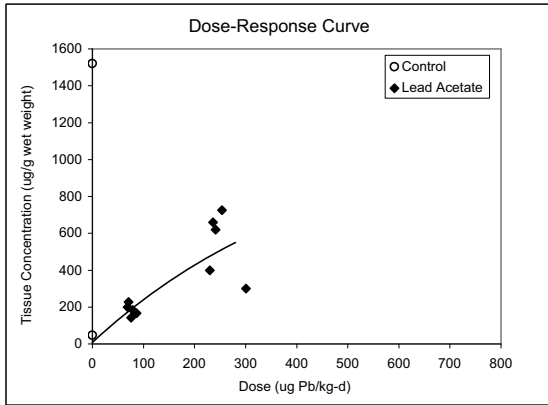
APPENDIX E

Figure 3b - All Data

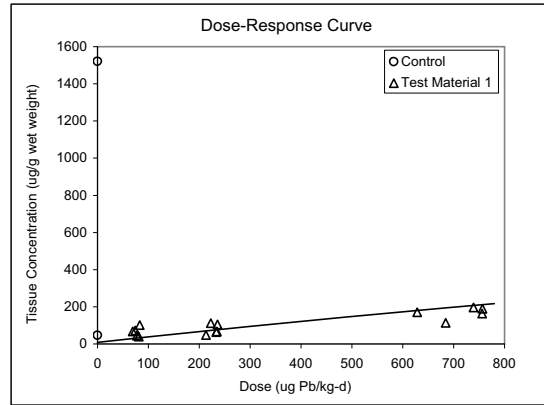
Phase II Experiment 6: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

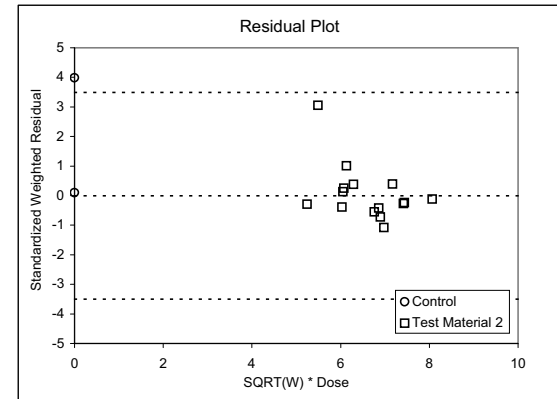
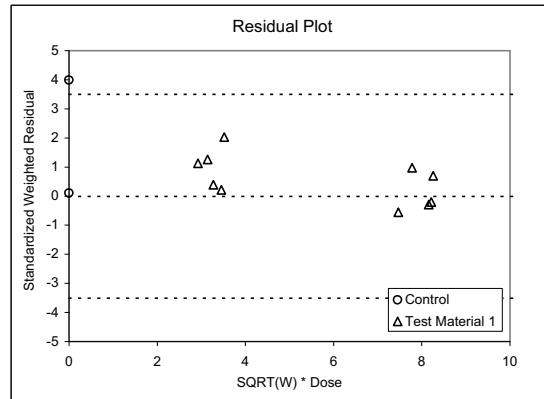
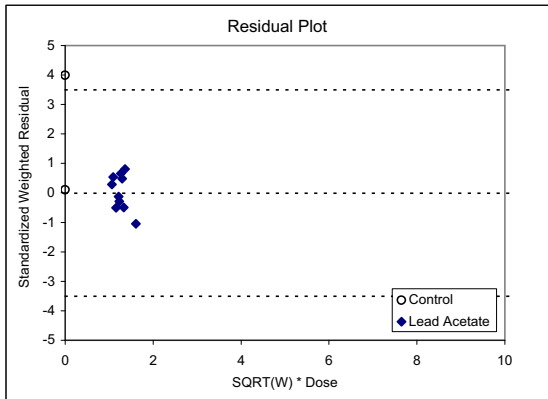
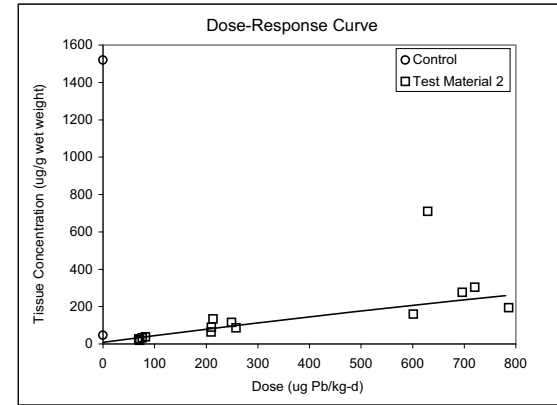
Reference Material (Lead Acetate)



Test Material 1 (Midvale Slag)



Test Material 2 (Butte Soil)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.36E+00	1.13E+01
b	1.21E+03	2.10E+03
c1	2.12E-03	4.39E-03
c2	2.42E-04	4.64E-04
c3	2.97E-04	5.74E-04
Covariance (c1,c2)	0.9899	--
Covariance (c1,c3)	0.9860	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	13.189
p	< 0.001
Adjusted R ²	0.5432
AIC	501.614

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.14
Lower bound	?	?
Upper bound	?	?
Standard Error	0.037*	0.051*

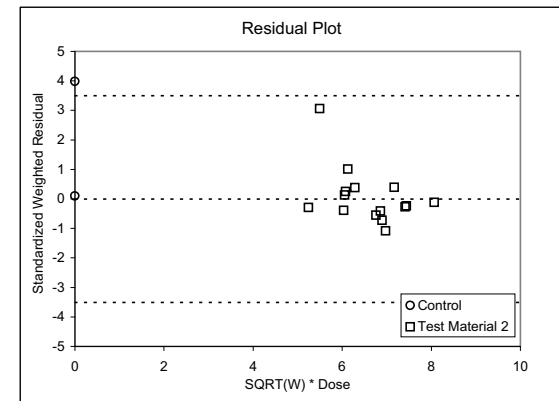
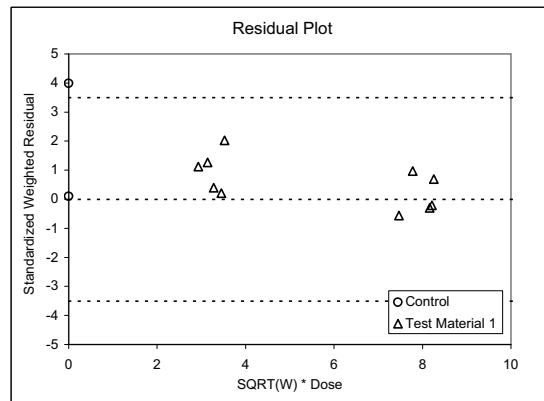
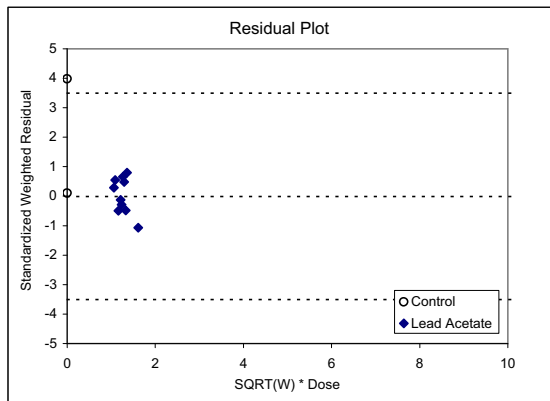
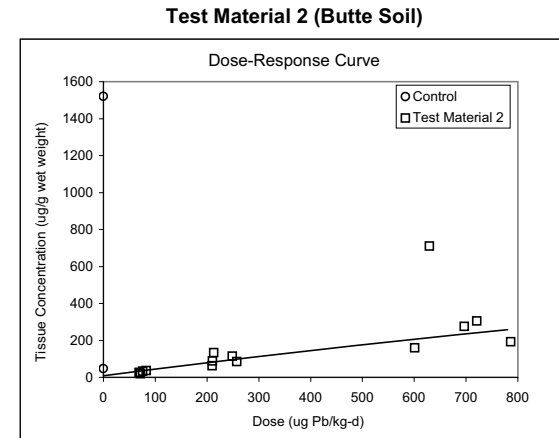
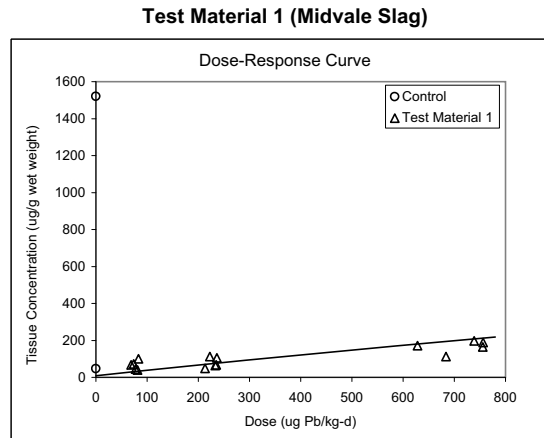
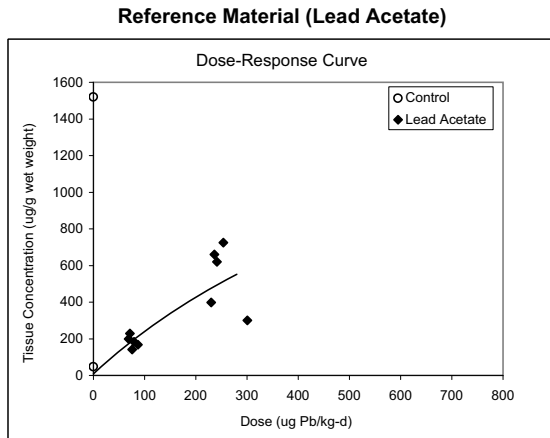
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3c - All Data

Phase II Experiment 6: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.28E+00	1.16E+01
b	2.22E+03	4.40E+03
c1	8.66E+02	2.04E+03
c2	7.54E+03	1.65E+04
c3	6.17E+03	1.36E+04
Covariance (c1,c2)	0.9923	--
Covariance (c1,c3)	0.9893	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	13.183
p	< 0.001
Adjusted R ²	0.5431
AIC	501.637

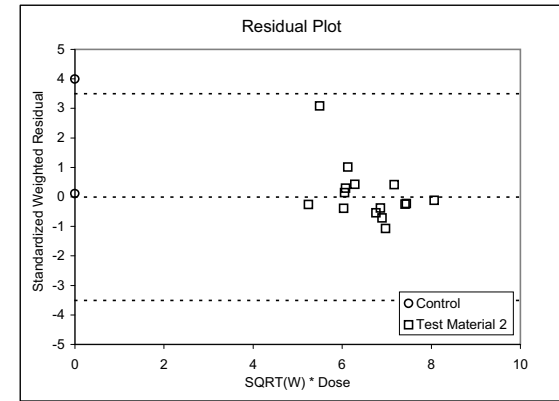
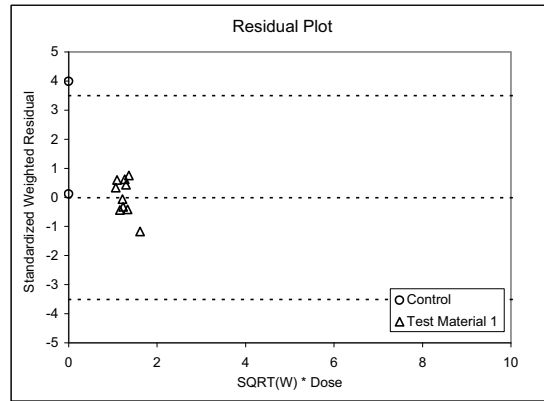
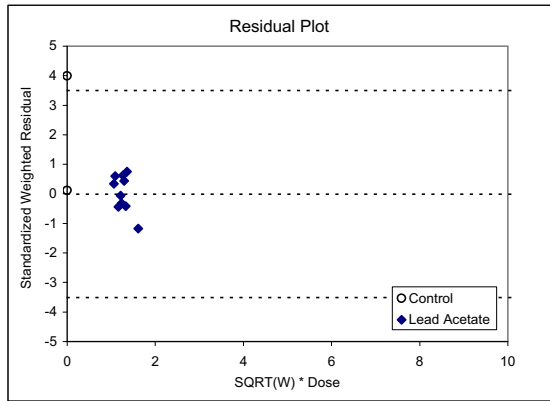
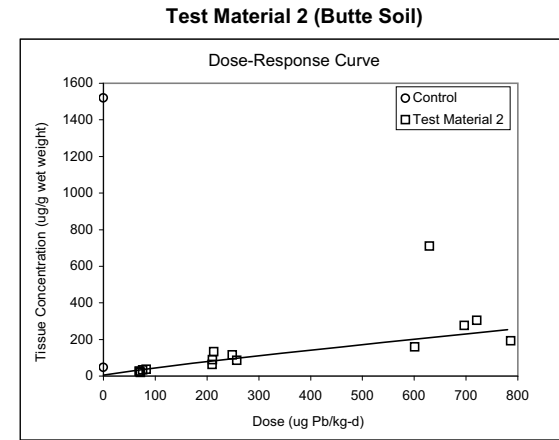
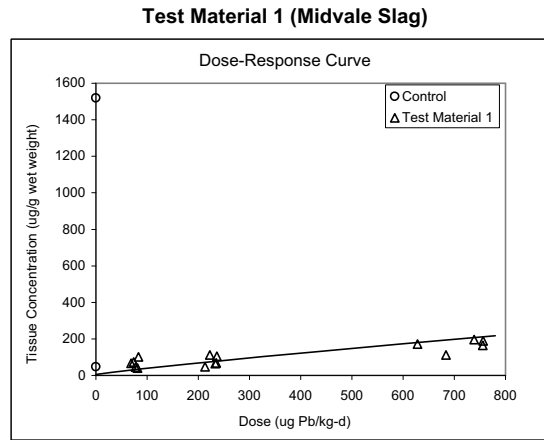
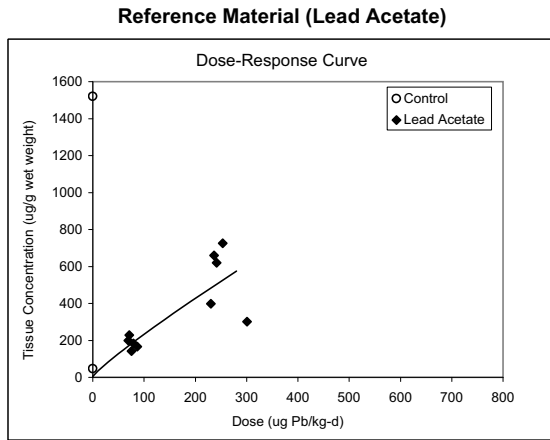
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.14
Lower bound	?	?
Upper bound	?	?
Standard Error	0.037*	0.051*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3d - All Data
Phase II Experiment 6: Kidney
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.15E+00	2.47E+01
b1	3.77E+00	5.85E+00
b2	5.63E-01	1.14E+00
b3	6.58E-01	1.31E+00
c	8.91E-01	2.94E-01
Covariance (b1,b2)	0.9901	--
Covariance (b1,b3)	0.9869	--
Degrees of Freedom	37	--

Goodness of Fit

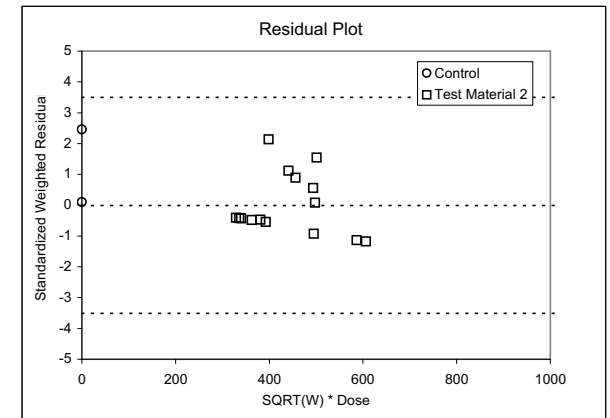
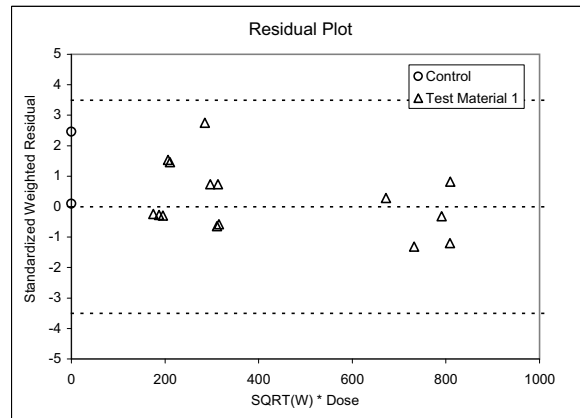
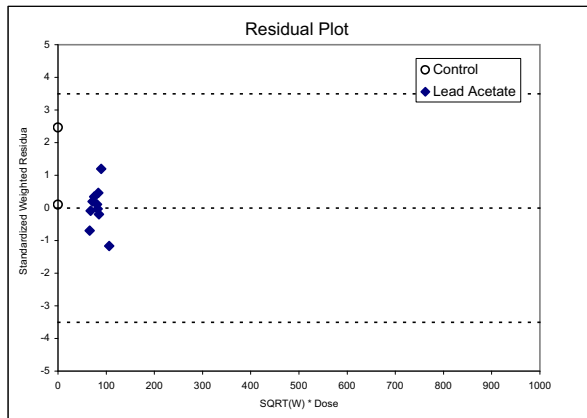
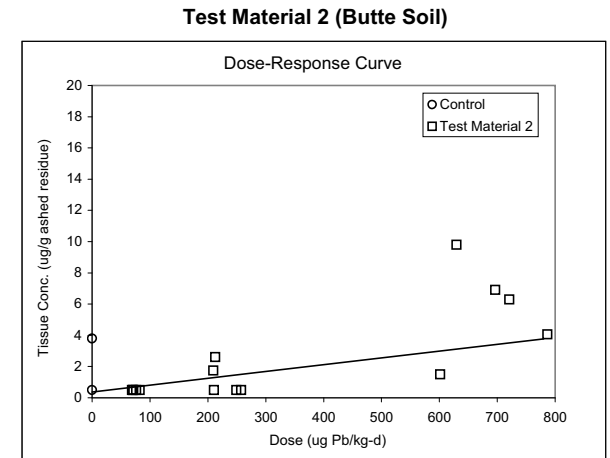
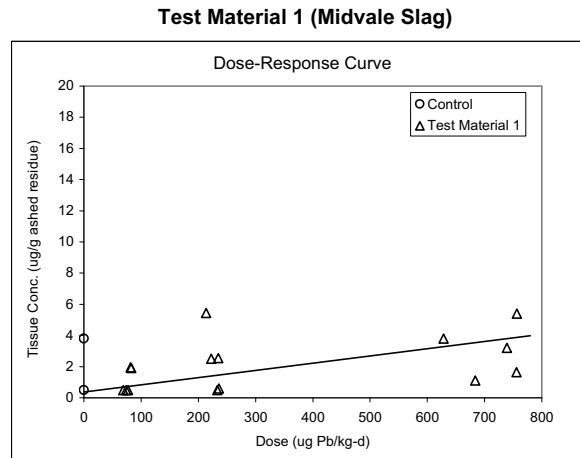
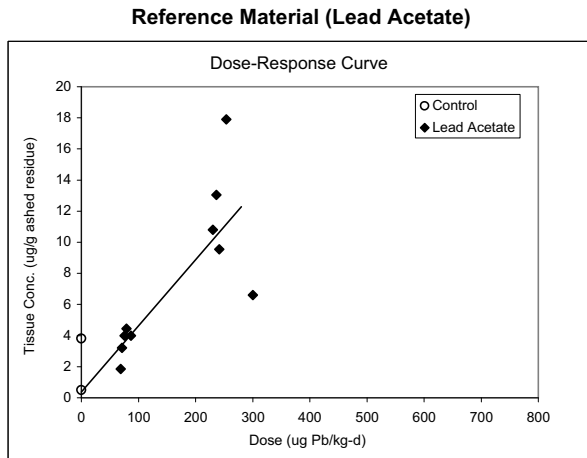
Statistic	Estimate
F	13.091
p	< 0.001
Adjusted R ²	0.5412
AIC	501.991

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.12	0.14
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

APPENDIX E

Figure 4a - All Data
Phase II Experiment 6: Femur
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	3.69E-01	2.21E-01
b1	4.26E-02	8.27E-03
b2	4.63E-03	1.22E-03
b3	4.36E-03	1.68E-03
Covariance (c1,c2)	0.0873	--
Covariance (c1,c3)	0.1409	--
Degrees of Freedom	38	--

Goodness of Fit

Statistic	Estimate
F	12.878
p	< 0.001
Adjusted R ²	0.4650
AIC	227.799

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.10
Lower bound	0.06	0.04
Upper bound	0.18	0.19
Standard Error	0.034*	0.042*

* $g \geq 0.05$, estimate is uncertain

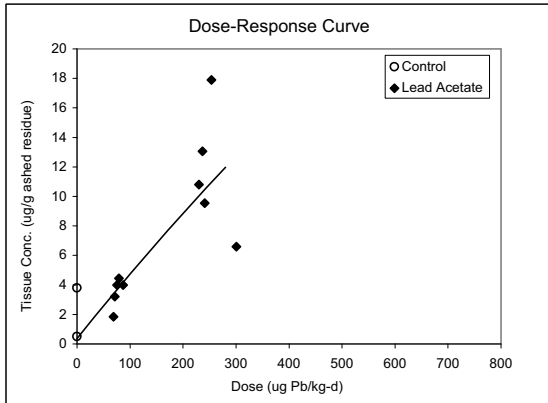
APPENDIX E

Figure 4b - All Data

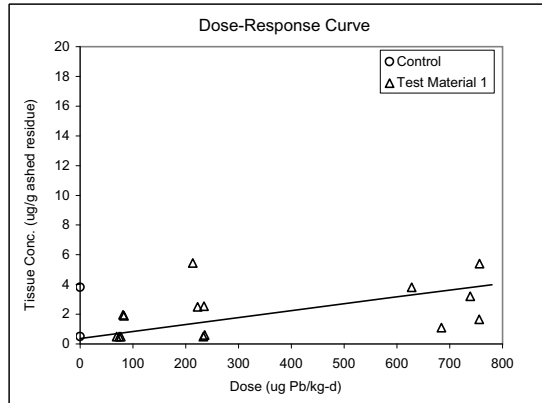
Phase II Experiment 6: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

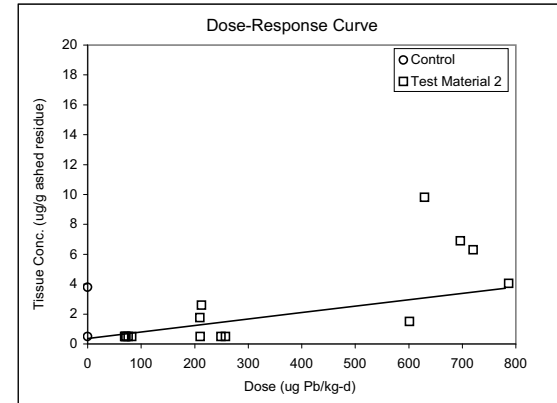
Reference Material (Lead Acetate)



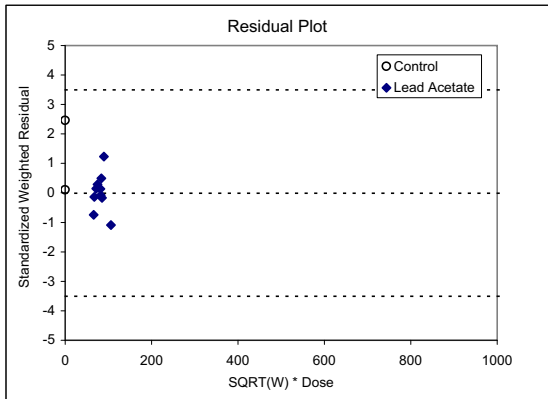
Test Material 1 (Midvale Slag)



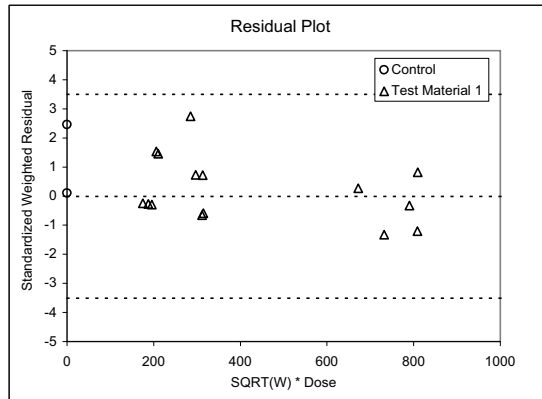
Test Material 2 (Butte Soil)



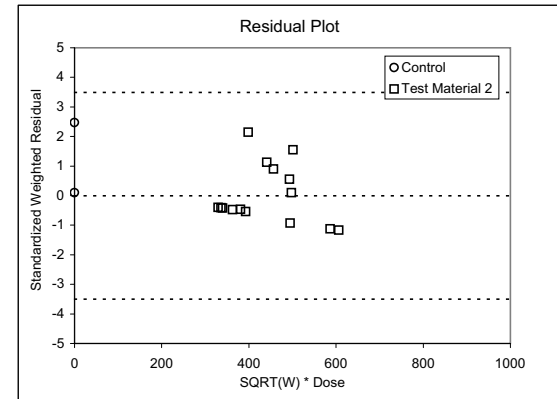
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	3.62E-01	2.38E-01
b	7.38E+01	5.10E+02
c1	6.11E-04	4.43E-03
c2	6.46E-05	4.55E-04
c3	5.98E-05	4.20E-04
Covariance (c1,c2)	0.9990	--
Covariance (c1,c3)	0.9982	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	9.415
p	< 0.001
Adjusted R ²	0.4508
AIC	229.705

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.10
Lower bound	?	?
Upper bound	?	?
Standard Error	0.041*	0.048*

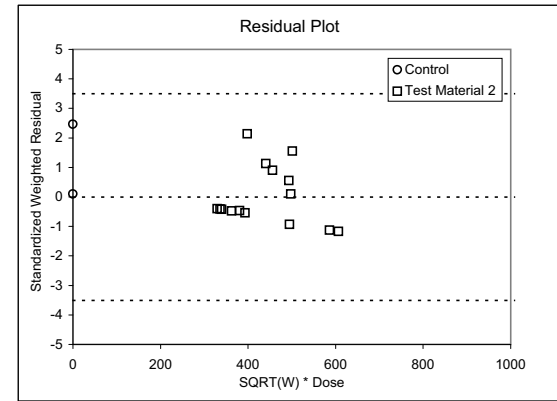
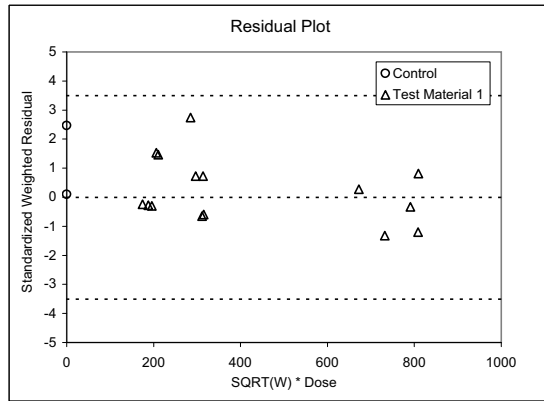
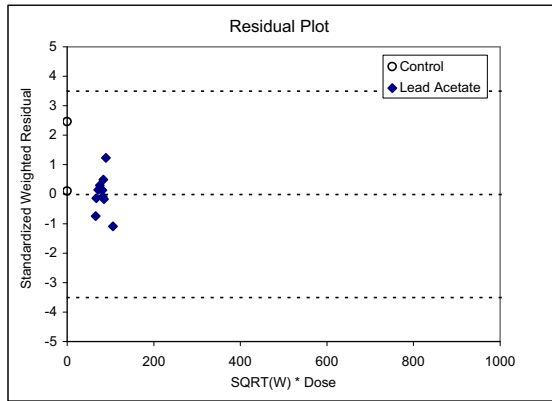
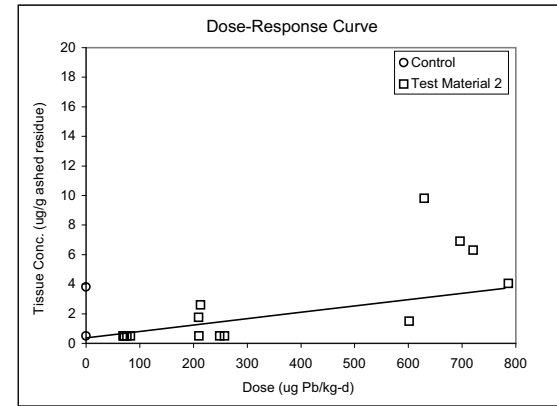
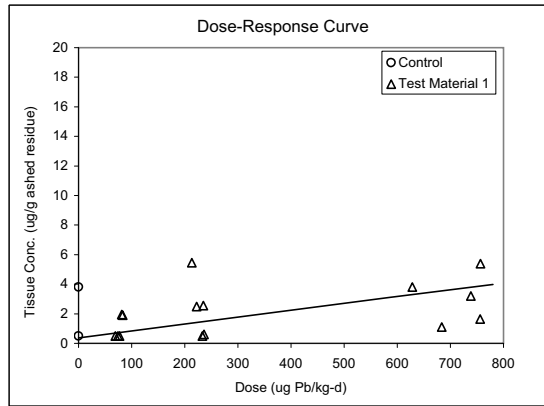
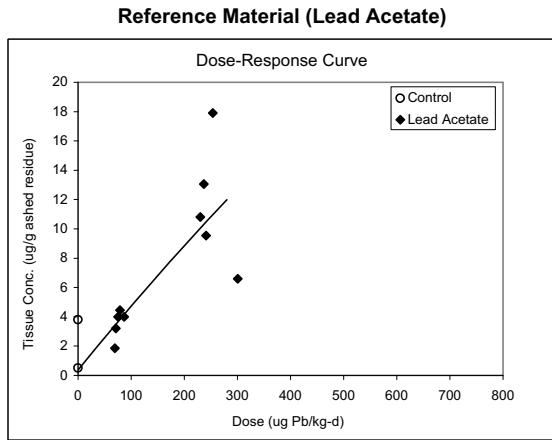
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4c - All Data

Phase II Experiment 6: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	3.62E-01	2.39E-01
b	1.52E+02	1.13E+03
c1	3.37E+03	2.65E+04
c2	3.18E+04	2.43E+05
c3	3.44E+04	2.62E+05
Covariance (c1,c2)	0.9991	--
Covariance (c1,c3)	0.9985	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	9.414
p	< 0.001
Adjusted R ²	0.4508
AIC	229.711

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.10
Lower bound	?	?
Upper bound	?	?
Standard Error	0.042*	0.047*

* g ≥ 0.05, estimate is uncertain

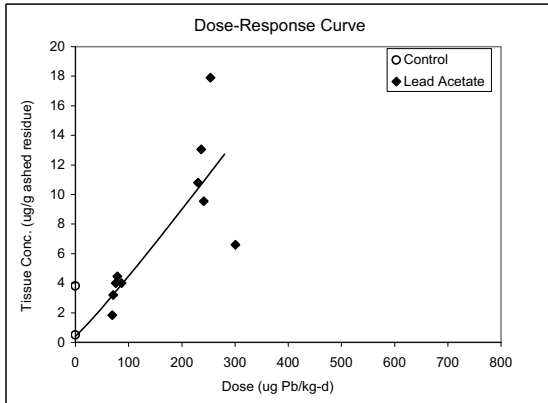
APPENDIX E

Figure 4d - All Data

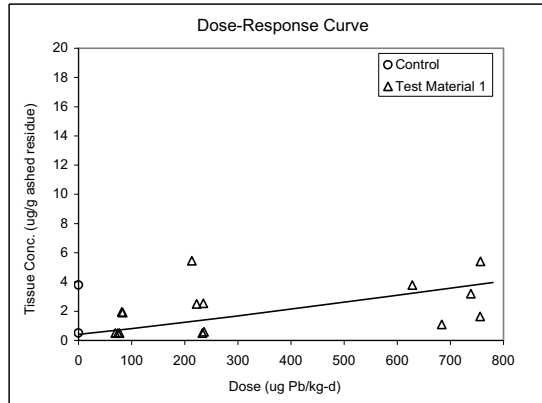
Phase II Experiment 6: Femur

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

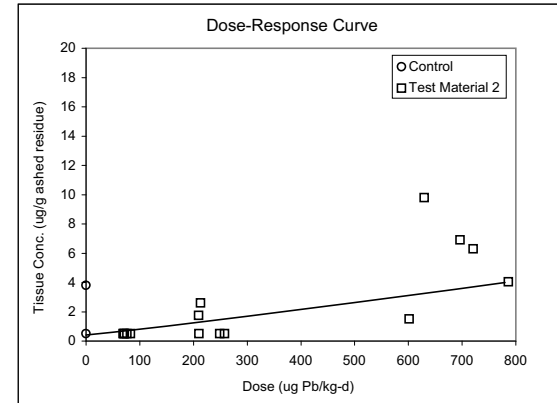
Reference Material (Lead Acetate)



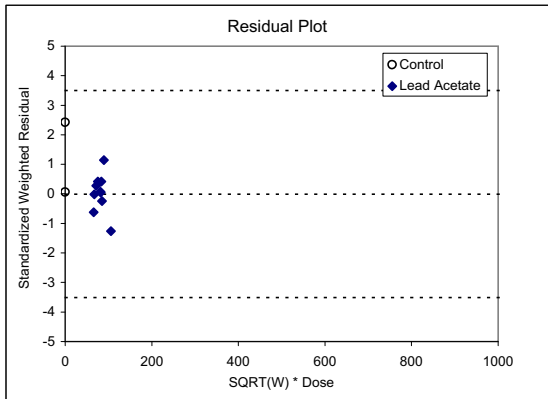
Test Material 1 (Midvale Slag)



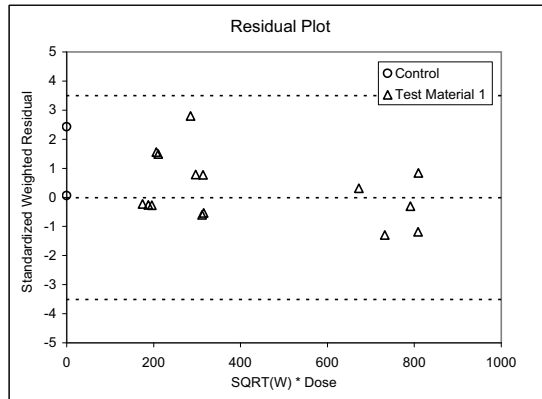
Test Material 2 (Butte Soil)



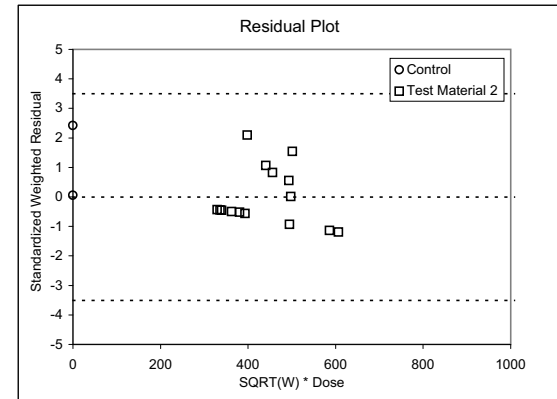
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	4.18E-01	3.29E-01
b1	2.85E-02	5.08E-02
b2	2.73E-03	6.24E-03
b3	2.75E-03	6.16E-03
c	1.08E+00	3.36E-01
Covariance (b1,b2)	0.9875	--
Covariance (b1,b3)	0.9814	--
Degrees of Freedom	37	--

Goodness of Fit

Statistic	Estimate
F	9.426
p	< 0.001
Adjusted R ²	0.4512
AIC	229.612

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.11	0.11
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

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APPENDIX E

EXPERIMENT 7

Test Material 1: California Gulch Phase I Residential Soil

Test Material 2: California Gulch Fe/Mn PbO

- Figure 1a Blood AUC - Linear Model (All Data)
- Figure 1a Blood AUC - Linear Model (Outlier Excluded)
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model (All Data)
- Figure 3a Kidney - Linear Model (Outlier Excluded)
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

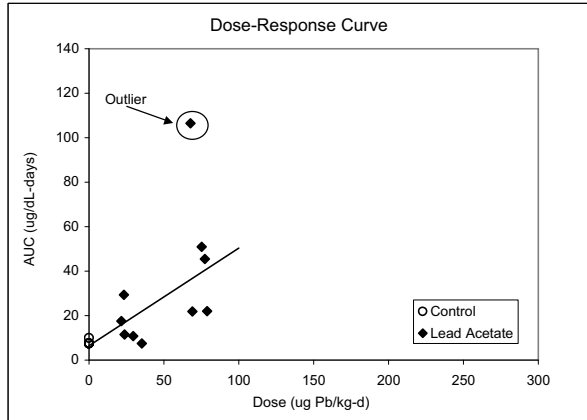
APPENDIX E

Figure 1a - All Data

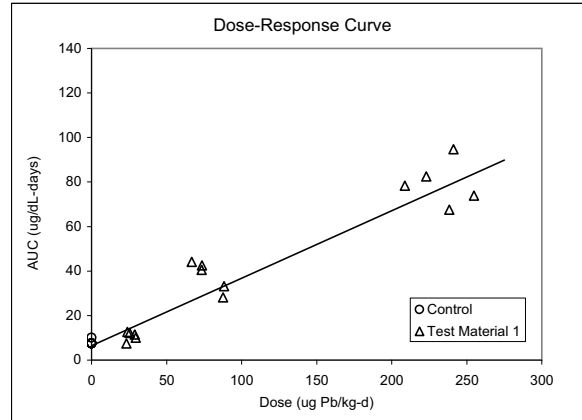
Phase II Experiment 7: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

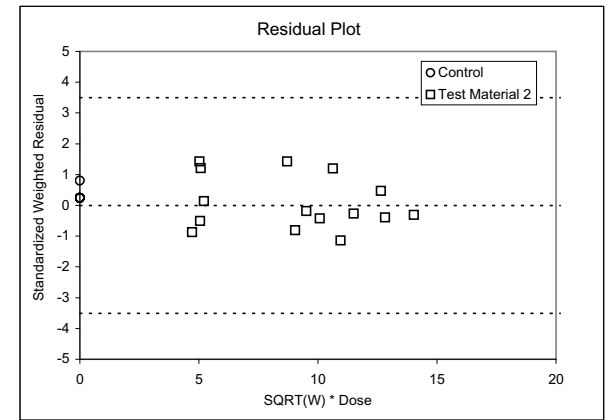
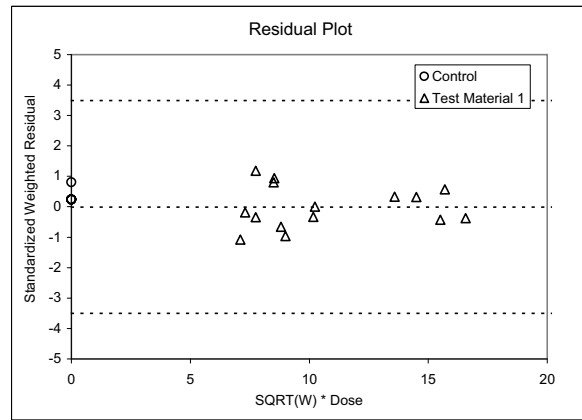
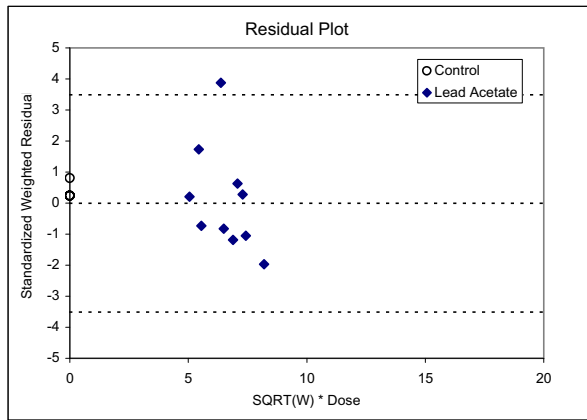
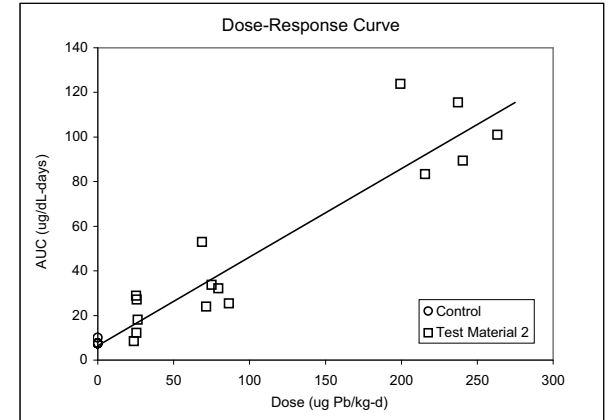
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.46E+00	1.59E+00
b1	4.39E-01	9.25E-02
b2	3.03E-01	4.49E-02
b3	3.97E-01	5.09E-02
Covariance (c1,c2)	0.1719	--
Covariance (c1,c3)	0.1351	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	33.889
p	< 0.001
Adjusted R ²	0.6916
AIC	394.354

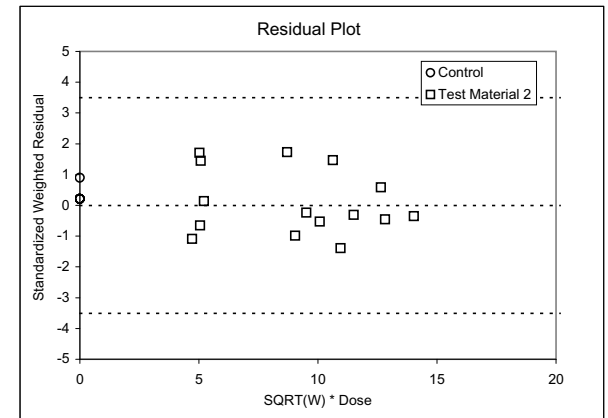
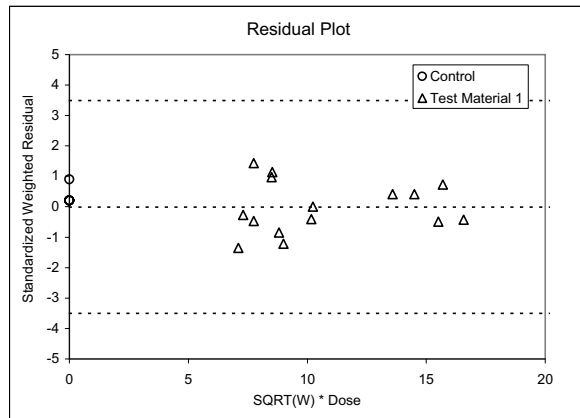
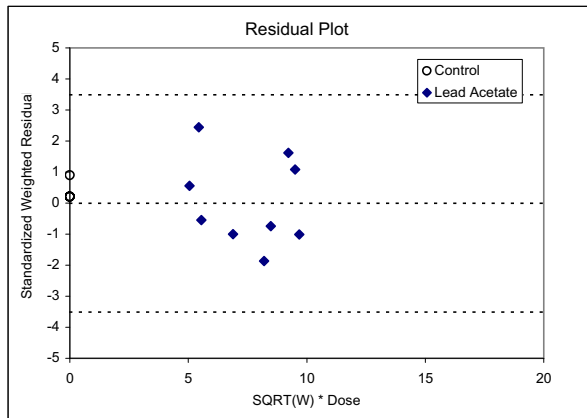
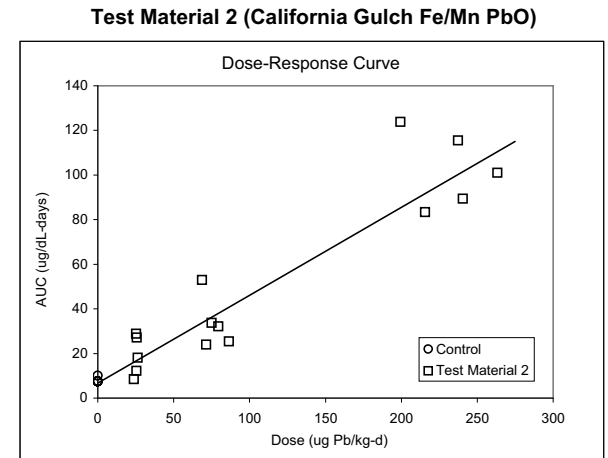
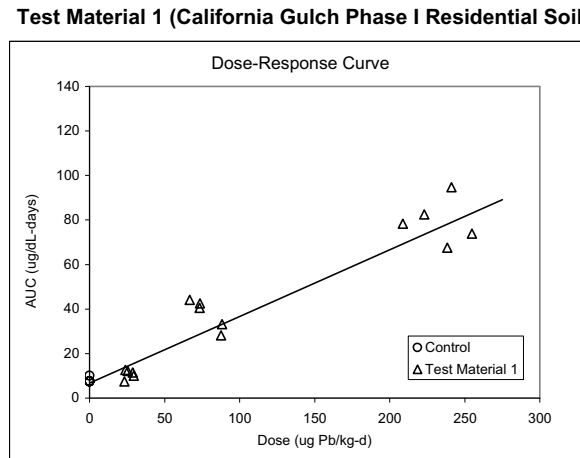
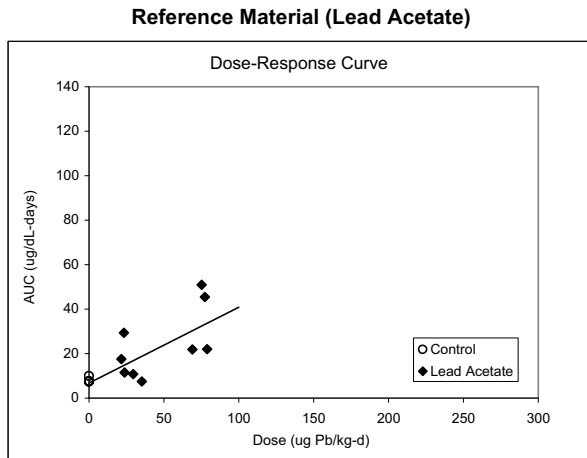
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.69	0.90
Lower bound	0.47	0.63
Upper bound	1.08	1.42
Standard Error	0.163*	0.209*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1a - Outlier Excluded
Phase II Experiment 7: Blood AUC
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.74E+00	1.30E+00
b1	3.40E-01	6.88E-02
b2	3.00E-01	3.69E-02
b3	3.94E-01	4.18E-02
Covariance (c1,c2)	0.1724	--
Covariance (c1,c3)	0.1355	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	47.669
p	< 0.001
Adjusted R ²	0.7650
AIC	341.729

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.88	1.16
Lower bound	0.62	0.83
Upper bound	1.34	1.76
Standard Error	0.192*	0.249*

* $g \geq 0.05$, estimate is uncertain

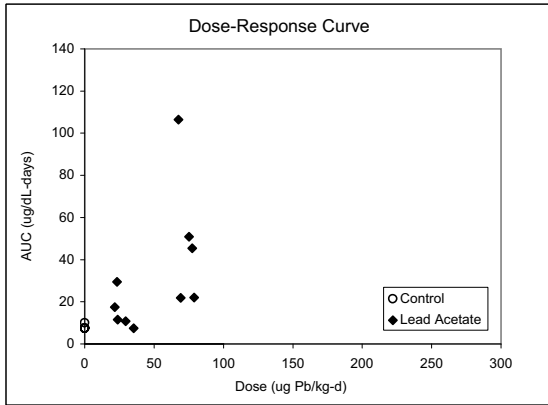
APPENDIX E

Figure 1b - All Data

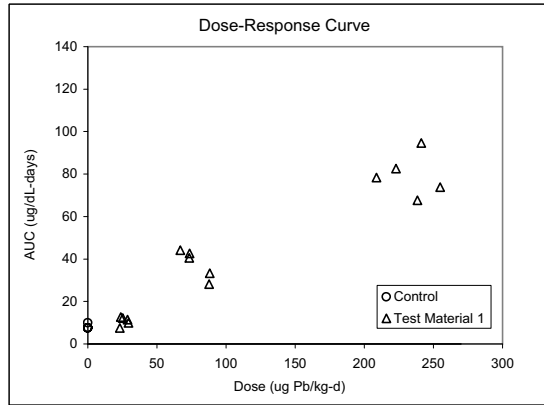
Phase II Experiment 7: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

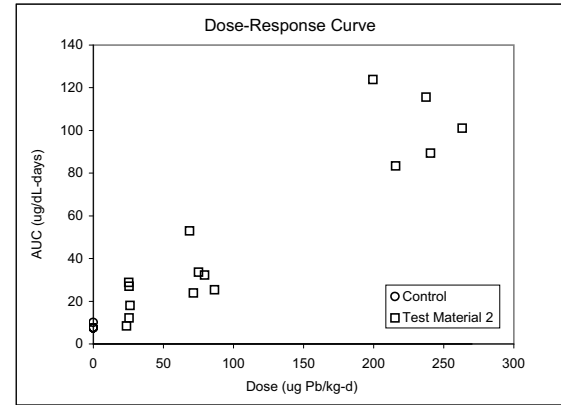
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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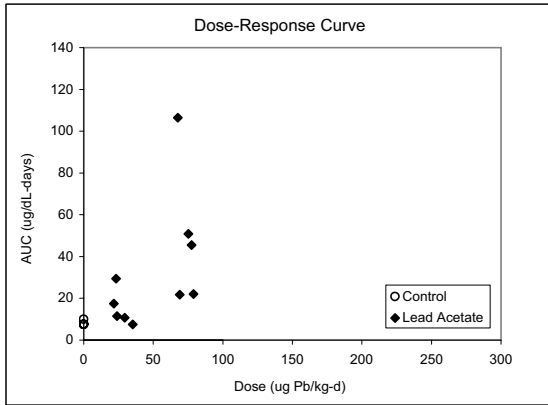
APPENDIX E

Figure 1c - All Data

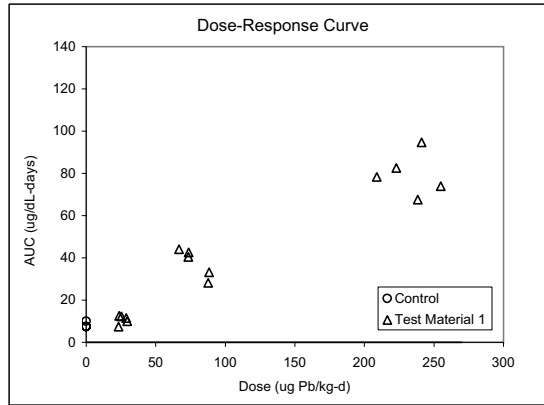
Phase II Experiment 7: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

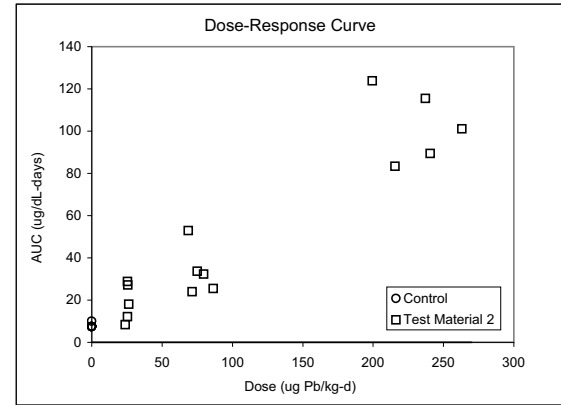
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



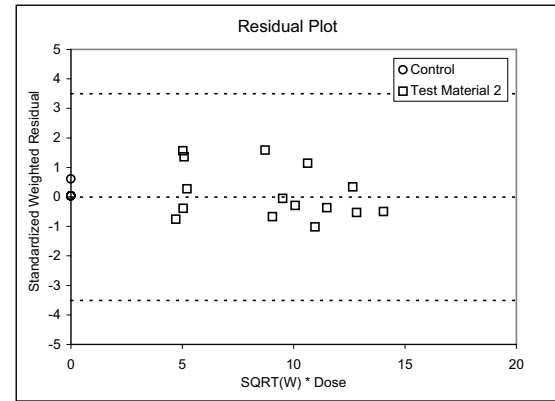
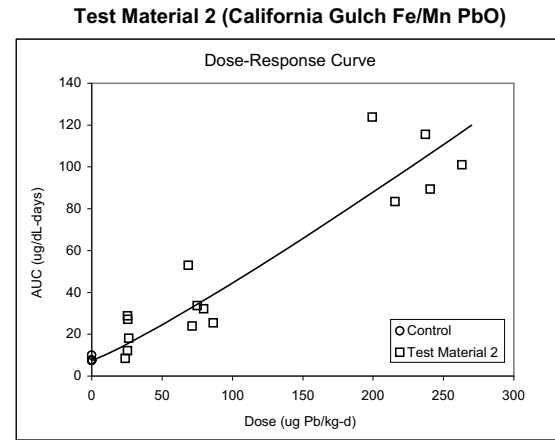
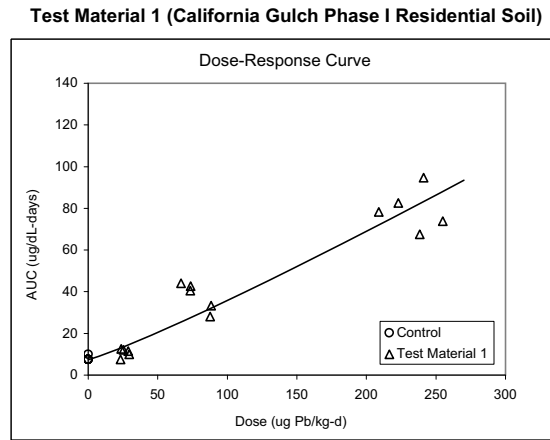
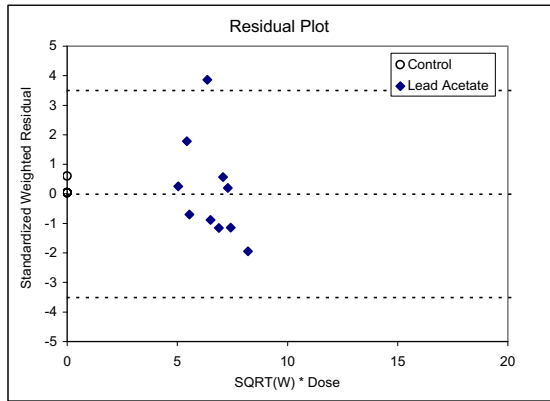
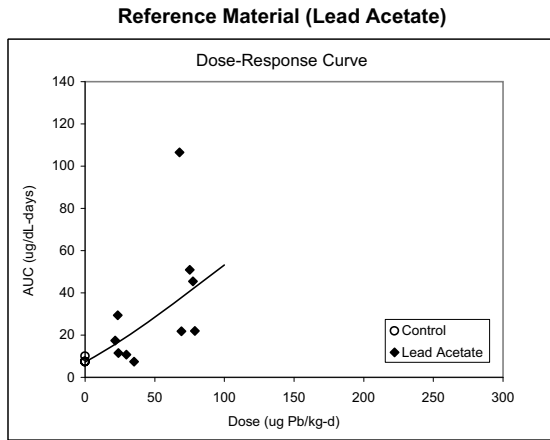
NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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APPENDIX E

Figure 1d - All Data
Phase II Experiment 7: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.34E+00	1.95E+00
b1	2.70E-01	1.92E-01
b2	1.68E-01	1.40E-01
b3	2.19E-01	1.79E-01
c	1.11E+00	1.56E-01
Covariance (b1,b2)	0.9447	--
Covariance (b1,b3)	0.9455	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	25.364
p	< 0.001
Adjusted R ²	0.6890
AIC	394.283

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.65	0.83
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

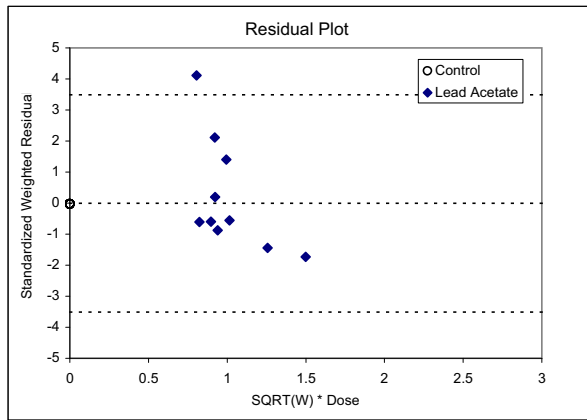
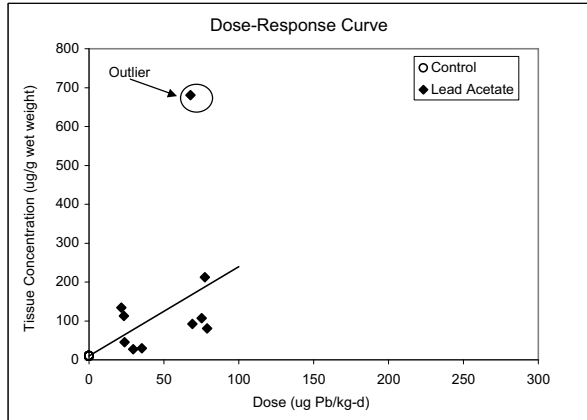
APPENDIX E

Figure 2a - All Data

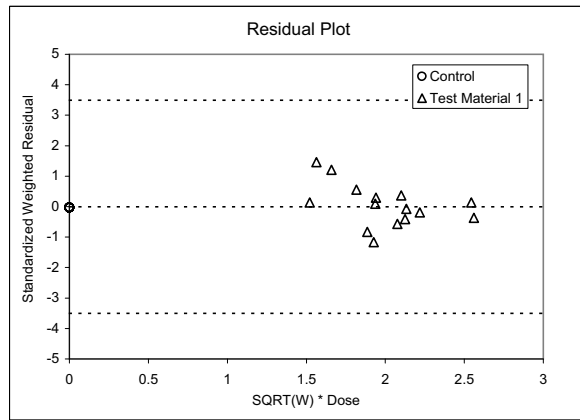
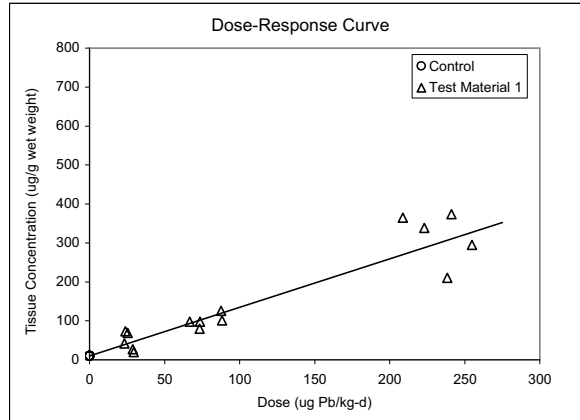
Phase II Experiment 7: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

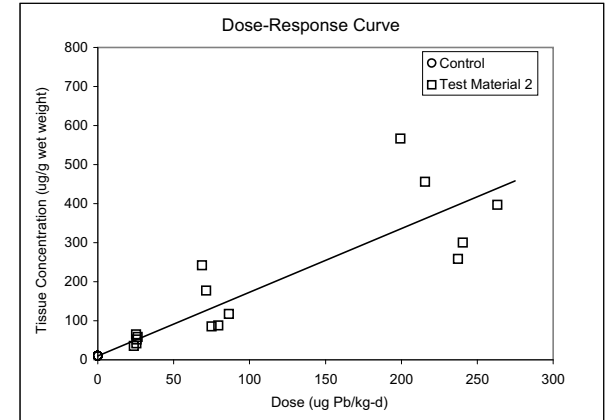
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.02E+01	2.08E+00
b1	2.29E+00	4.81E-01
b2	1.24E+00	2.01E-01
b3	1.63E+00	2.60E-01
Covariance (c1,c2)	0.0199	--
Covariance (c1,c3)	0.0177	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	32.074
p	< 0.001
Adjusted R ²	0.6794
AIC	503.462

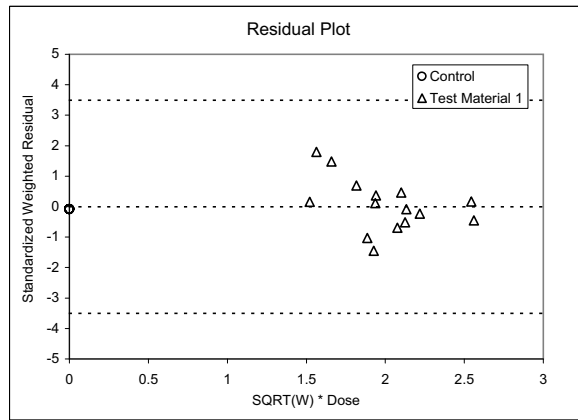
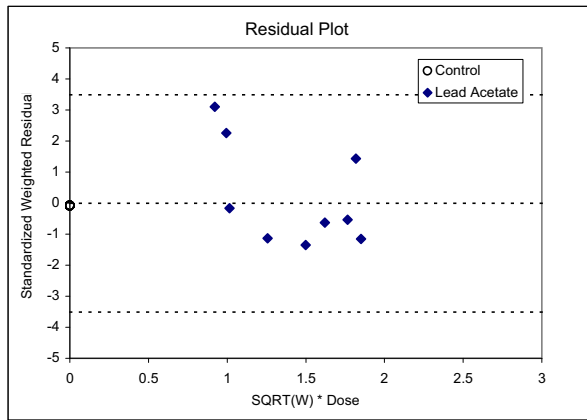
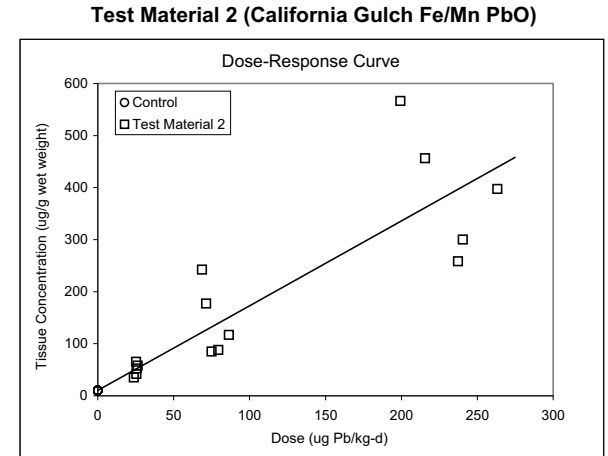
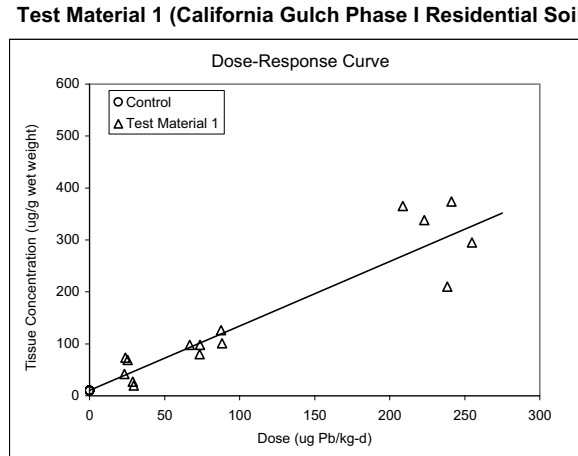
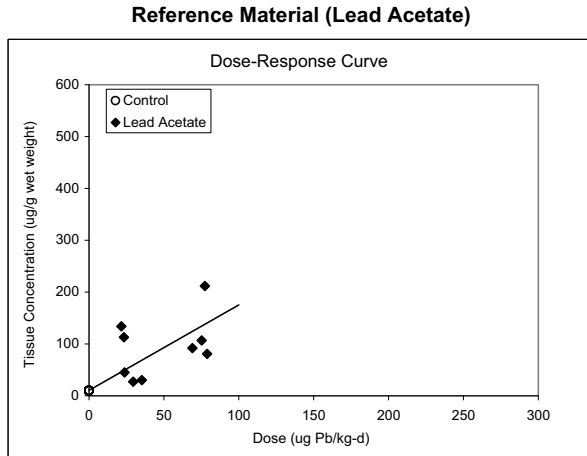
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.54	0.71
Lower bound	0.35	0.46
Upper bound	0.89	1.16
Standard Error	0.142*	0.186*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 7: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.03E+01	1.68E+00
b1	1.65E+00	2.89E-01
b2	1.24E+00	1.62E-01
b3	1.63E+00	2.11E-01
Covariance (c1,c2)	0.0204	--
Covariance (c1,c3)	0.0181	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	48.222
p	< 0.001
Adjusted R ²	0.7671
AIC	451.637

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.75	0.99
Lower bound	0.53	0.69
Upper bound	1.12	1.46
Standard Error	0.163*	0.213*

* $g \geq 0.05$, estimate is uncertain

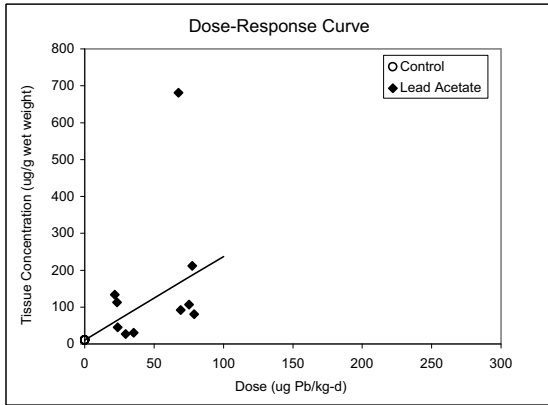
APPENDIX E

Figure 2b - All Data

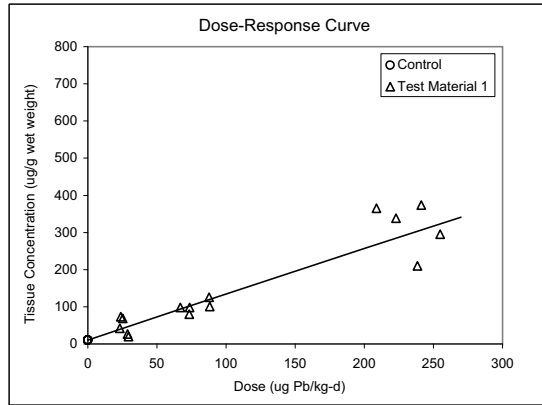
Phase II Experiment 7: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

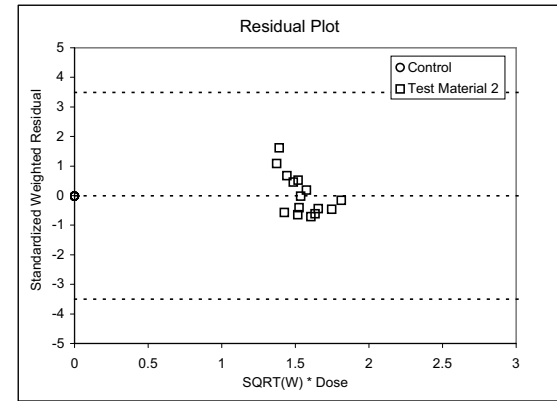
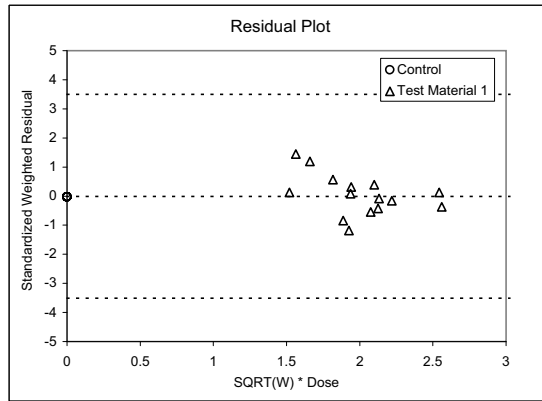
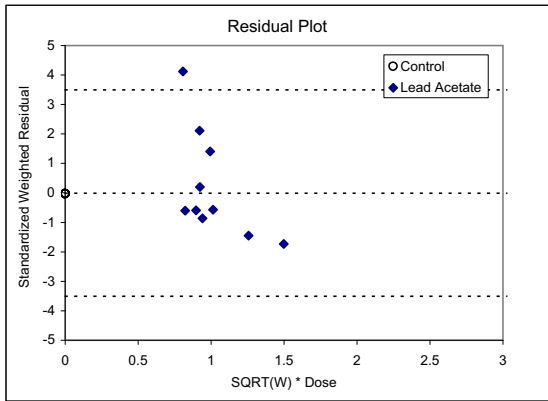
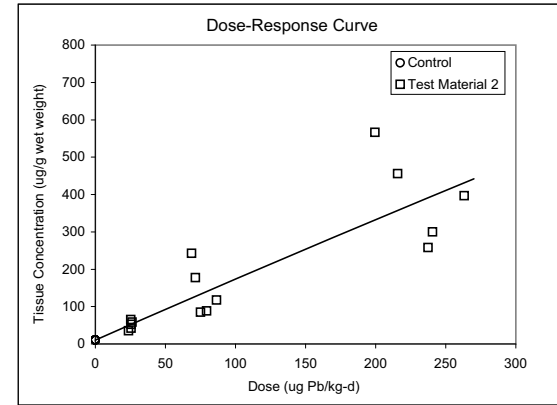
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.01E+01	2.13E+00
b	6.22E+03	6.44E+04
c1	3.71E-04	3.99E-03
c2	2.02E-04	2.18E-03
c3	2.66E-04	2.88E-03
Covariance (c1,c2)	0.9997	--
Covariance (c1,c3)	0.9997	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	23.468
p	< 0.001
Adjusted R ²	0.6713
AIC	505.440

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.54	0.72
Lower bound	?	?
Upper bound	?	?
Standard Error	0.145*	0.196*

* $g \geq 0.05$, estimate is uncertain

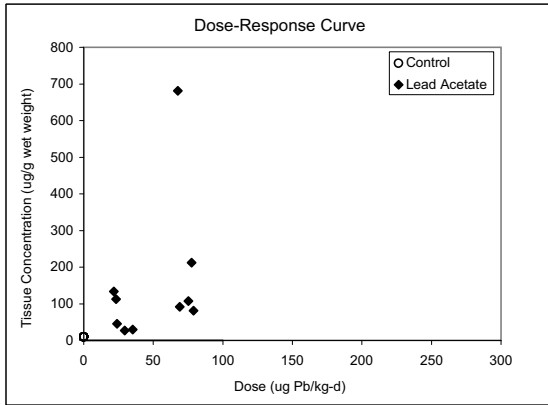
APPENDIX E

Figure 2c - All Data

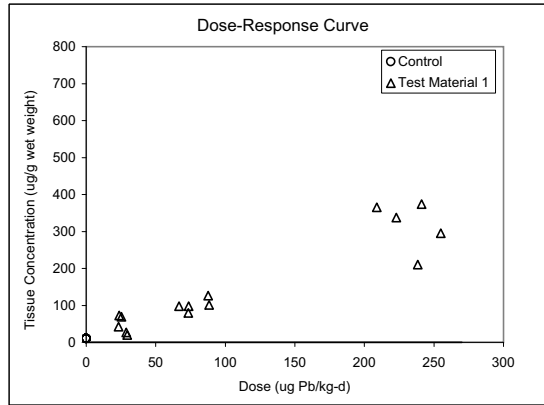
Phase II Experiment 7: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

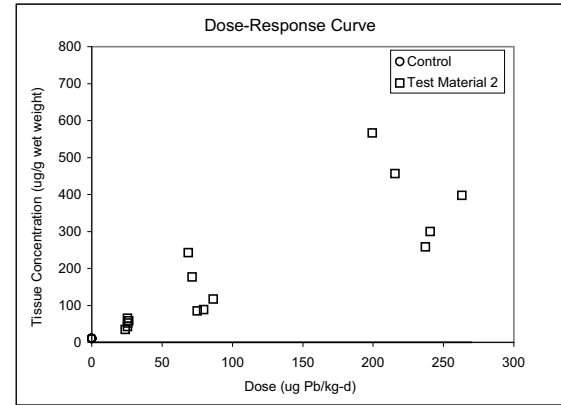
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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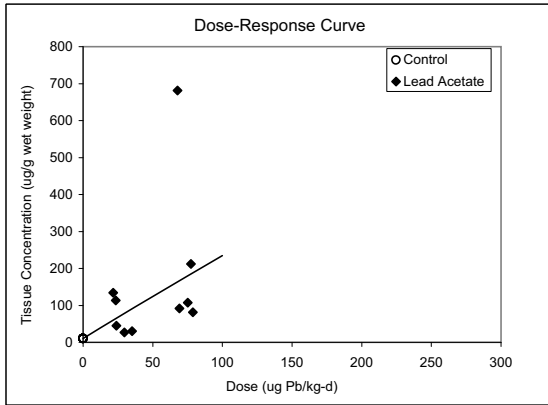
APPENDIX E

Figure 2d - All Data

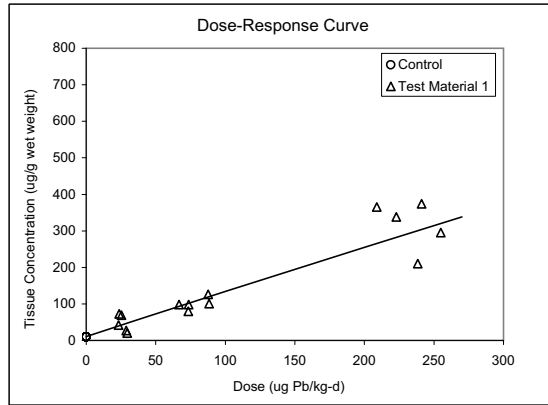
Phase II Experiment 7: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

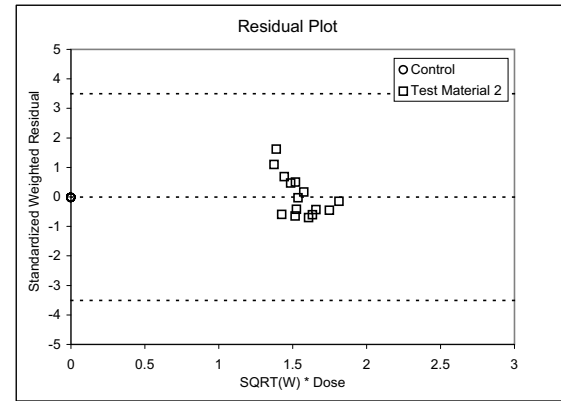
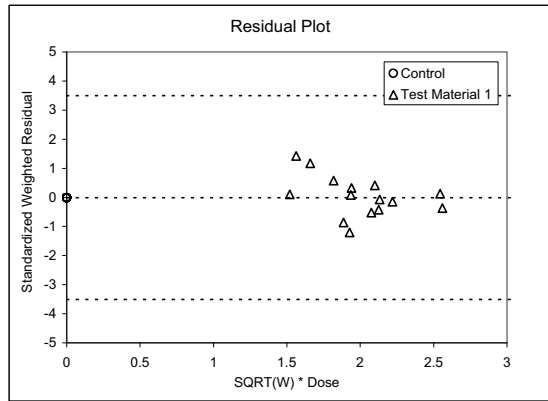
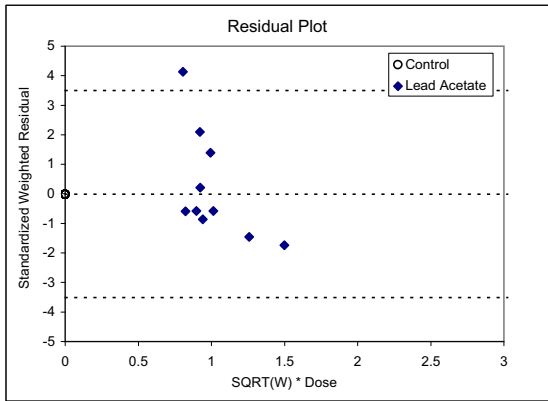
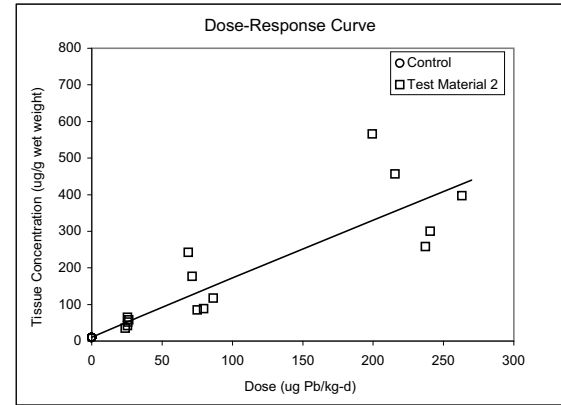
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.01E+01	2.14E+00
b1	2.48E+00	1.28E+00
b2	1.37E+00	8.06E-01
b3	1.79E+00	1.03E+00
c	9.79E-01	1.26E-01
Covariance (b1,b2)	0.8779	--
Covariance (b1,b3)	0.8769	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	23.491
p	< 0.001
Adjusted R ²	0.6716
AIC	505.398

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.54	0.72
Lower bound	0.01	0.08
Upper bound	1.08	1.46
Standard Error	--	--

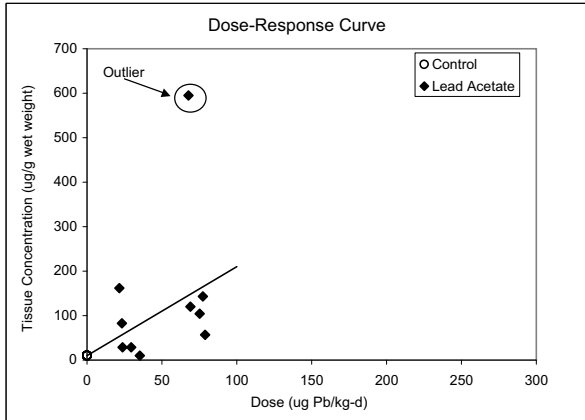
APPENDIX E

Figure 3a - All Data

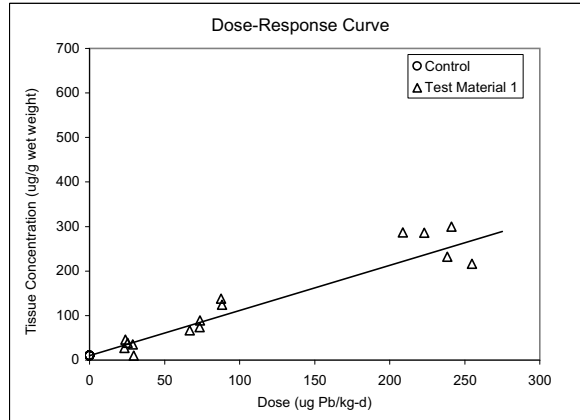
Phase II Experiment 7: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

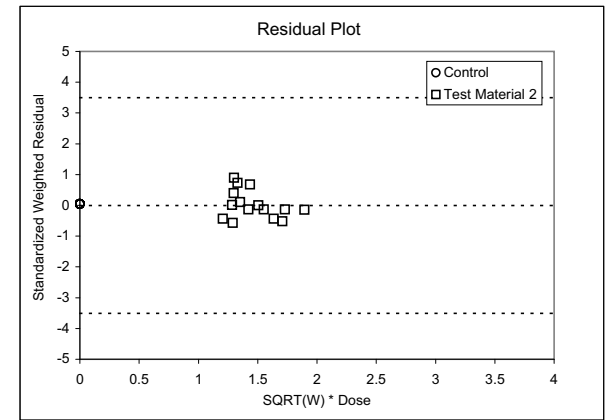
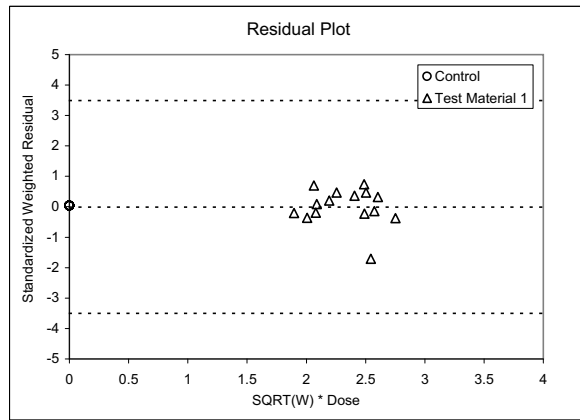
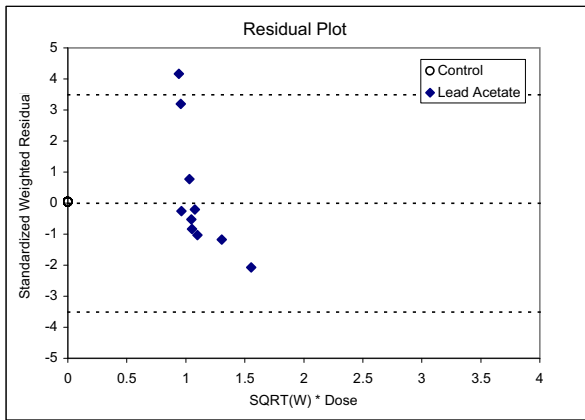
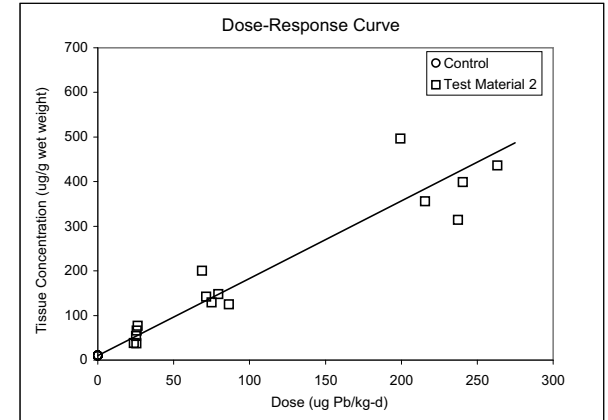
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.78E+00	2.53E+00
b1	2.01E+00	4.46E-01
b2	1.02E+00	1.77E-01
b3	1.73E+00	2.75E-01
Covariance (c1,c2)	0.0375	--
Covariance (c1,c3)	0.0222	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	29.081
p	< 0.001
Adjusted R ²	0.6569
AIC	501.595

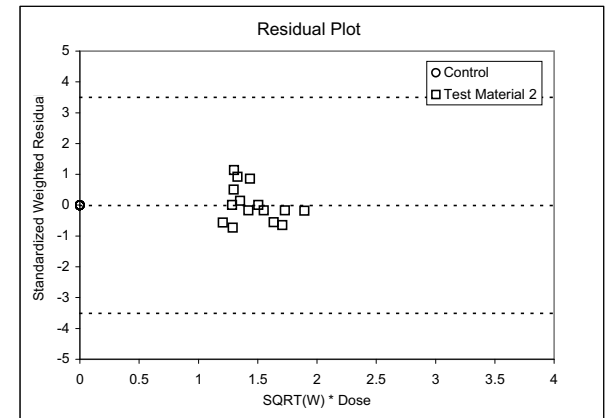
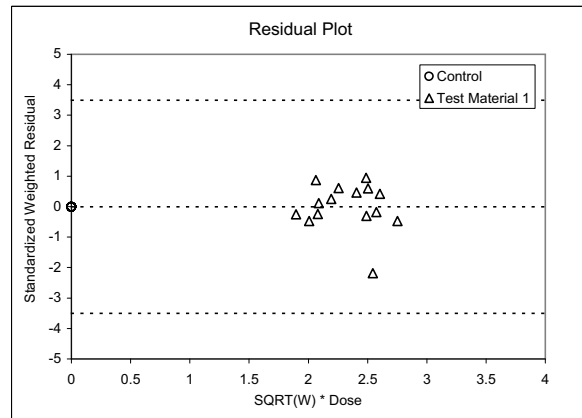
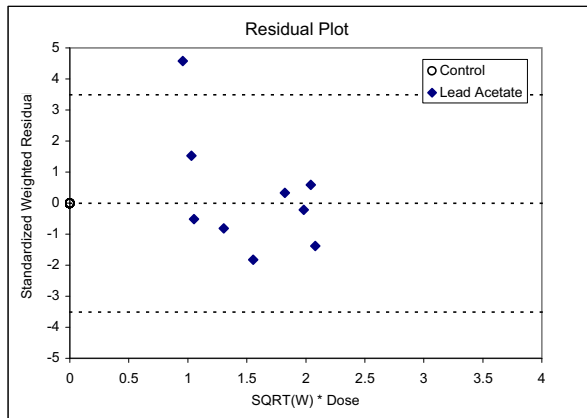
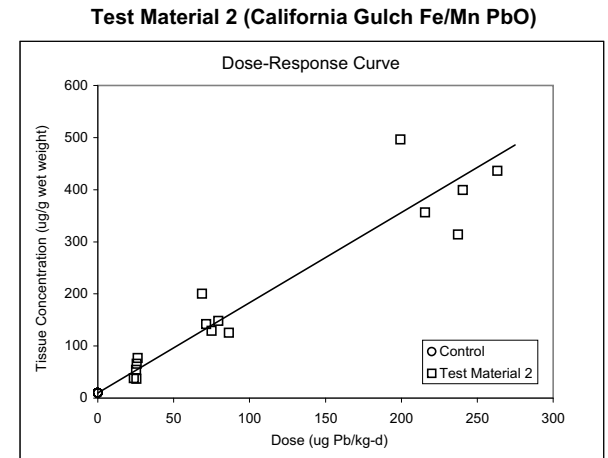
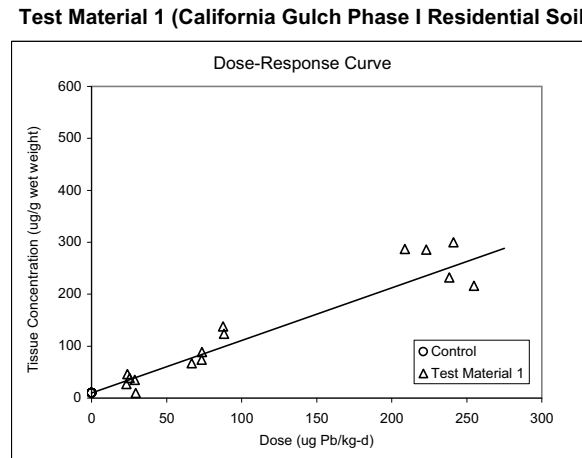
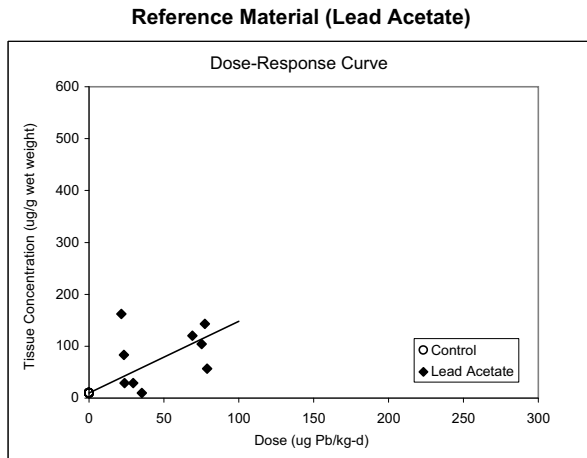
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.51	0.86
Lower bound	0.32	0.56
Upper bound	0.85	1.45
Standard Error	0.141*	0.234*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3a - Outlier Excluded
Phase II Experiment 7: Kidney
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.00E+01	1.99E+00
b1	1.38E+00	2.59E-01
b2	1.01E+00	1.39E-01
b3	1.73E+00	2.16E-01
Covariance (c1,c2)	0.0390	--
Covariance (c1,c3)	0.0230	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	45.535
p	< 0.001
Adjusted R ²	0.7565
AIC	446.484

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.73	1.25
Lower bound	0.50	0.88
Upper bound	1.12	1.91
Standard Error	0.167*	0.280*

* $g \geq 0.05$, estimate is uncertain

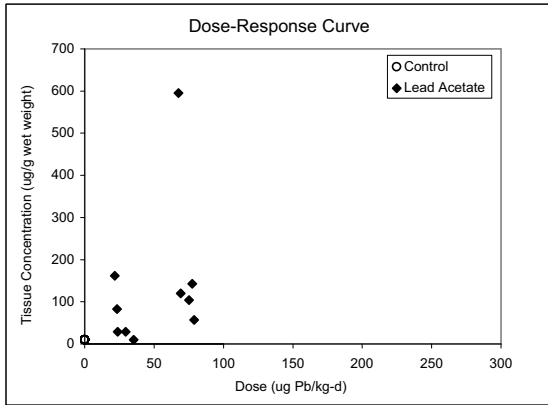
APPENDIX E

Figure 3b - All Data

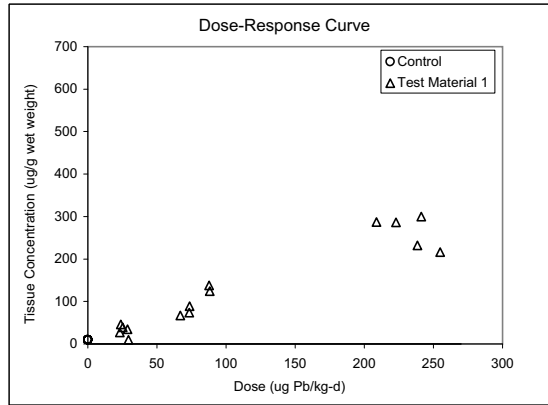
Phase II Experiment 7: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

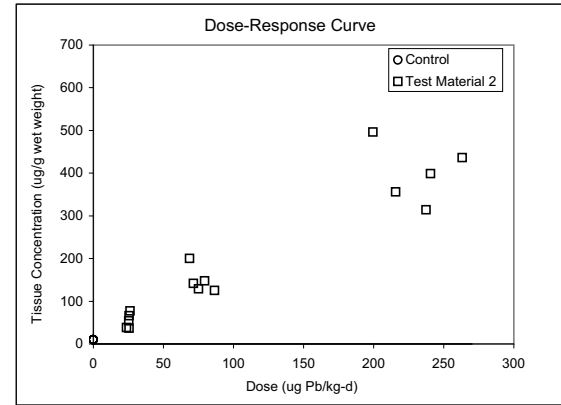
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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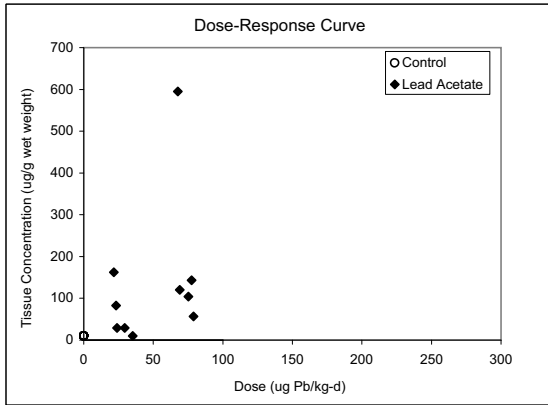
APPENDIX E

Figure 3c - All Data

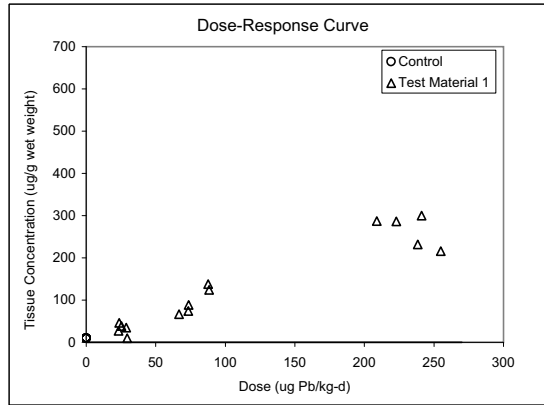
Phase II Experiment 7: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

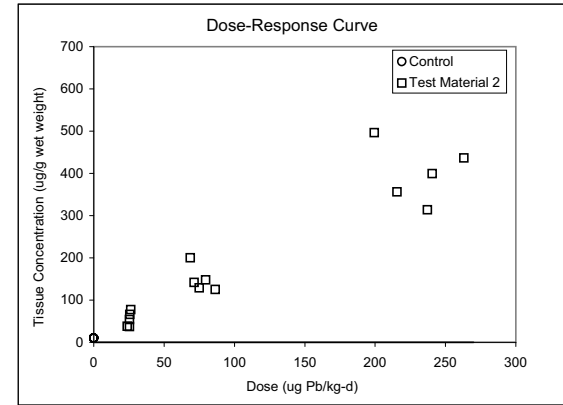
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



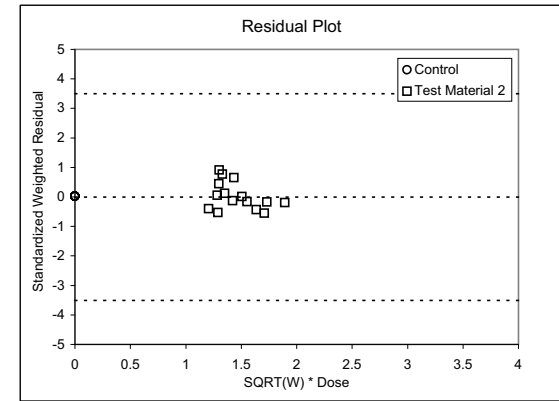
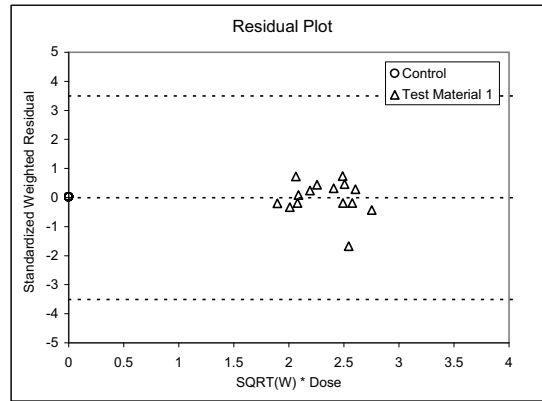
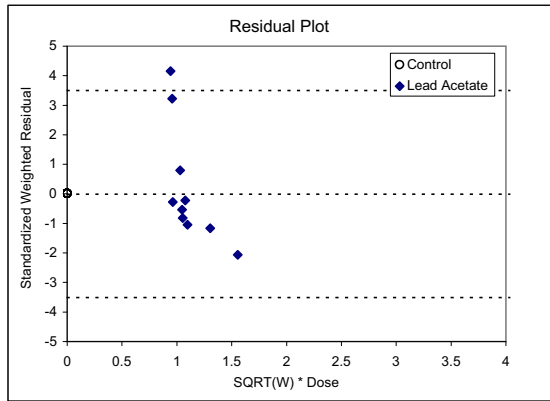
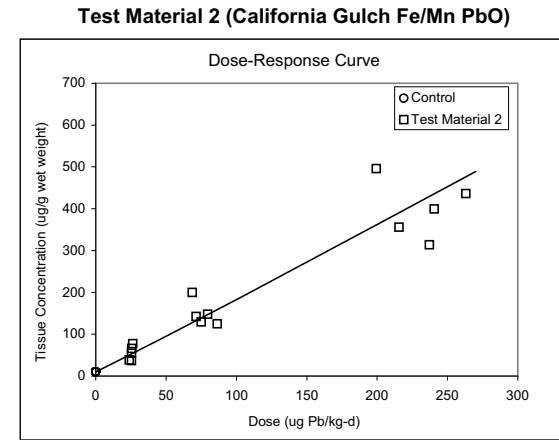
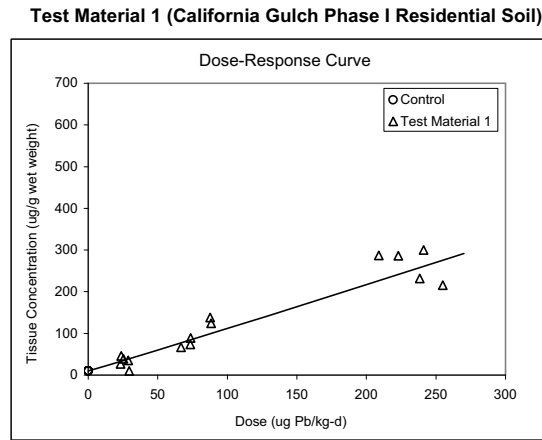
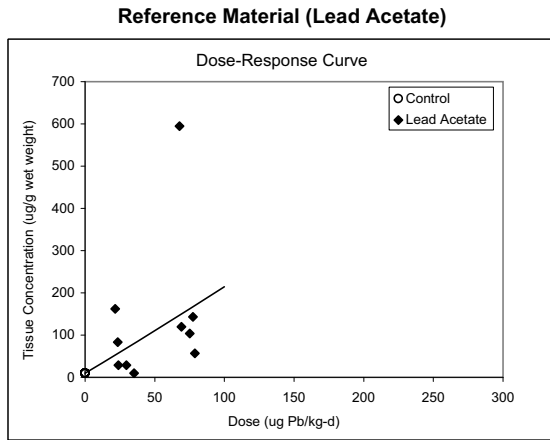
NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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APPENDIX E

Figure 3d - All Data
Phase II Experiment 7: Kidney
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.90E+00	2.64E+00
b1	1.83E+00	9.89E-01
b2	9.14E-01	5.60E-01
b3	1.55E+00	9.55E-01
c	1.02E+00	1.28E-01
Covariance (b1,b2)	0.8746	--
Covariance (b1,b3)	0.8793	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	21.305
p	< 0.001
Adjusted R ²	0.6486
AIC	503.510

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.51	0.85
Lower bound	?	?
Upper bound	1.12	1.83
Standard Error	--	--

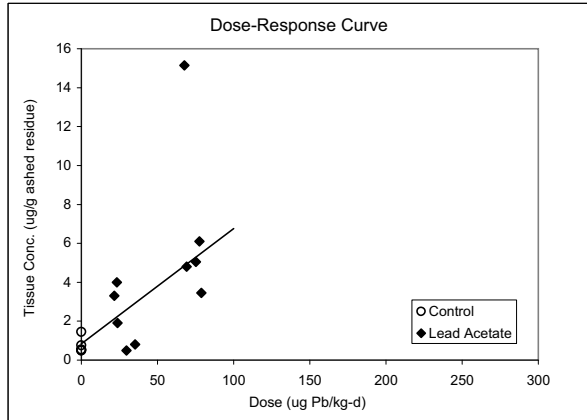
APPENDIX E

Figure 4a - All Data

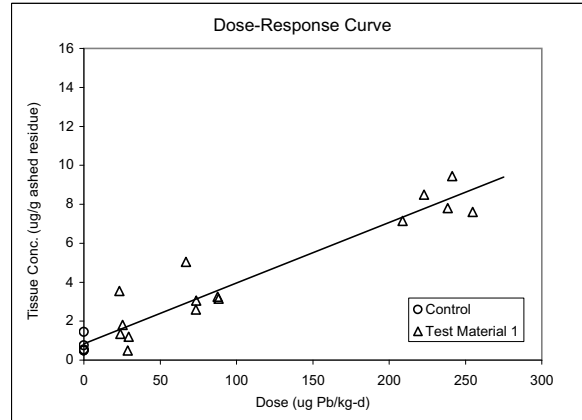
Phase II Experiment 7: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

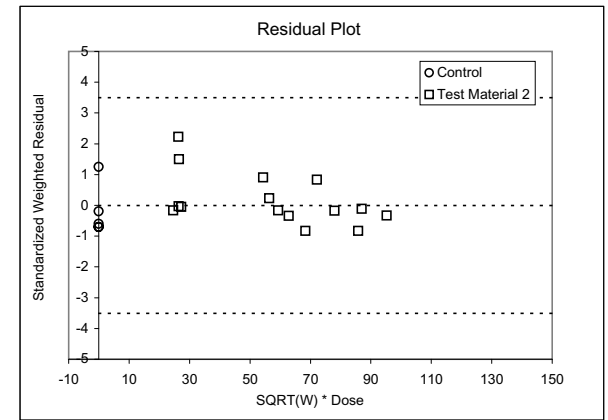
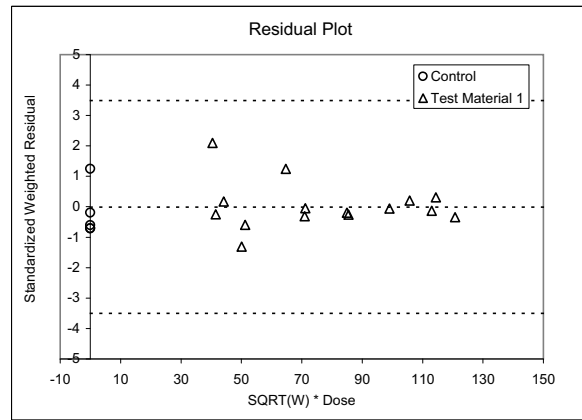
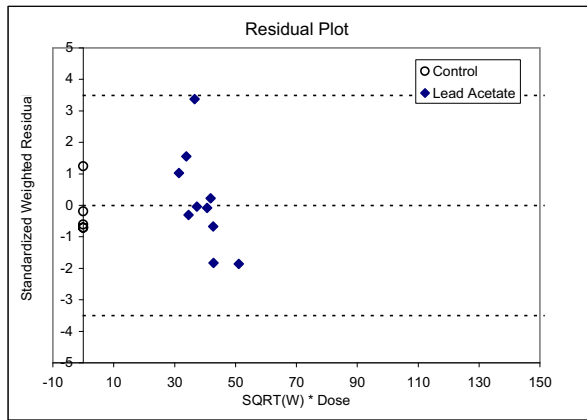
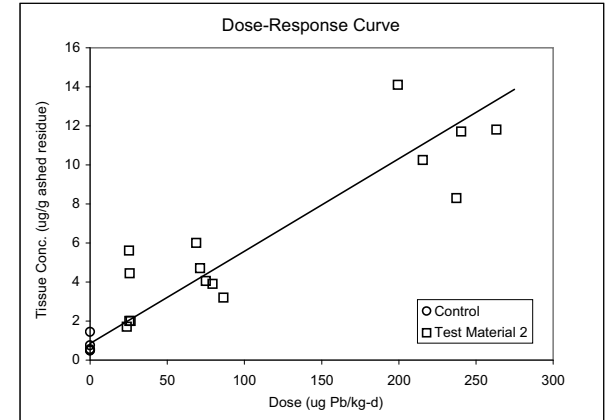
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.45E-01	1.98E-01
b1	5.91E-02	1.46E-02
b2	3.11E-02	5.78E-03
b3	4.73E-02	7.42E-03
Covariance (c1,c2)	0.1175	--
Covariance (c1,c3)	0.0828	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	24.456
p	< 0.001
Adjusted R ²	0.6153
AIC	216.348

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.53	0.80
Lower bound	0.33	0.51
Upper bound	0.93	1.40
Standard Error	0.153*	0.225*

* $g \geq 0.05$, estimate is uncertain

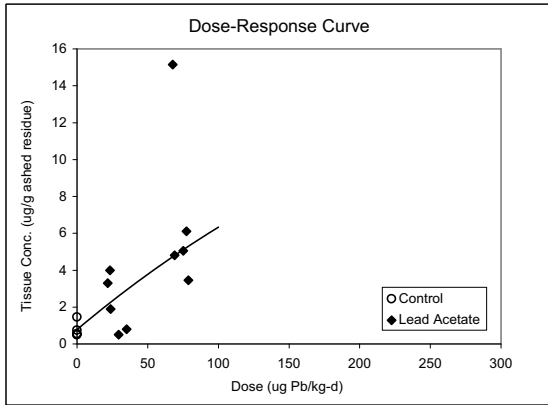
APPENDIX E

Figure 4b - All Data

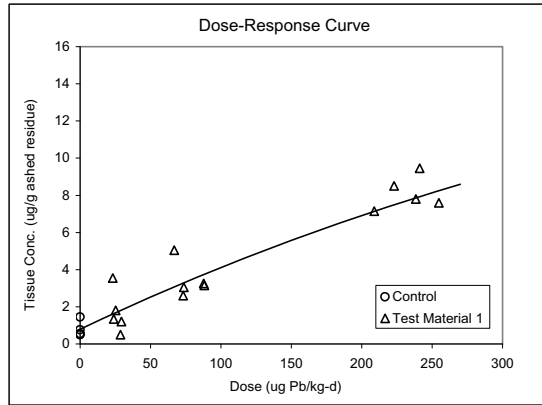
Phase II Experiment 7: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

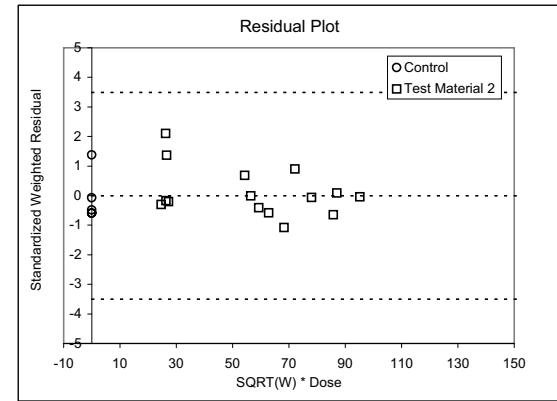
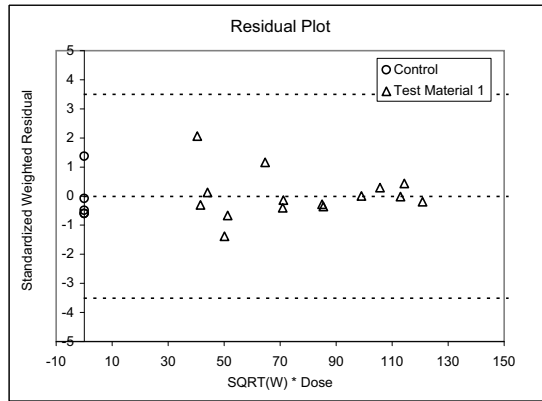
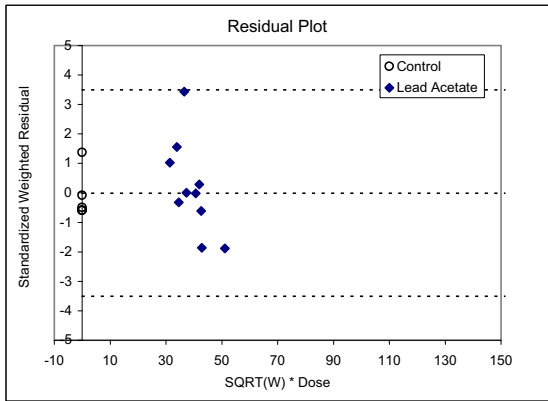
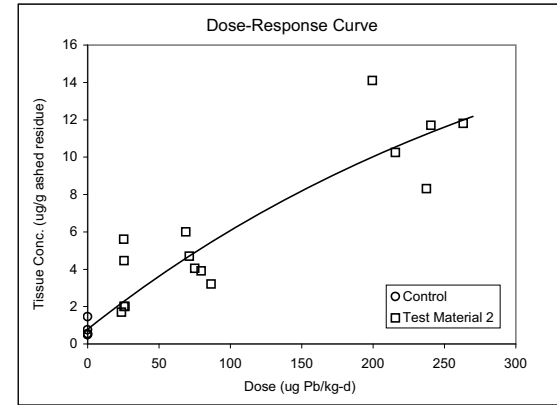
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.87E-01	2.14E-01
b	2.09E+01	2.14E+01
c1	3.08E-03	3.58E-03
c2	1.73E-03	2.09E-03
c3	2.91E-03	3.75E-03
Covariance (c1,c2)	0.9636	--
Covariance (c1,c3)	0.9659	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	18.305
p	< 0.001
Adjusted R ²	0.6114
AIC	216.591

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.56	0.95
Lower bound	?	?
Upper bound	?	?
Standard Error	0.181*	0.324*

* g ≥ 0.05, estimate is uncertain

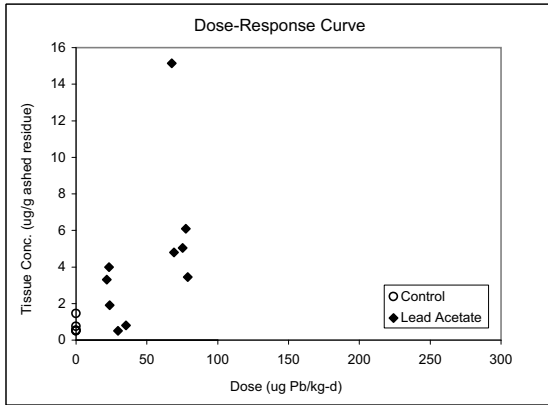
APPENDIX E

Figure 4c - All Data

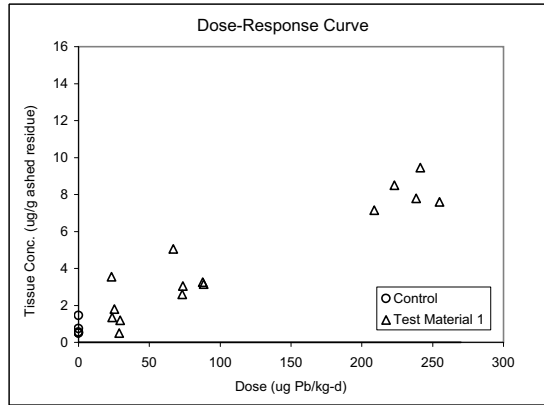
Phase II Experiment 7: Femur

Michaelis-Menton Model: $y = a + b \cdot x1 / (c1 + x1) + b \cdot x2 / (c2 + x2) + b \cdot x3 / (c3 + x3)$

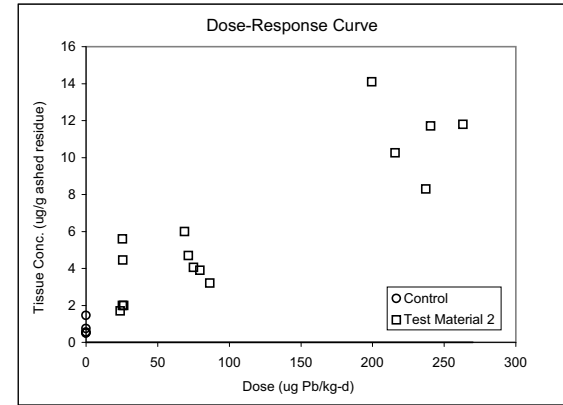
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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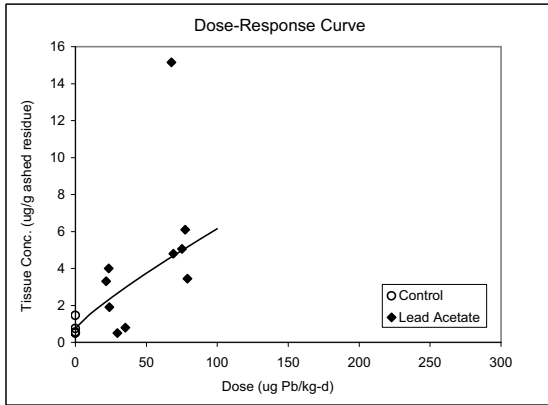
APPENDIX E

Figure 4d - All Data

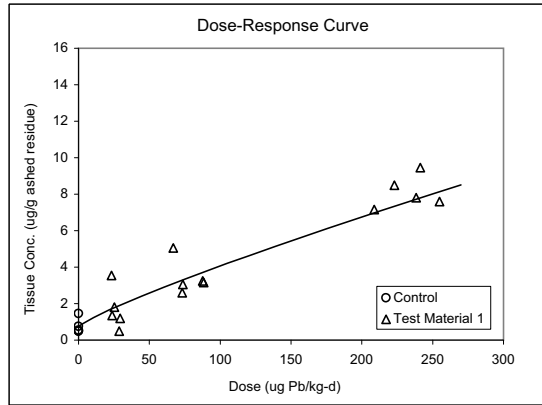
Phase II Experiment 7: Femur

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

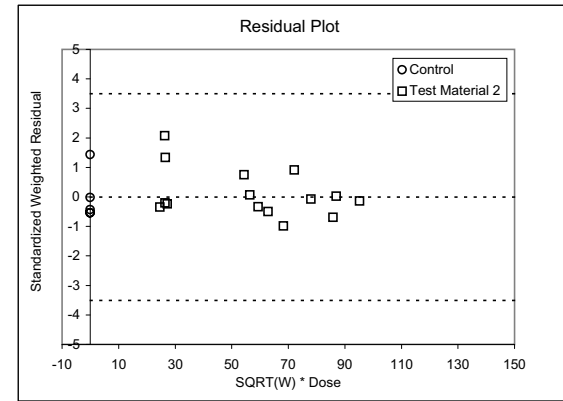
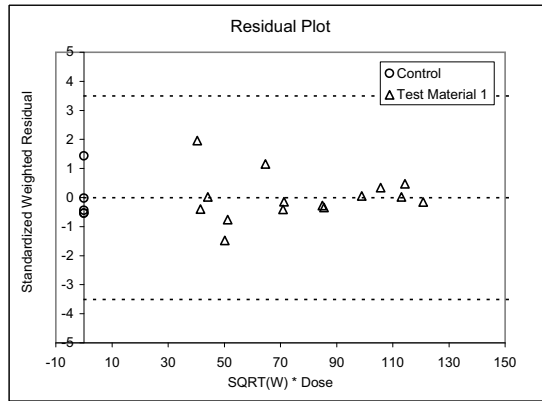
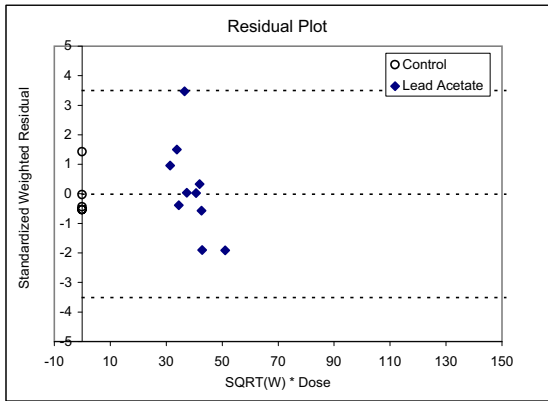
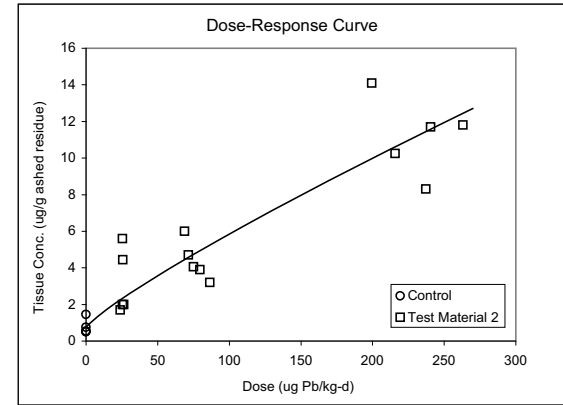
Reference Material (Lead Acetate)



Test Material 1 (California Gulch Phase I Residential Soil)



Test Material 2 (California Gulch Fe/Mn PbO)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.61E-01	2.24E-01
b1	1.03E-01	6.71E-02
b2	6.31E-02	4.86E-02
b3	9.73E-02	7.39E-02
c	8.59E-01	1.51E-01
Covariance (b1,b2)	0.9128	--
Covariance (b1,b3)	0.9157	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	18.357
p	< 0.001
Adjusted R ²	0.6121
AIC	216.374

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.56	0.93
Lower bound	?	?
Upper bound	?	?
Standard Error	--	--

APPENDIX E

EXPERIMENT 8

Test Material 1: California Gulch AV Slag
Test Material 2: Lead Acetate - IV (for ABA determination)

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model (All Data)
- Figure 2a Liver - Linear Model (Outlier Excluded)
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model (All Data)
- Figure 3a Kidney - Linear Model (Outlier Excluded)
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

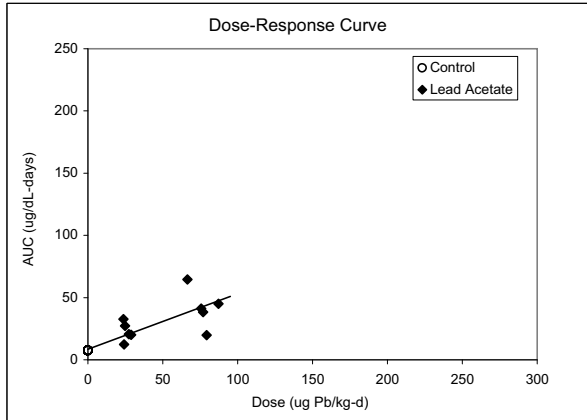
APPENDIX E

Figure 1a - All Data

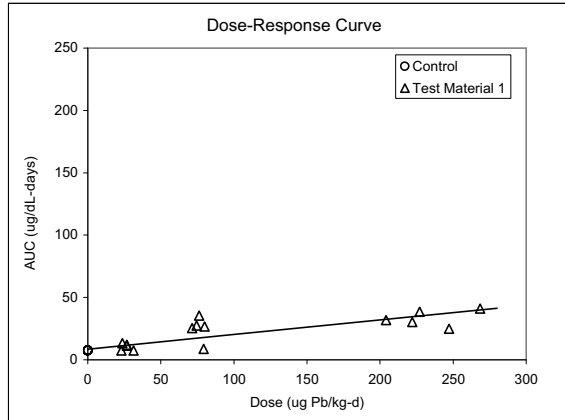
Phase II Experiment 8: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

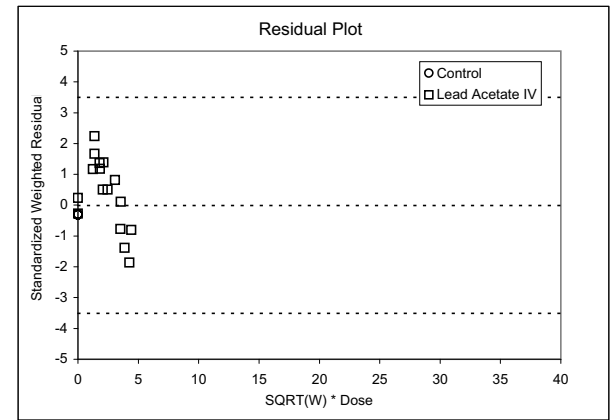
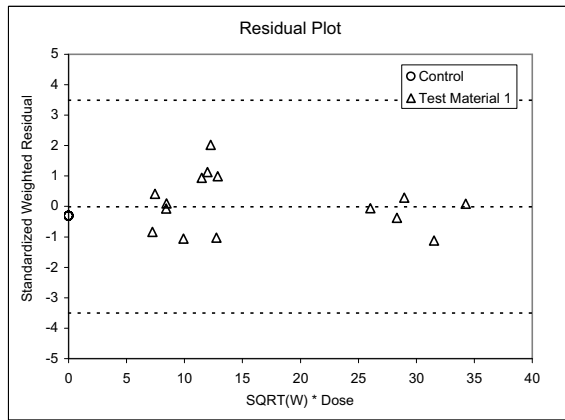
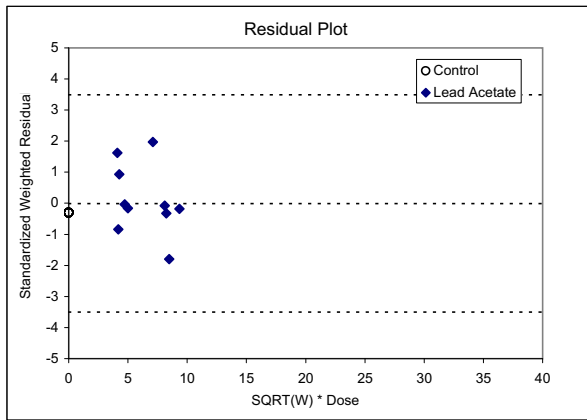
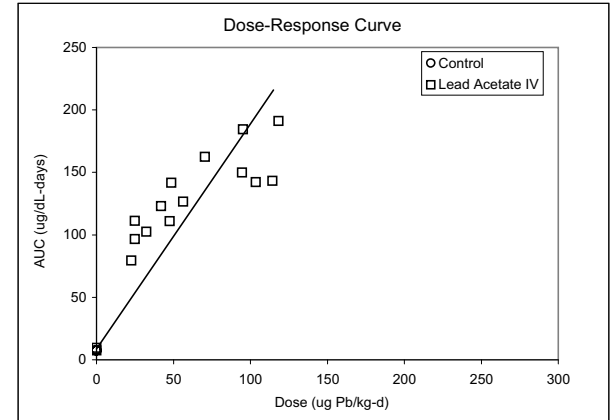
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.59E+00	1.20E+00
b1	4.44E-01	7.45E-02
b2	1.17E-01	2.20E-02
b3	1.80E+00	1.41E-01
Covariance (c1,c2)	0.1238	--
Covariance (c1,c3)	0.0351	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	70.263
p	< 0.001
Adjusted R ²	0.8220
AIC	377.196

RBA and Uncertainty

	Test Material 1
RBA	0.26
Lower bound	0.17
Upper bound	0.39
Standard Error	0.062*

* $g \geq 0.05$, estimate is uncertain

ABA and Uncertainty

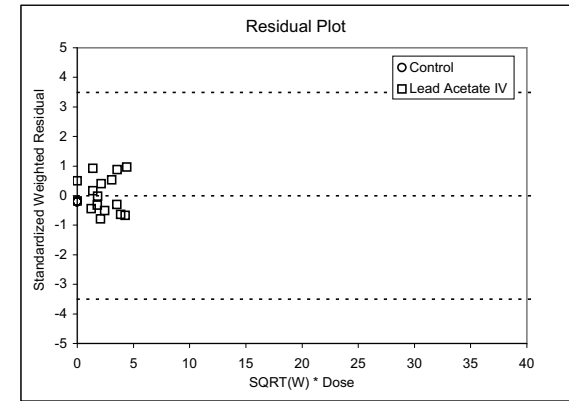
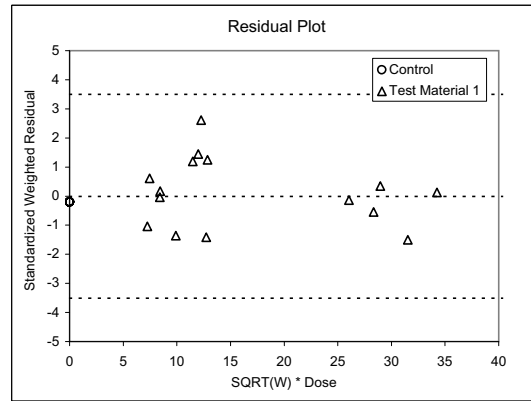
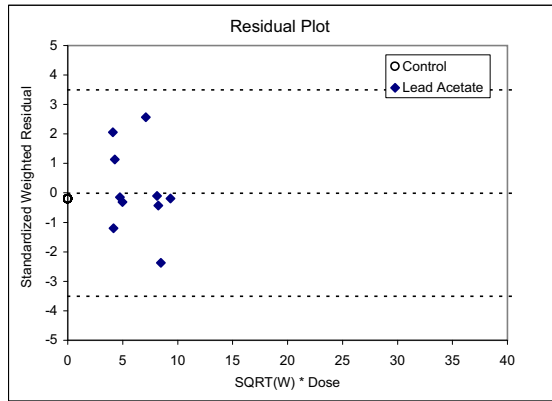
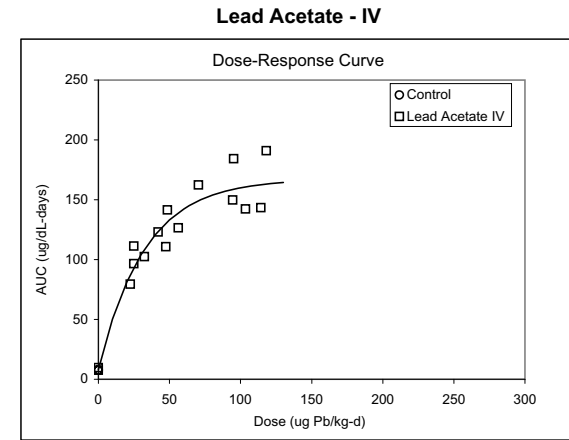
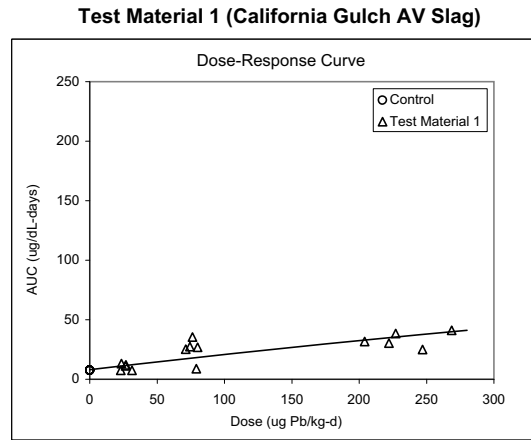
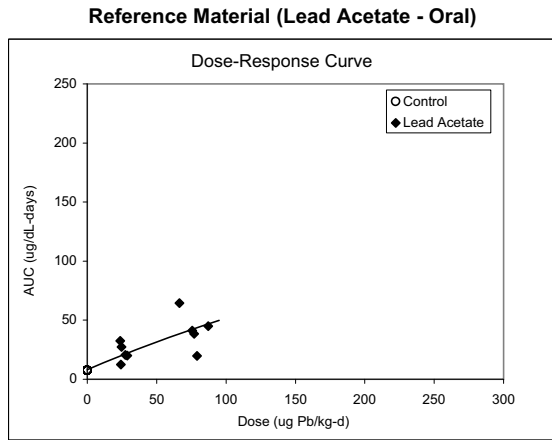
	Lead Acetate
ABA	0.25
Lower bound	0.17
Upper bound	0.33
Standard Error	0.045

APPENDIX E

Figure 1b - All Data

Phase II Experiment 8: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.04E+00	9.29E-01
b	1.59E+02	1.76E+01
c1	3.20E-03	5.86E-04
c2	8.34E-04	1.59E-04
c3	3.08E-02	8.40E-03
Covariance (c1,c2)	0.4920	--
Covariance (c1,c3)	0.5858	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	99.719
p	< 0.001
Adjusted R ²	0.8977
AIC	337.913

RBA and Uncertainty

	Test Material 1
RBA	0.26
Lower bound	0.19
Upper bound	0.36
Standard Error	0.049*

* $g \geq 0.05$, estimate is uncertain

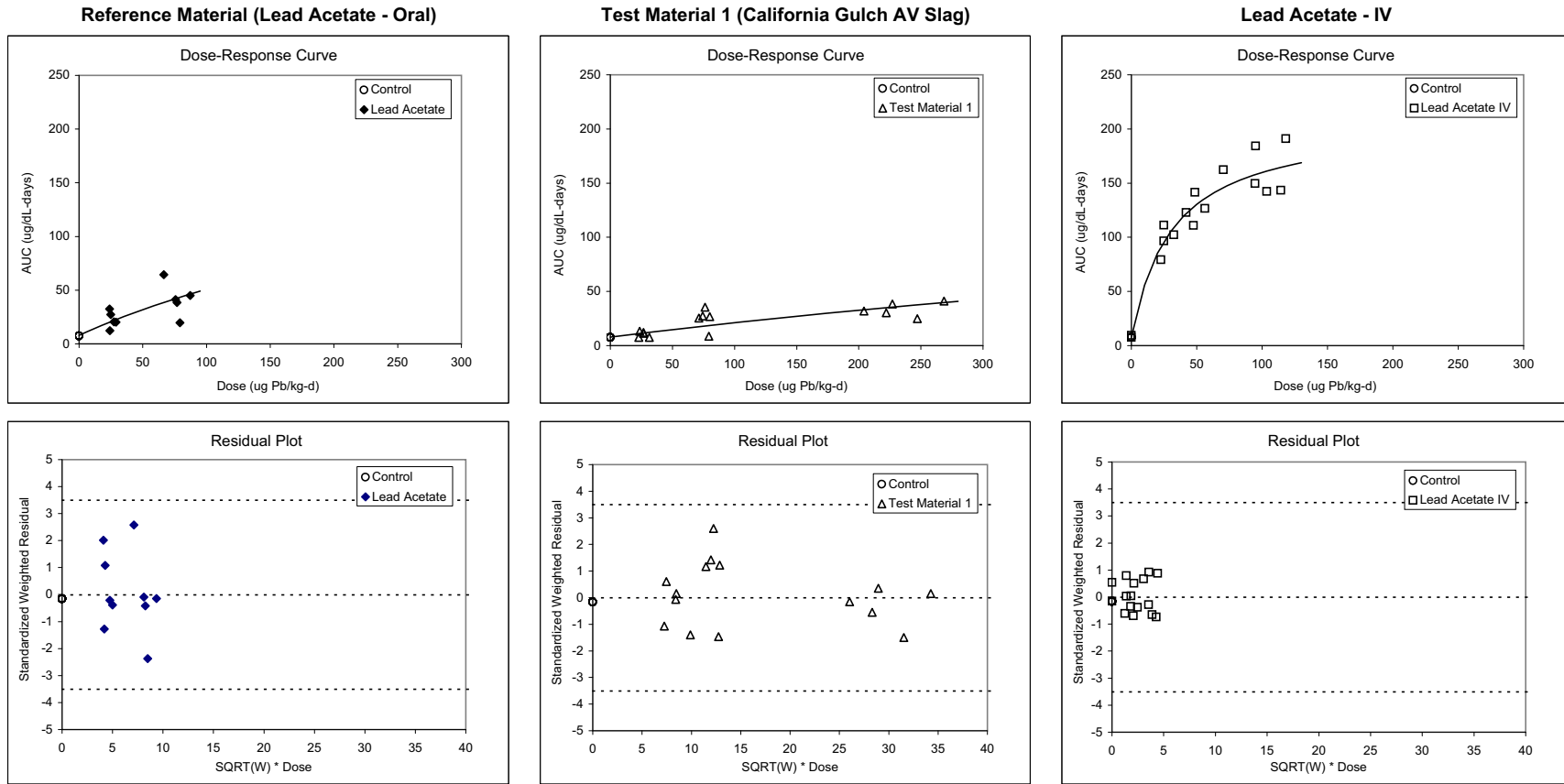
ABA and Uncertainty

	Lead Acetate
ABA	0.10
Lower bound	0.07
Upper bound	0.17
Standard Error	0.023*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1c - All Data
Phase II Experiment 8: Blood AUC
Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.93E+00	9.30E-01
b	2.00E+02	3.32E+01
c1	3.67E+02	8.85E+01
c2	1.42E+03	3.47E+02
c3	3.18E+01	1.39E+01
Covariance (c1,c2)	0.6808	--
Covariance (c1,c3)	0.7694	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	101.785
p	< 0.001
Adjusted R ²	0.8996
AIC	336.939

RBA and Uncertainty

	Test Material 1
RBA	0.26
Lower bound	0.18
Upper bound	0.37
Standard Error	0.050*

*g ≥ 0.05, estimate is uncertain

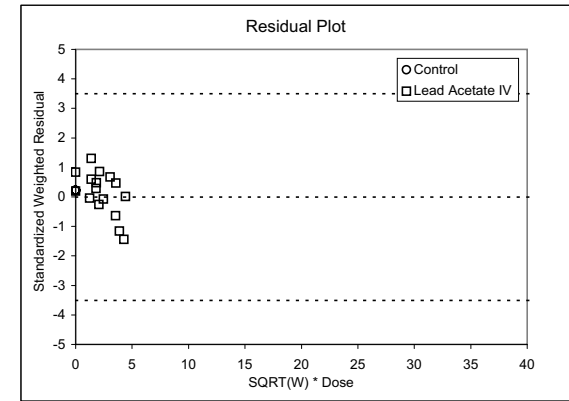
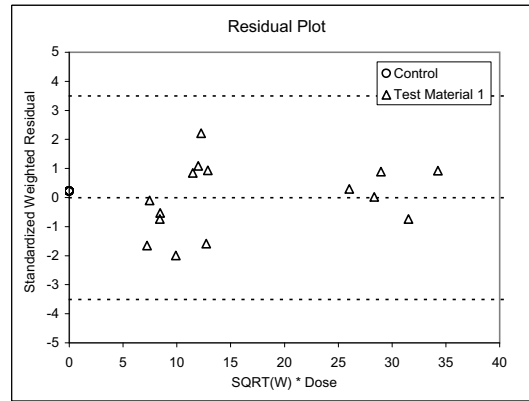
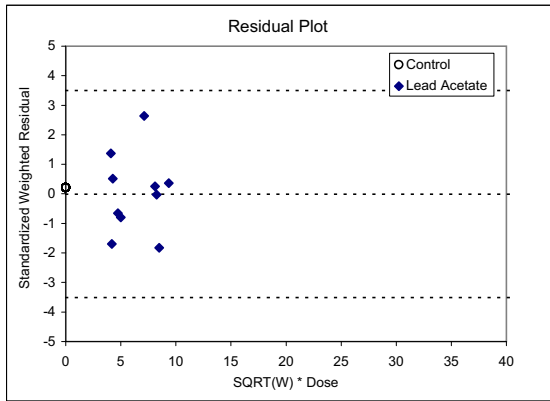
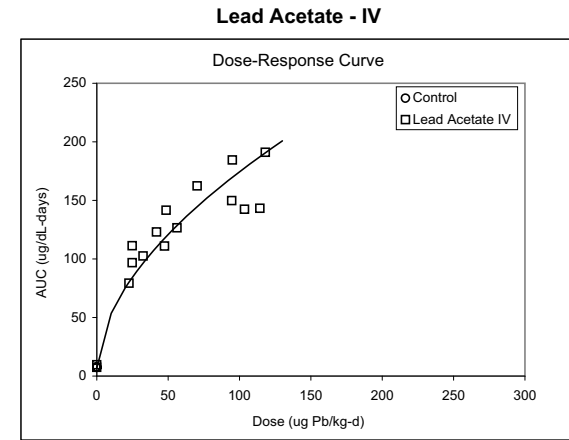
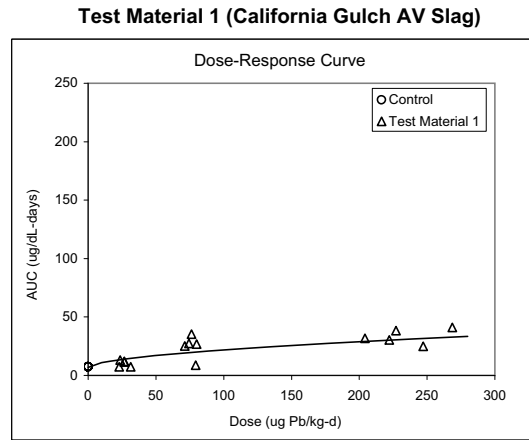
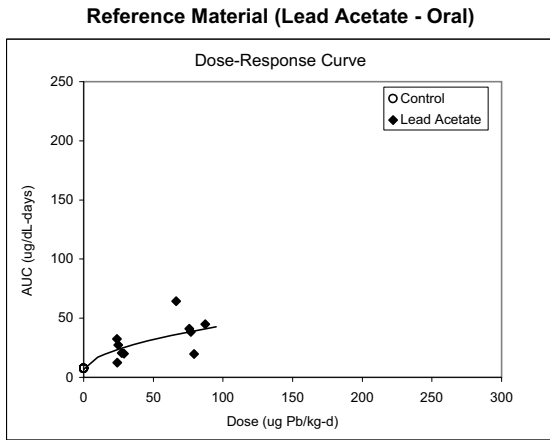
ABA and Uncertainty

	Lead Acetate
ABA	0.09
Lower bound	0.03
Upper bound	0.13
Standard Error	0.026*

*g ≥ 0.05, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 8: Blood AUC
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.89E+00	1.11E+00
b1	2.86E+00	1.01E+00
b2	1.16E+00	4.93E-01
b3	1.30E+01	4.52E+00
c	5.56E-01	8.15E-02
Covariance (b1,b2)	0.8993	--
Covariance (b1,b3)	0.9228	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	87.734
p	< 0.001
Adjusted R ²	0.8852
AIC	344.366

RBA and Uncertainty

	Test Material 1
RBA	0.20
Lower bound	0.07
Upper bound	0.34
Standard Error	--

ABA and Uncertainty

	Lead Acetate
ABA	0.07
Lower bound	0.04
Upper bound	0.11
Standard Error	--

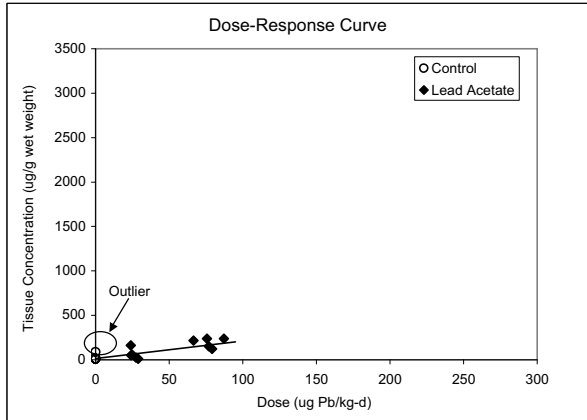
APPENDIX E

Figure 2a - All Data

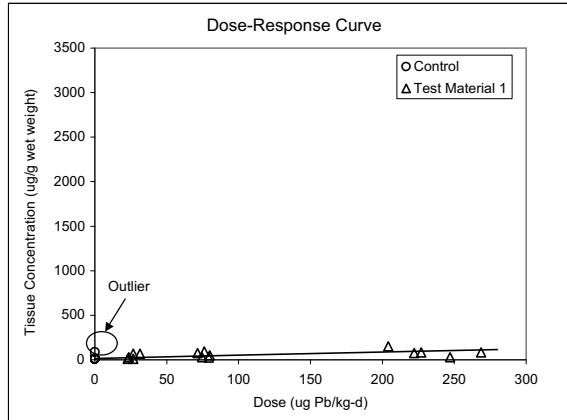
Phase II Experiment 8: Liver

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

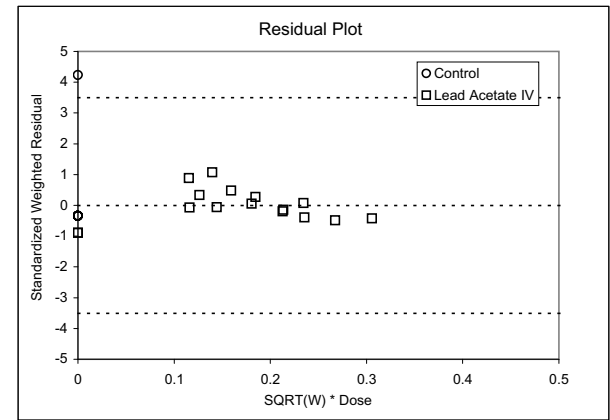
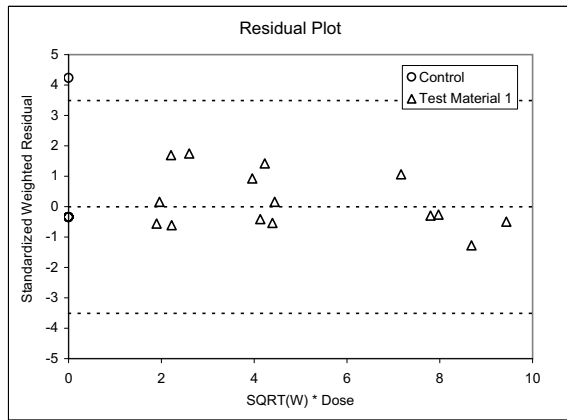
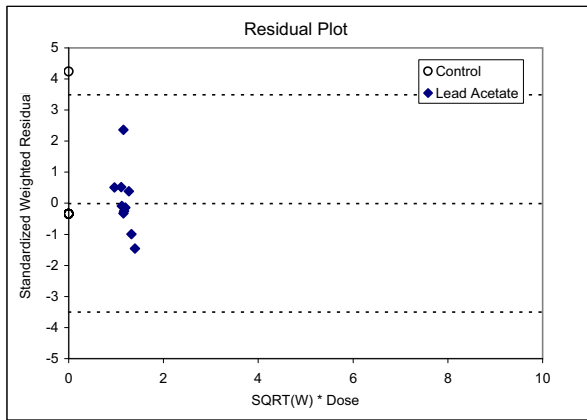
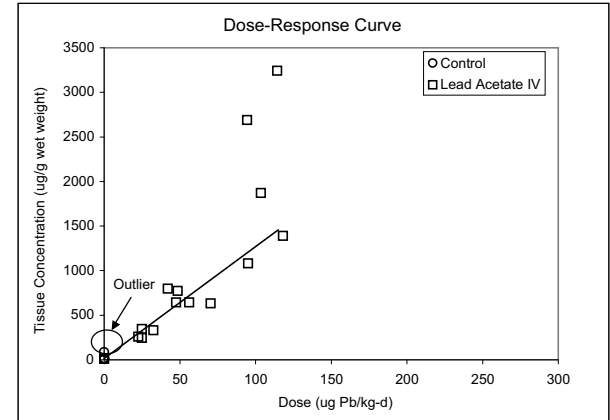
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.56E+01	3.76E+00
b1	1.94E+00	5.76E-01
b2	3.55E-01	1.04E-01
b3	1.25E+01	2.91E+00
Covariance (c1,c2)	0.0491	--
Covariance (c1,c3)	0.0059	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	13.353
p	< 0.001
Adjusted R ²	0.4516
AIC	629.699

RBA and Uncertainty

	Test Material 1
RBA	0.18
Lower bound	0.08
Upper bound	0.40
Standard Error	0.074*

* g ≥ 0.05, estimate is uncertain

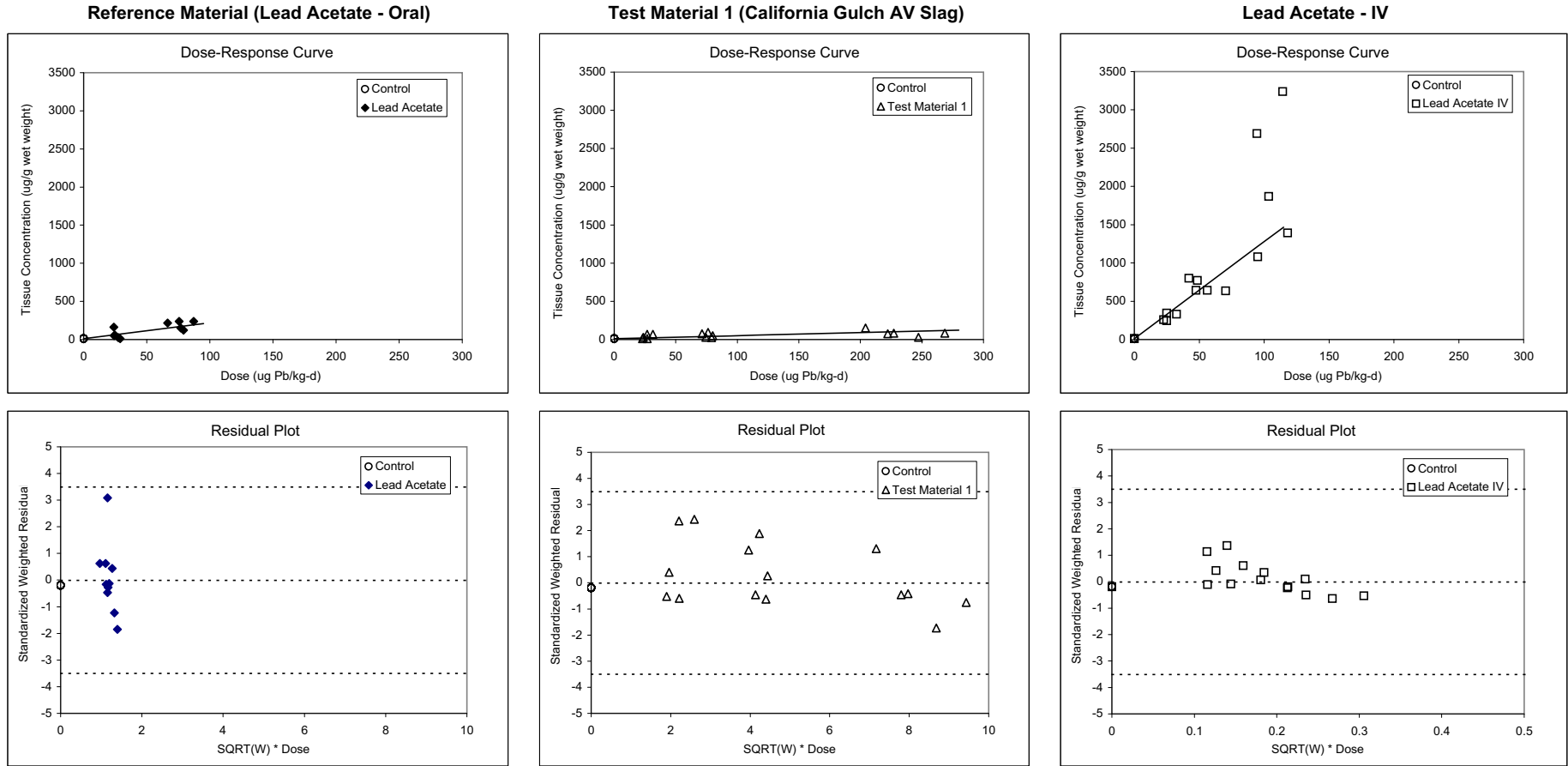
ABA and Uncertainty

	Lead Acetate
ABA	0.15
Lower bound	0.07
Upper bound	0.29
Standard Error	0.058*

* g ≥ 0.05, estimate is uncertain

APPENDIX E

Figure 2a - Outlier Excluded
Phase II Experiment 8: Liver
Linear Model: $y = a + b_1 \cdot x_1 + b_2 \cdot x_2 + b_3 \cdot x_3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.10E+01	2.03E+00
b1	2.07E+00	4.45E-01
b2	3.91E-01	7.97E-02
b3	1.27E+01	2.26E+00
Covariance (c1,c2)	0.0243	--
Covariance (c1,c3)	0.0028	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	25.206
p	< 0.001
Adjusted R ²	0.6227
AIC	537.628

RBA and Uncertainty

	Test Material 1
RBA	0.19
Lower bound	0.11
Upper bound	0.32
Standard Error	0.055*

* $g \geq 0.05$, estimate is uncertain

ABA and Uncertainty

	Lead Acetate
ABA	0.16
Lower bound	0.10
Upper bound	0.26
Standard Error	0.046*

* $g \geq 0.05$, estimate is uncertain

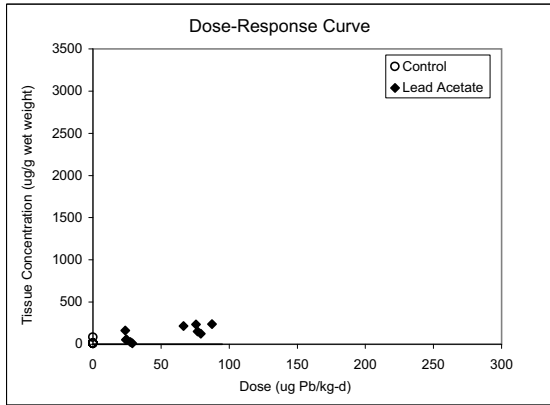
APPENDIX E

Figure 2b - All Data

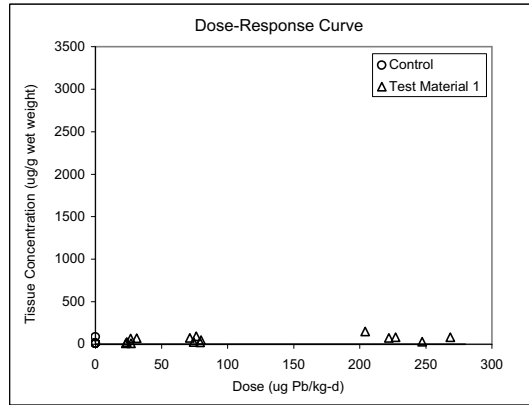
Phase II Experiment 8: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

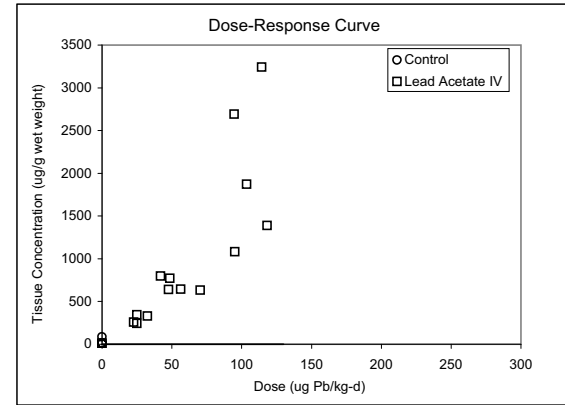
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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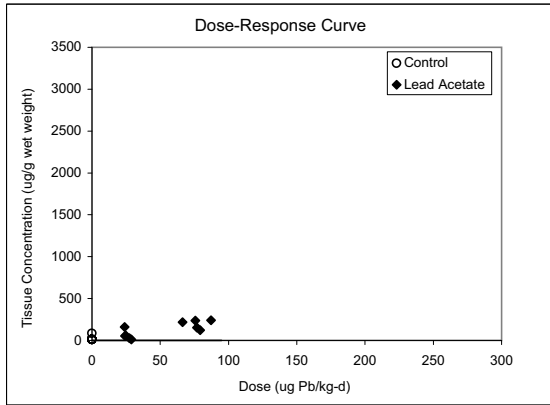
APPENDIX E

Figure 2c - All Data

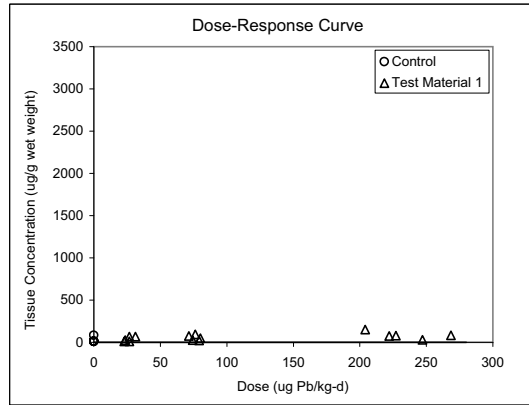
Phase II Experiment 8: Liver

Michaelis-Menton Model: $y = a + \frac{b \cdot x_1}{c_1 + x_1} + \frac{b \cdot x_2}{c_2 + x_2} + \frac{b \cdot x_3}{c_3 + x_3}$

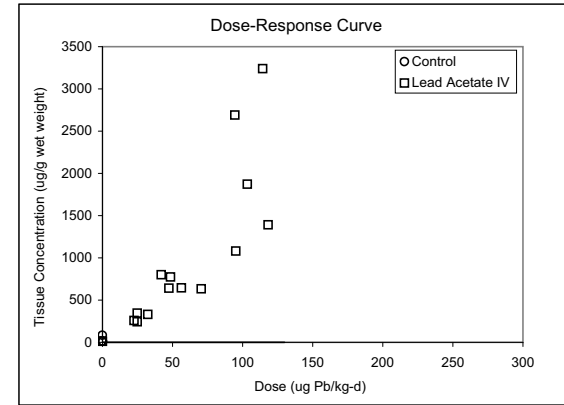
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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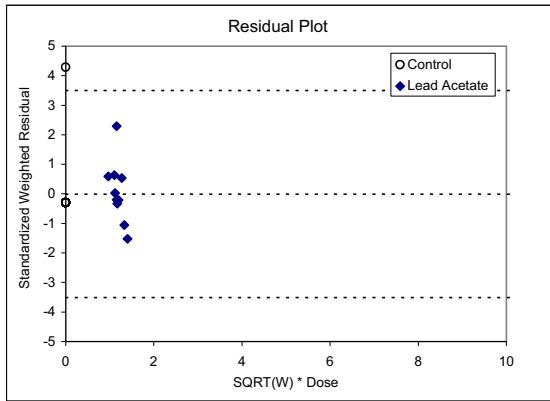
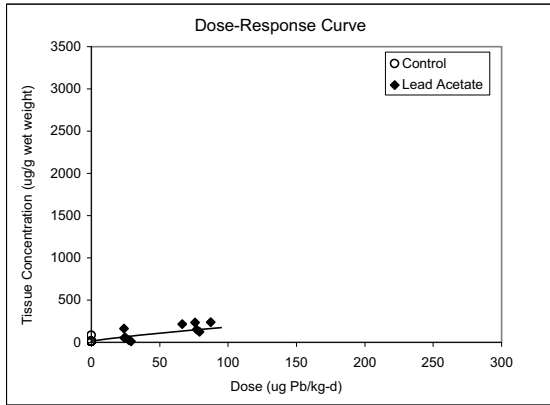
APPENDIX E

Figure 2d - All Data

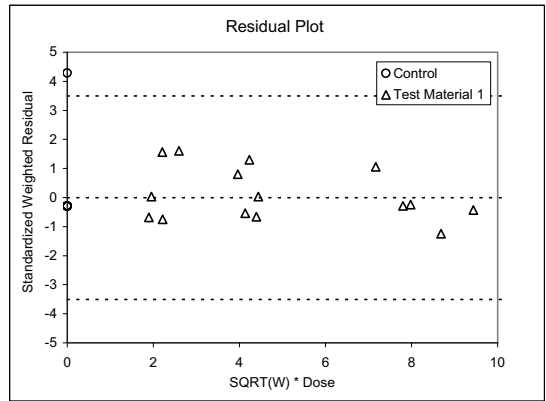
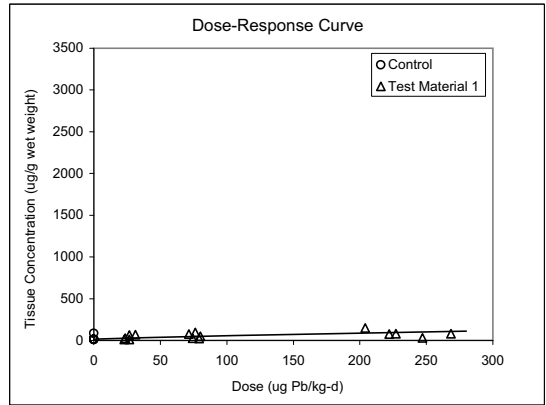
Phase II Experiment 8: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

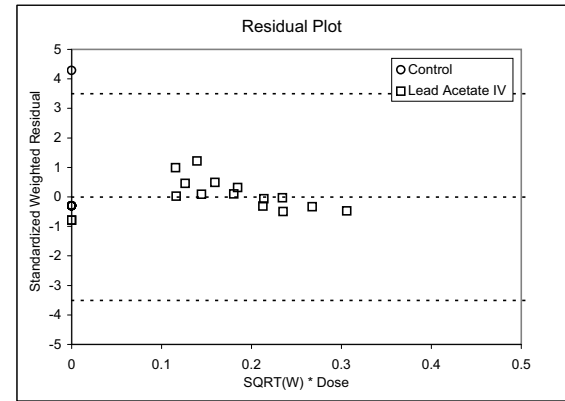
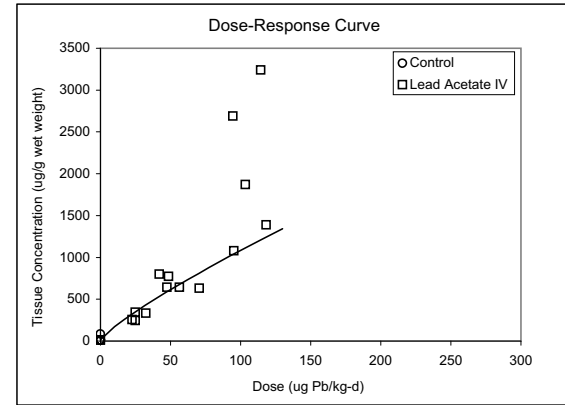
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.49E+01	3.93E+00
b1	3.60E+00	3.67E+00
b2	8.77E-01	1.19E+00
b3	2.31E+01	2.32E+01
c	8.33E-01	2.63E-01
Covariance (b1,b2)	0.9380	--
Covariance (b1,b3)	0.9287	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	9.890
p	< 0.001
Adjusted R ²	0.4414
AIC	630.613

RBA and Uncertainty

	Test Material 1
RBA	0.18
Lower bound	?
Upper bound	?
Standard Error	--

ABA and Uncertainty

	Lead Acetate
ABA	0.11
Lower bound	?
Upper bound	?
Standard Error	--

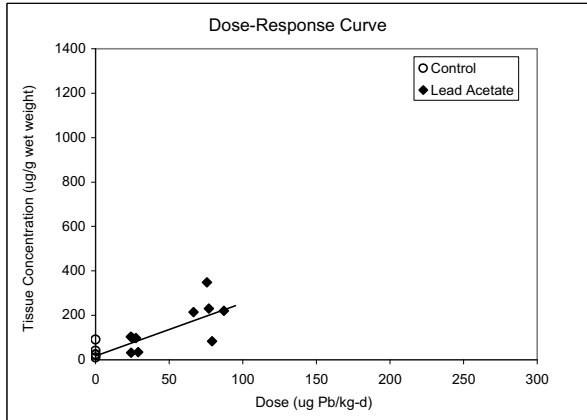
APPENDIX E

Figure 3a - All Data

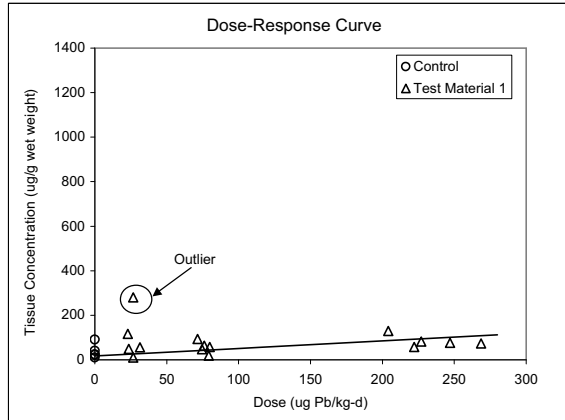
Phase II Experiment 8: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

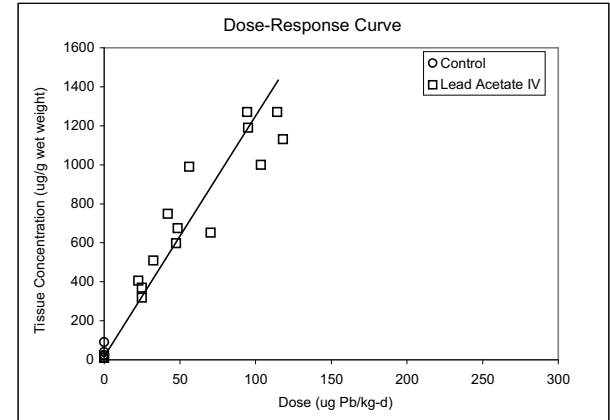
Reference Material (Lead Acetate - Oral)



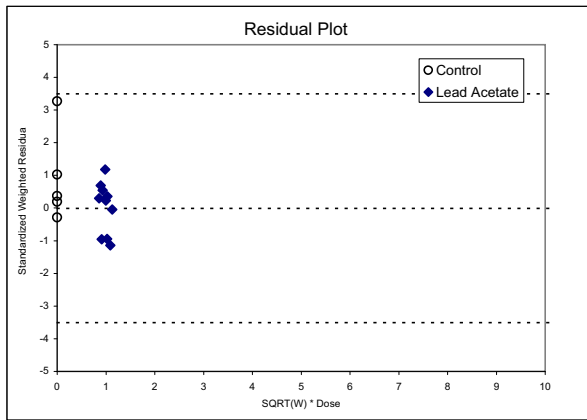
Test Material 1 (California Gulch AV Slag)



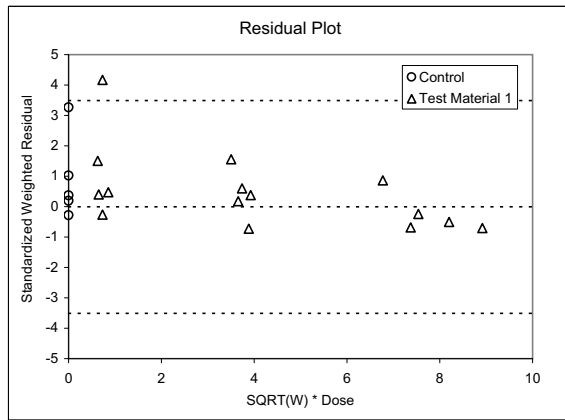
Lead Acetate - IV



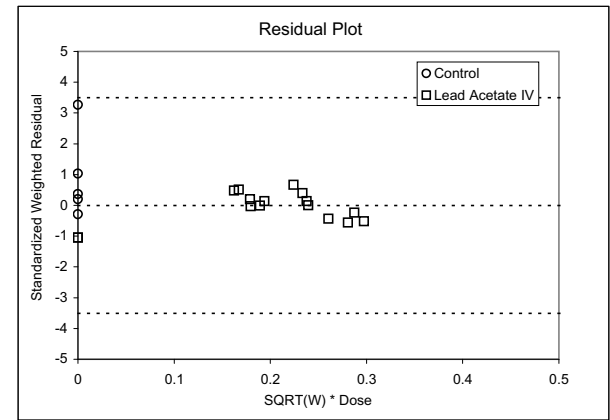
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.66E+01	4.21E+00
b1	2.39E+00	5.76E-01
b2	3.42E-01	9.48E-02
b3	1.23E+01	2.07E+00
Covariance (c1,c2)	0.0503	--
Covariance (c1,c3)	0.0067	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	21.139
p	< 0.001
Adjusted R ²	0.5731
AIC	586.555

RBA and Uncertainty

Statistic	Test Material 1
RBA	0.14
Lower bound	0.07
Upper bound	0.27
Standard Error	0.051*

* g ≥ 0.05, estimate is uncertain

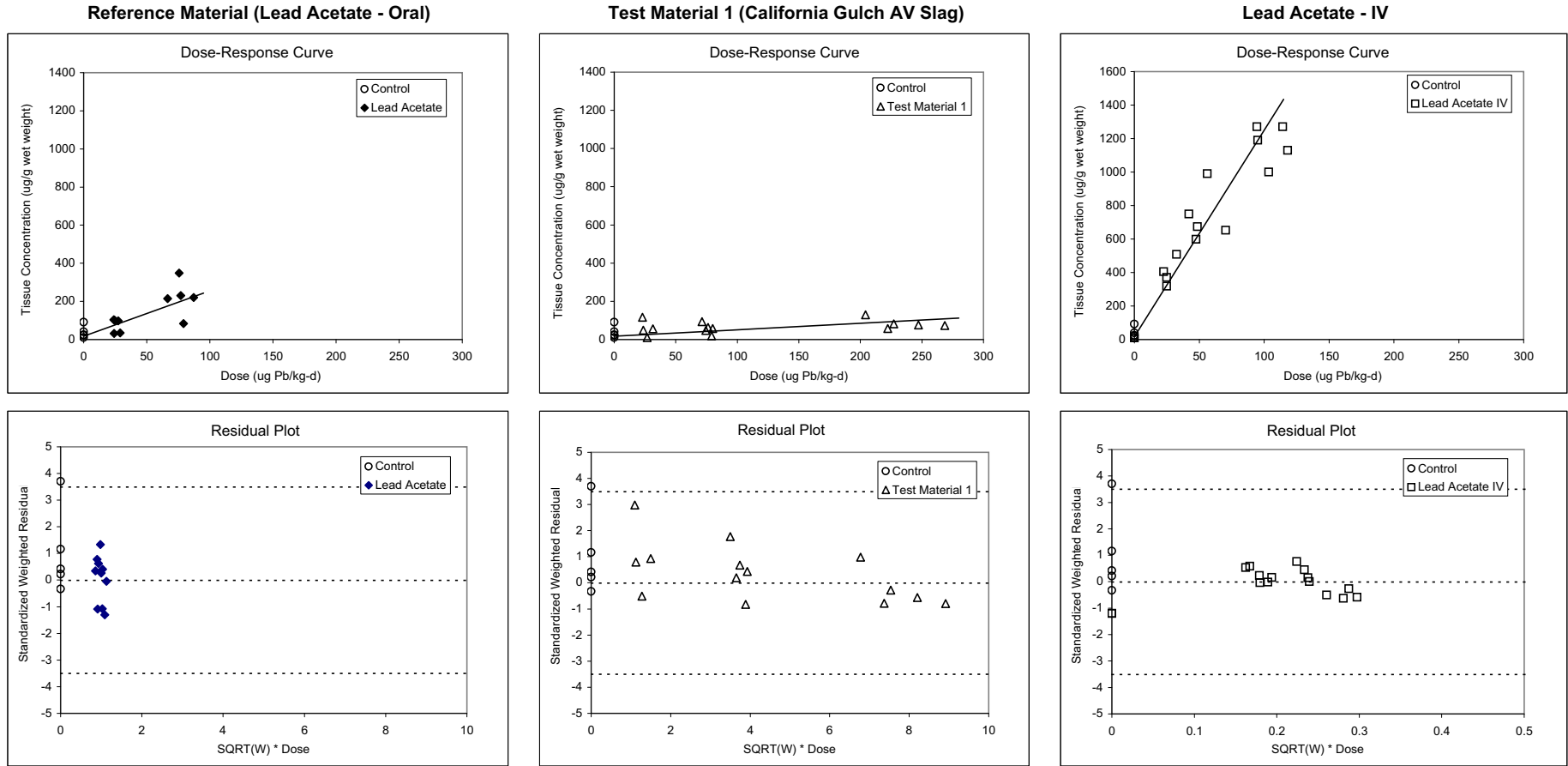
ABA and Uncertainty

Statistic	Lead Acetate
ABA	0.19
Lower bound	0.11
Upper bound	0.31
Standard Error	0.057*

* g ≥ 0.05, estimate is uncertain

APPENDIX E

Figure 3a - Outlier Excluded
Phase II Experiment 8: Kidney
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.67E+01	3.65E+00
b1	2.39E+00	5.05E-01
b2	3.41E-01	8.29E-02
b3	1.23E+01	1.82E+00
Covariance (c1,c2)	0.0519	--
Covariance (c1,c3)	0.0065	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	27.487
p	< 0.001
Adjusted R ²	0.6436
AIC	540.150

RBA and Uncertainty

	Test Material 1
RBA	0.14
Lower bound	0.08
Upper bound	0.25
Standard Error	0.045*

* g ≥ 0.05, estimate is uncertain

ABA and Uncertainty

	Lead Acetate
ABA	0.19
Lower bound	0.12
Upper bound	0.29
Standard Error	0.050*

* g ≥ 0.05, estimate is uncertain

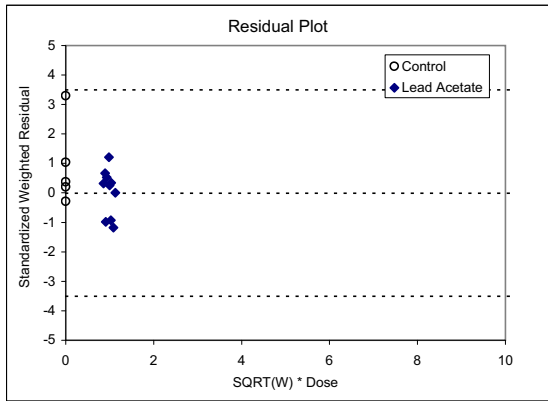
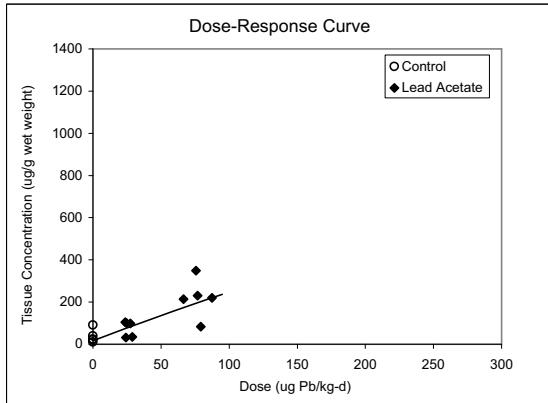
APPENDIX E

Figure 3b - All Data

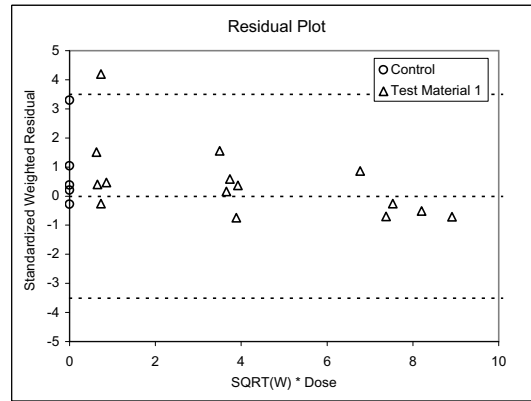
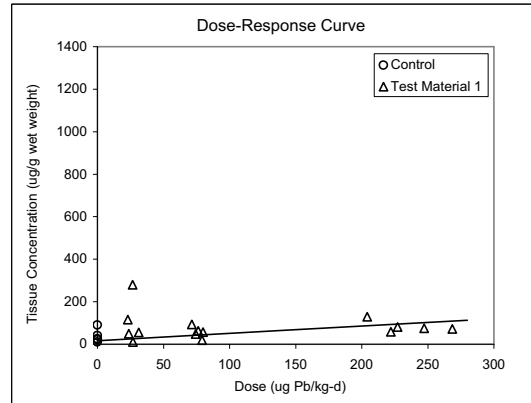
Phase II Experiment 8: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

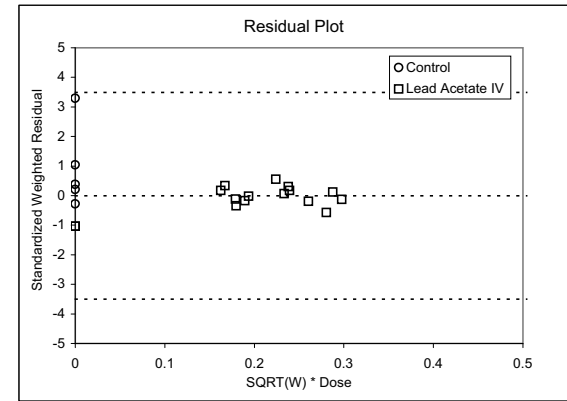
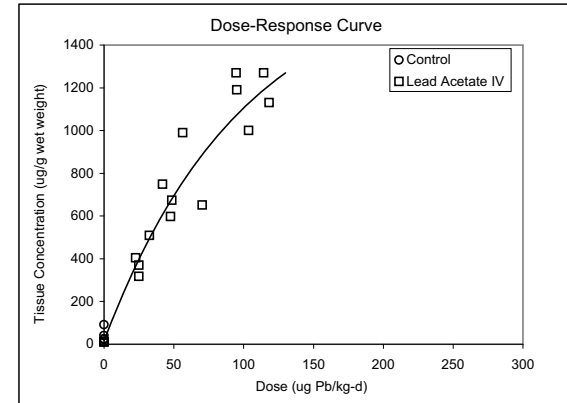
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.65E+01	4.23E+00
b	1.72E+03	1.60E+03
c1	1.44E-03	1.44E-03
c2	2.05E-04	2.04E-04
c3	1.00E-02	1.29E-02
Covariance (c1,c2)	0.9322	--
Covariance (c1,c3)	0.9527	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	15.994
p	< 0.001
Adjusted R ²	0.5713
AIC	585.963

RBA and Uncertainty

	Test Material 1
RBA	0.14
Lower bound	?
Upper bound	?
Standard Error	0.052*

* $g \geq 0.05$, estimate is uncertain

ABA and Uncertainty

	Lead Acetate
ABA	0.14
Lower bound	?
Upper bound	?
Standard Error	0.064*

* $g \geq 0.05$, estimate is uncertain

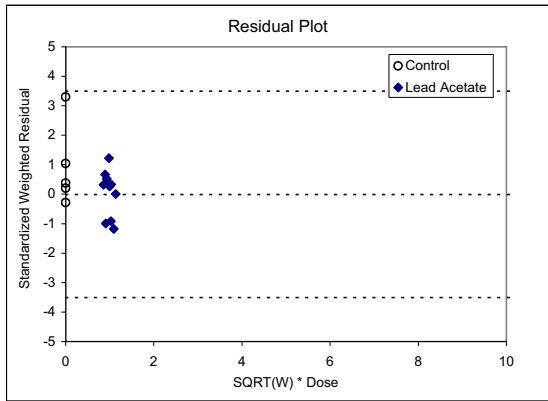
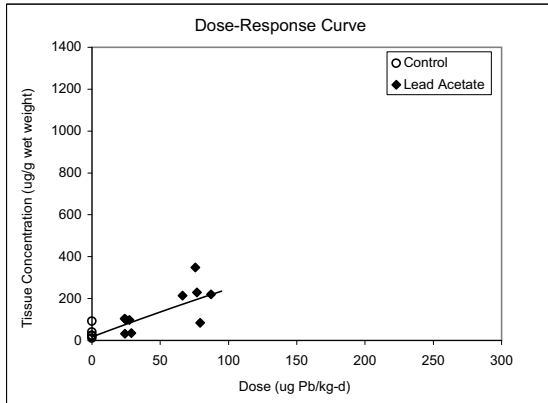
APPENDIX E

Figure 3c - All Data

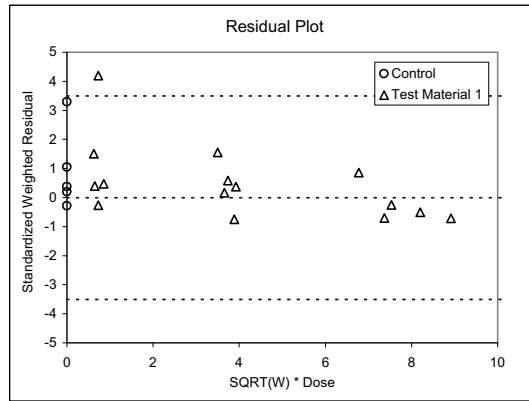
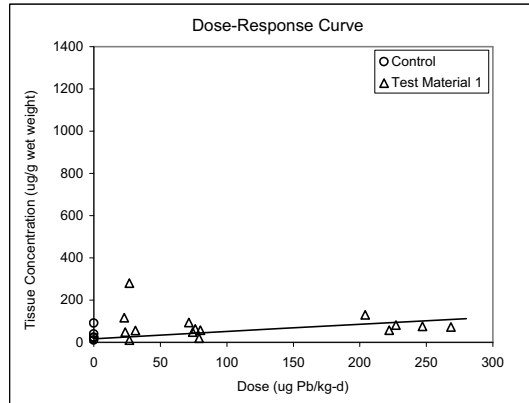
Phase II Experiment 8: Kidney

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

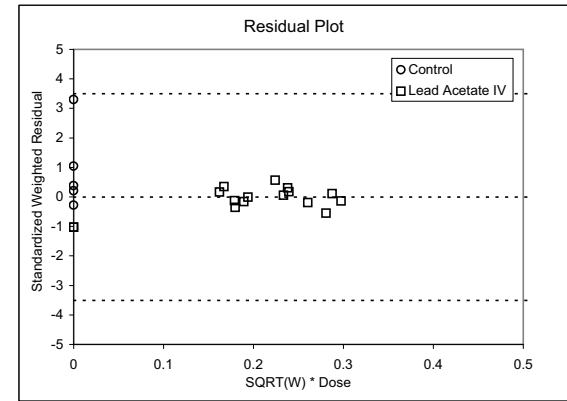
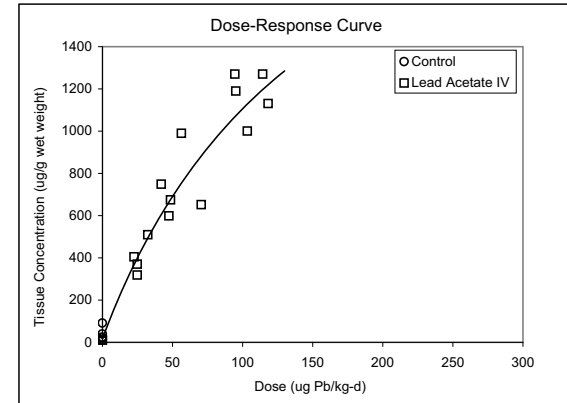
Reference Material (Lead Acetate - Oral)



Test Material 1 (California Gulch AV Slag)



Lead Acetate - IV



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.64E+01	4.23E+00
b	2.81E+03	3.20E+03
c1	1.13E+03	1.37E+03
c2	7.92E+03	9.53E+03
c3	1.58E+02	2.46E+02
Covariance (c1,c2)	0.9535	--
Covariance (c1,c3)	0.9679	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	15.996
p	< 0.001
Adjusted R ²	0.5714
AIC	585.953

RBA and Uncertainty

	Test Material 1
RBA	0.14
Lower bound	?
Upper bound	?
Standard Error	0.053*

* $g \geq 0.05$, estimate is uncertain

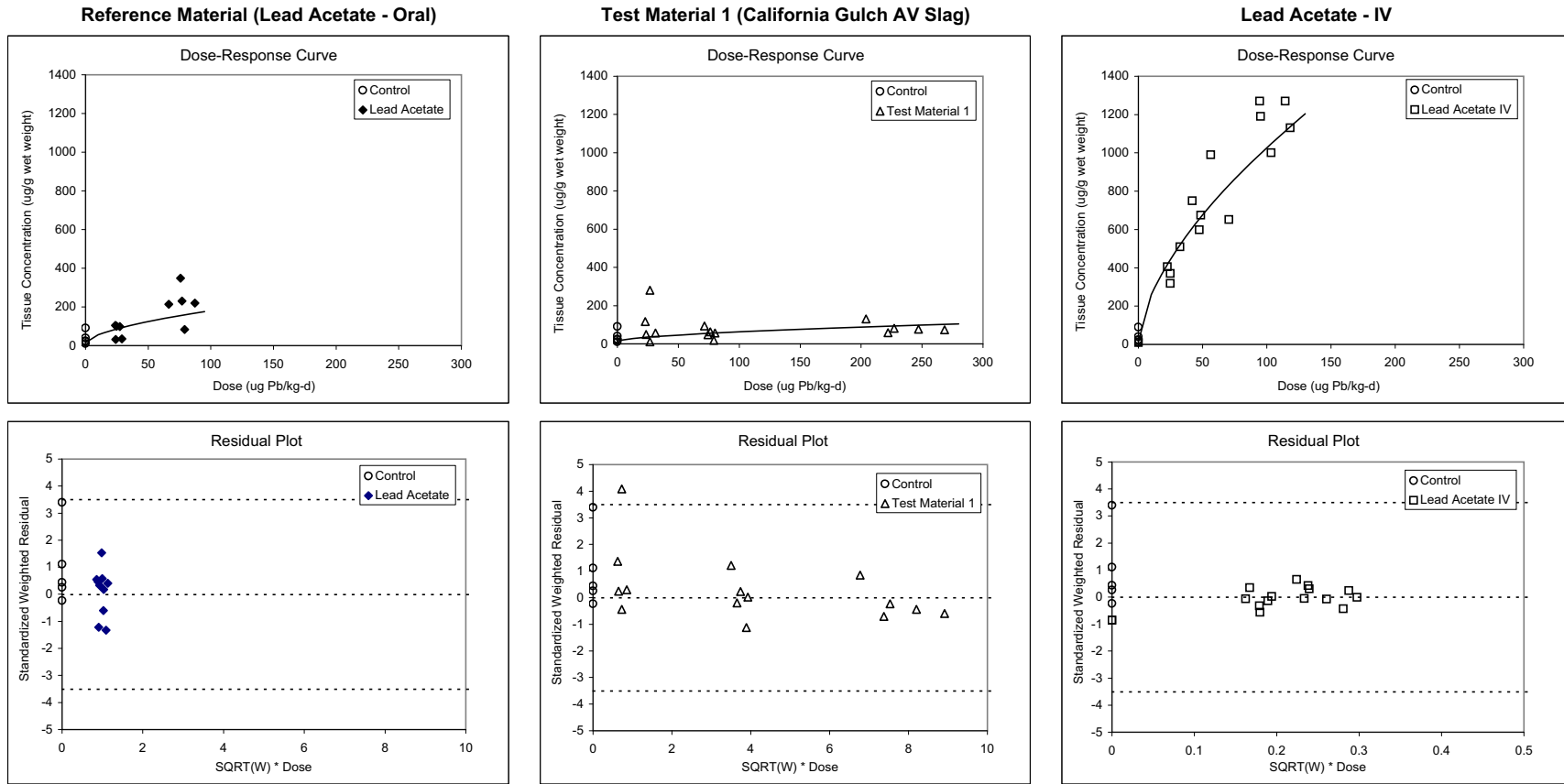
ABA and Uncertainty

	Lead Acetate
ABA	0.14
Lower bound	?
Upper bound	?
Standard Error	0.068*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3d - All Data
Phase II Experiment 8: Kidney
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.53E+01	4.23E+00
b1	9.75E+00	7.60E+00
b2	2.77E+00	2.94E+00
b3	5.93E+01	4.88E+01
c	6.16E-01	2.04E-01
Covariance (b1,b2)	0.9292	--
Covariance (b1,b3)	0.9318	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	16.981
p	< 0.001
Adjusted R ²	0.5869
AIC	581.290

RBA and Uncertainty

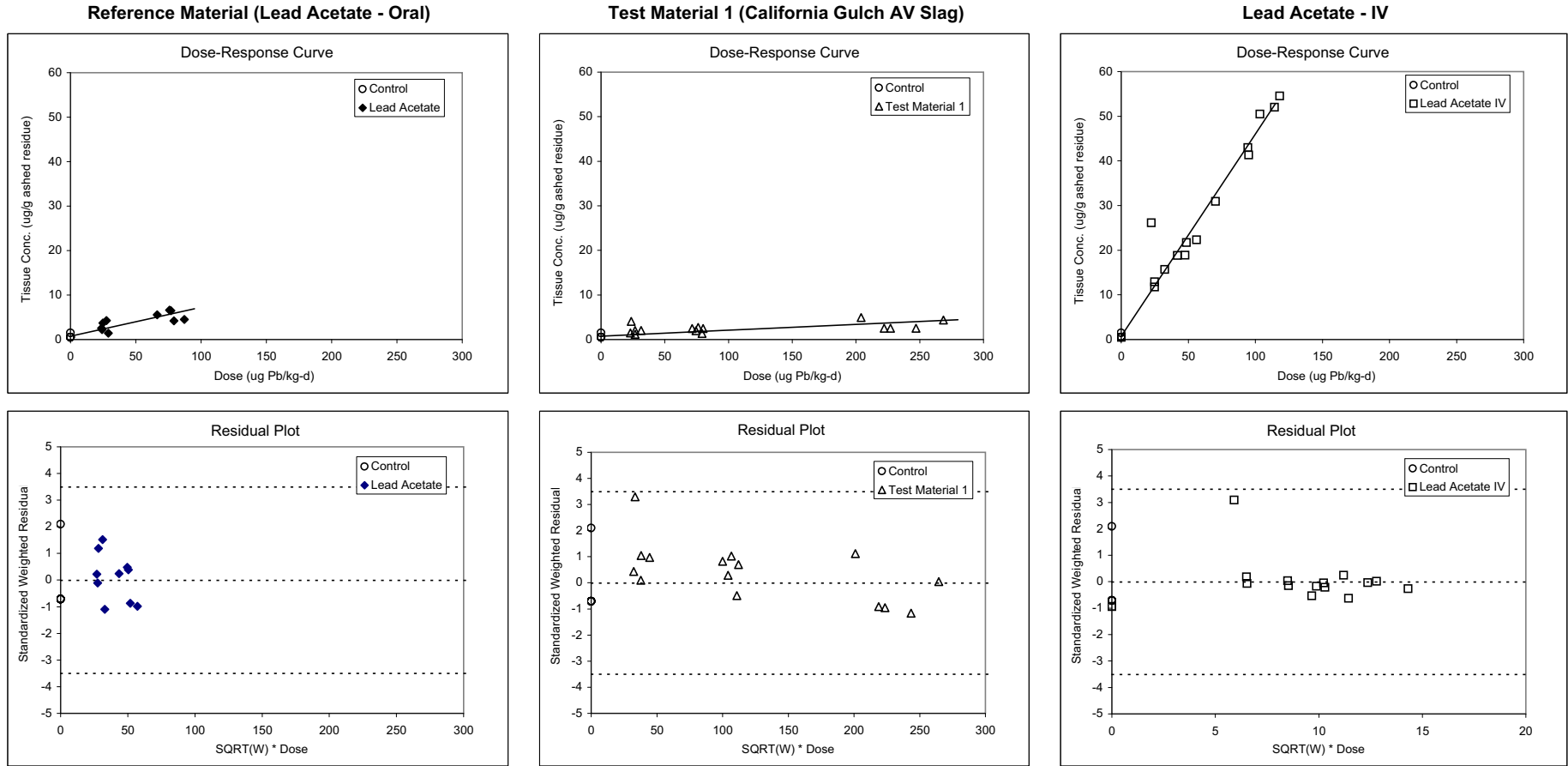
	Test Material 1
RBA	0.13
Lower bound	?
Upper bound	?
Standard Error	--

ABA and Uncertainty

	Lead Acetate
ABA	0.05
Lower bound	?
Upper bound	?
Standard Error	--

APPENDIX E

Figure 4a - All Data
Phase II Experiment 8: Femur
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.54E-01	1.21E-01
b1	6.49E-02	1.05E-02
b2	1.32E-02	2.45E-03
b3	4.53E-01	3.53E-02
Covariance (c1,c2)	0.0708	--
Covariance (c1,c3)	0.0128	--
Degrees of Freedom	42	--

Goodness of Fit

Statistic	Estimate
F	74.474
p	< 0.001
Adjusted R ²	0.8305
AIC	193.909

RBA and Uncertainty

	Test Material 1
RBA	0.20
Lower bound	0.13
Upper bound	0.30
Standard Error	0.048*

* $g \geq 0.05$, estimate is uncertain

ABA and Uncertainty

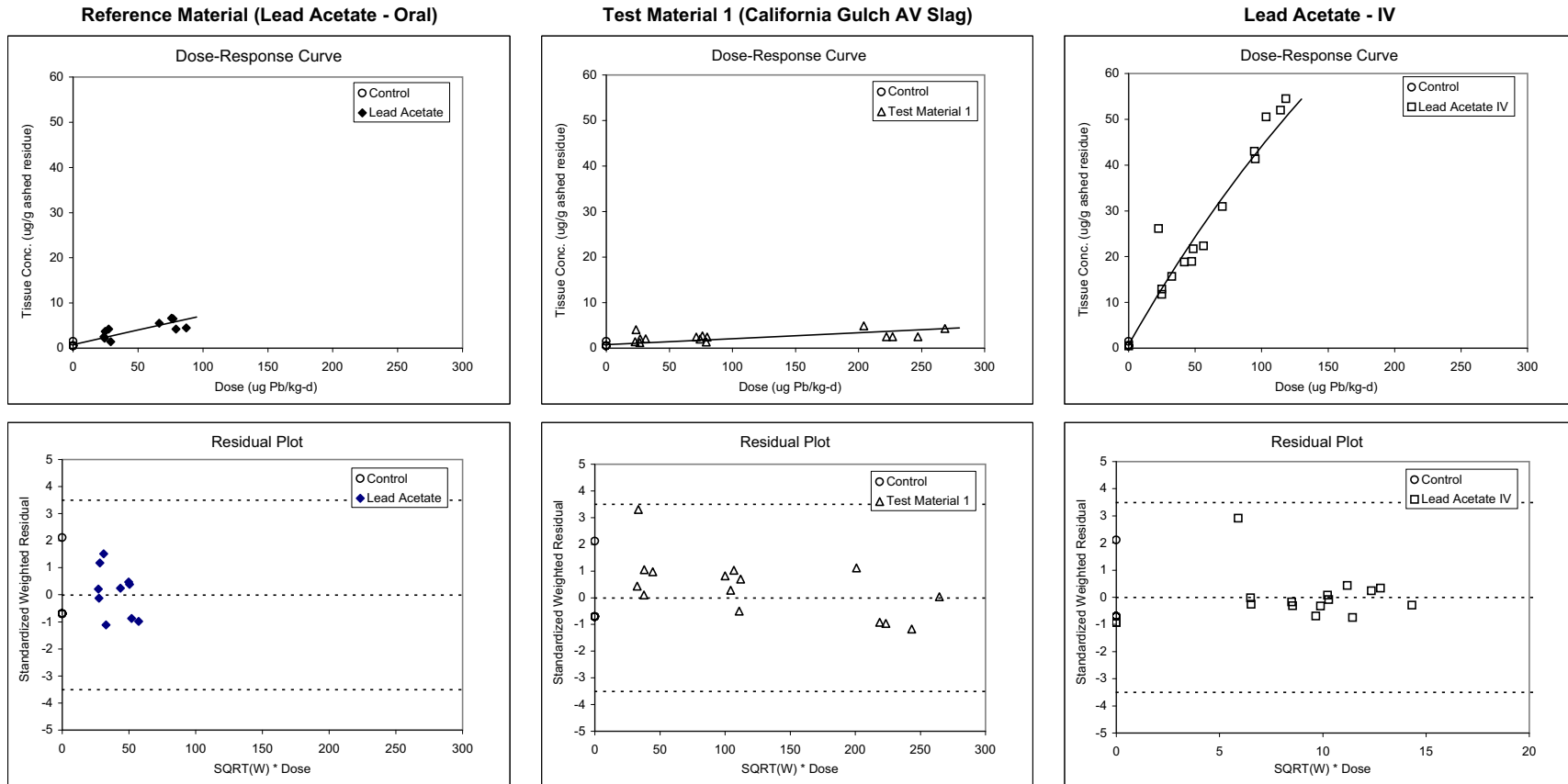
	Lead Acetate
ABA	0.14
Lower bound	0.10
Upper bound	0.19
Standard Error	0.026

APPENDIX E

Figure 4b - All Data

Phase II Experiment 8: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.50E-01	1.22E-01
b	1.48E+02	2.03E+02
c1	4.47E-04	6.30E-04
c2	9.03E-05	1.27E-04
c3	3.47E-03	5.42E-03
Covariance (c1,c2)	0.9853	--
Covariance (c1,c3)	0.9917	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	55.160
p	< 0.001
Adjusted R ²	0.8280
AIC	195.180

RBA and Uncertainty

	Test Material 1
RBA	0.20
Lower bound	?
Upper bound	?
Standard Error	0.049*

* g ≥ 0.05, estimate is uncertain

ABA and Uncertainty

	Lead Acetate
ABA	0.13
Lower bound	?
Upper bound	?
Standard Error	0.032*

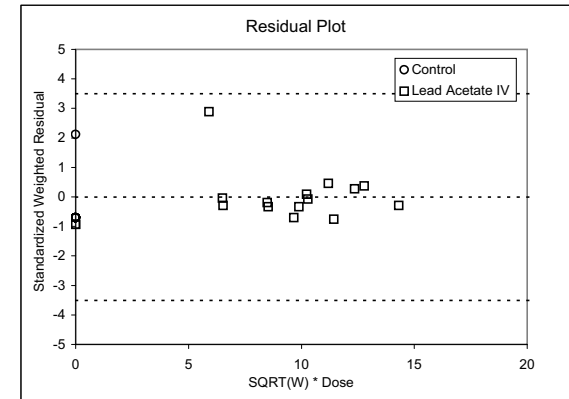
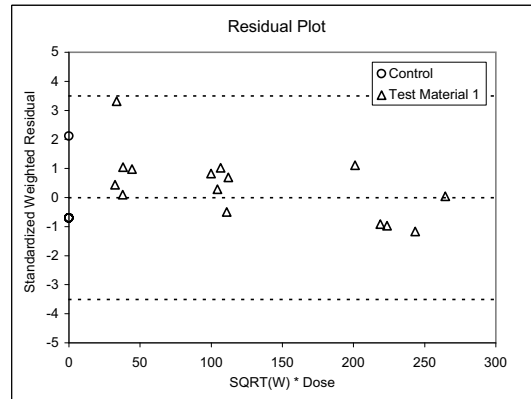
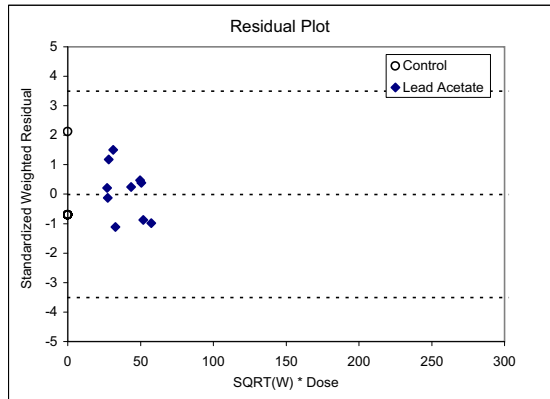
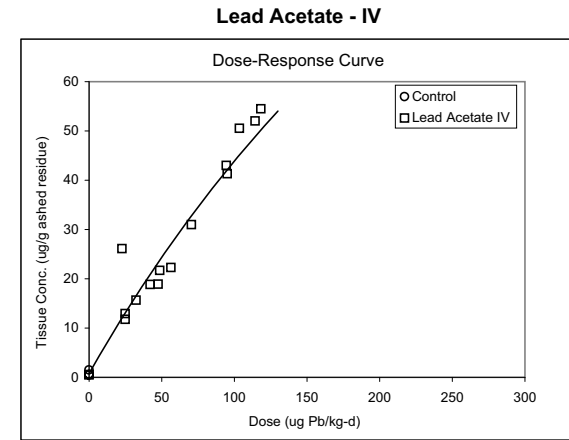
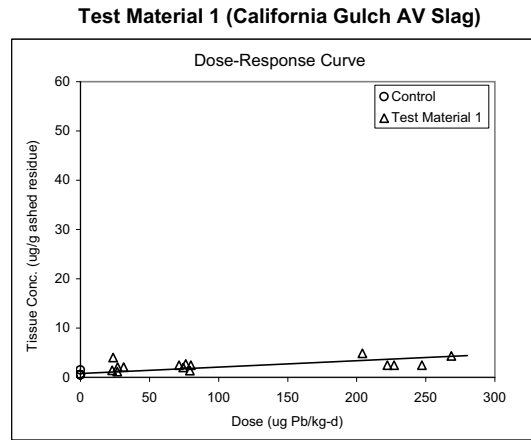
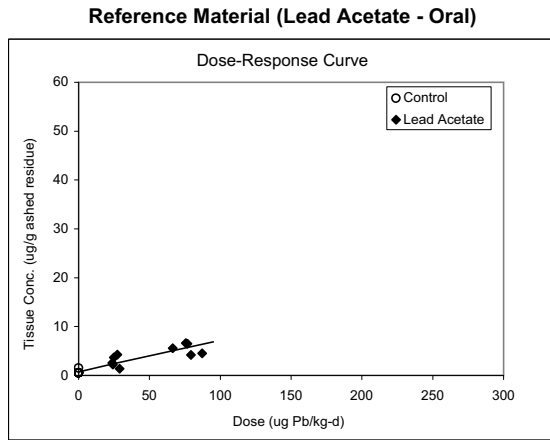
* g ≥ 0.05, estimate is uncertain

APPENDIX E

Figure 4c - All Data

Phase II Experiment 8: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.49E-01	1.22E-01
b	2.47E+02	3.32E+02
c1	3.72E+03	5.14E+03
c2	1.84E+04	2.54E+04
c3	4.72E+02	7.29E+02
Covariance (c1,c2)	0.9848	--
Covariance (c1,c3)	0.9913	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	55.226
p	< 0.001
Adjusted R ²	0.8282
AIC	195.104

RBA and Uncertainty

	Test Material 1
RBA	0.20
Lower bound	?
Upper bound	?
Standard Error	0.049*

* $g \geq 0.05$, estimate is uncertain

ABA and Uncertainty

	Lead Acetate
ABA	0.13
Lower bound	?
Upper bound	?
Standard Error	0.032*

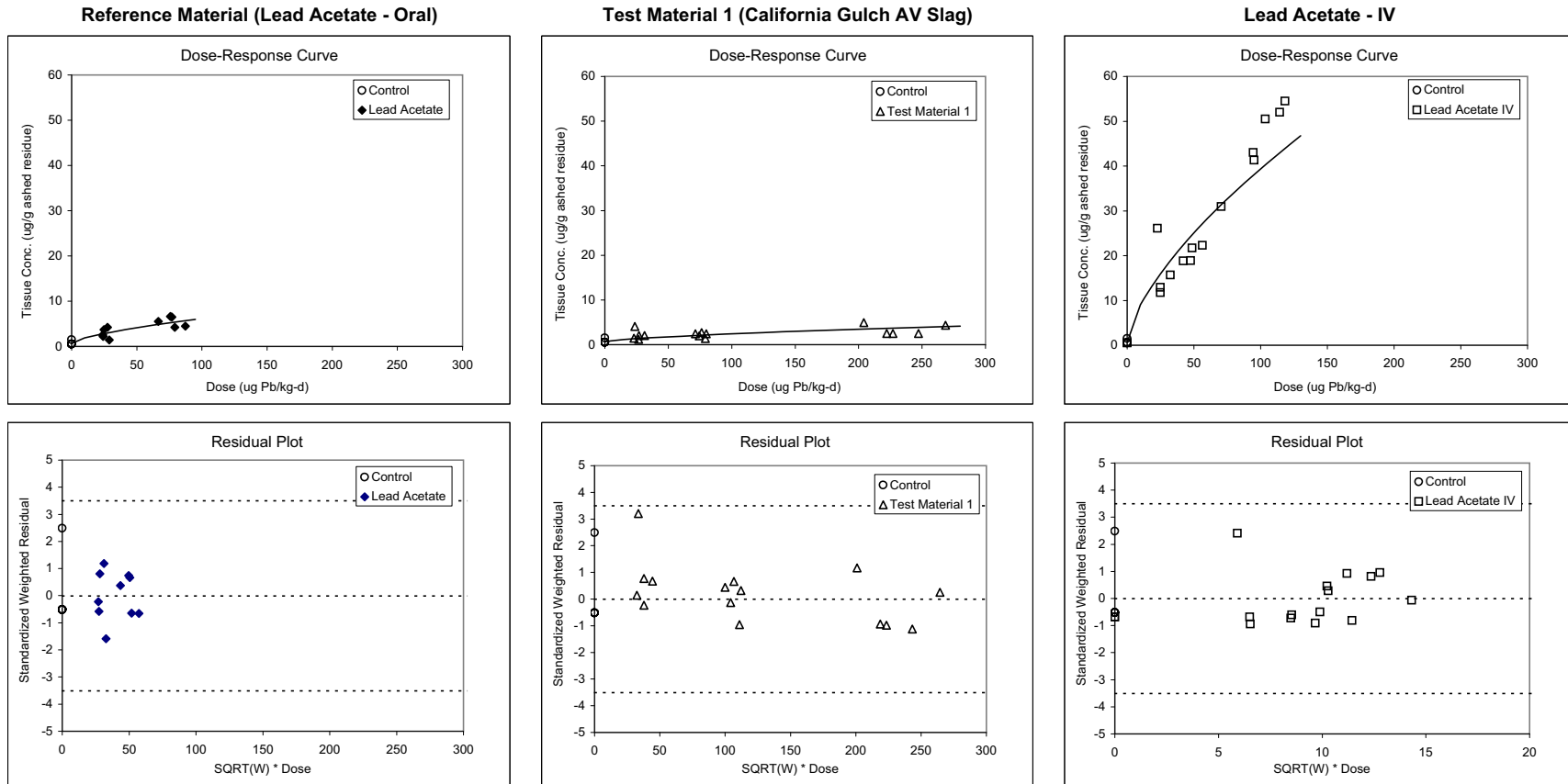
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4d - All Data

Phase II Experiment 8: Femur

Power Model: $y = a + b1 \cdot x1^c + b2 \cdot x2^c + b3 \cdot x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.72E-01	1.18E-01
b1	2.56E-01	1.15E-01
b2	8.15E-02	4.63E-02
b3	1.81E+00	7.96E-01
c	6.66E-01	1.07E-01
Covariance (b1,b2)	0.9154	--
Covariance (b1,b3)	0.9329	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	64.812
p	< 0.001
Adjusted R ²	0.8501
AIC	185.595

RBA and Uncertainty

	Test Material 1
RBA	0.18
Lower bound	0.01
Upper bound	0.31
Standard Error	--

ABA and Uncertainty

	Lead Acetate
ABA	0.05
Lower bound	0.03
Upper bound	0.10
Standard Error	--

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APPENDIX E

EXPERIMENT 9

Test Material 1: Palmerton Location 2

Test Material 2: Palmerton Location 4

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

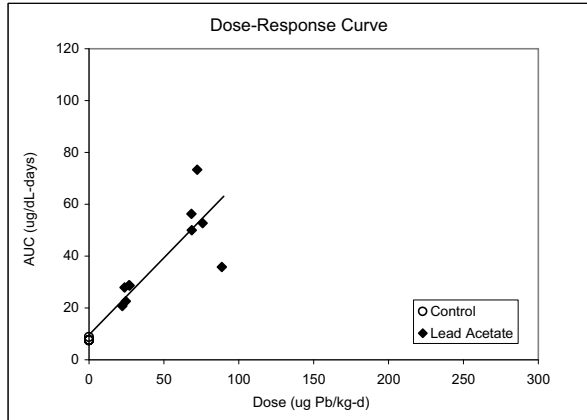
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Figure 1a - All Data

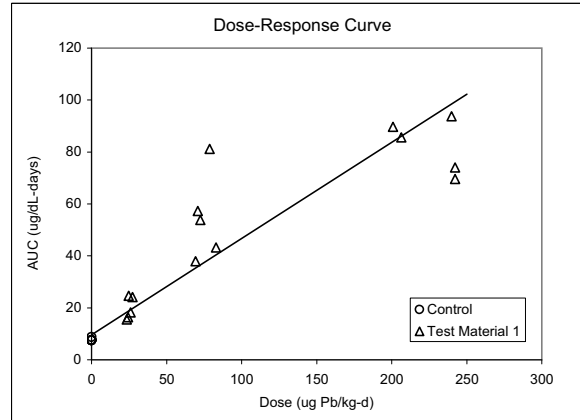
Phase II Experiment 9: Blood AUC

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

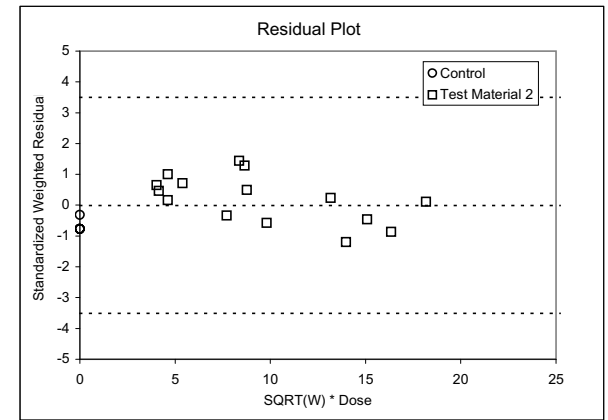
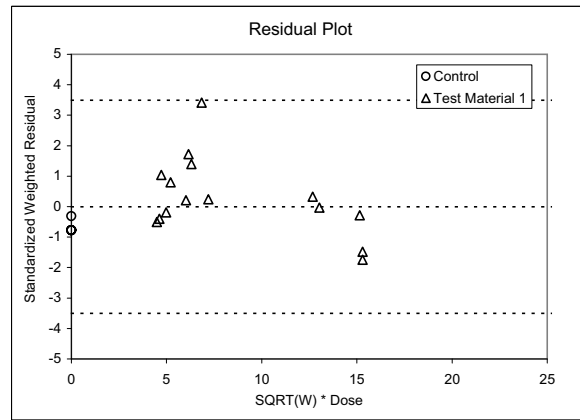
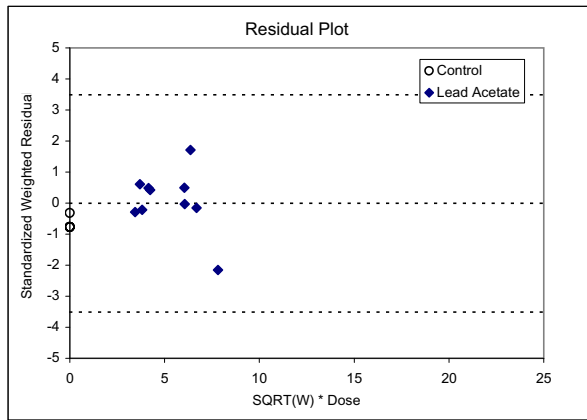
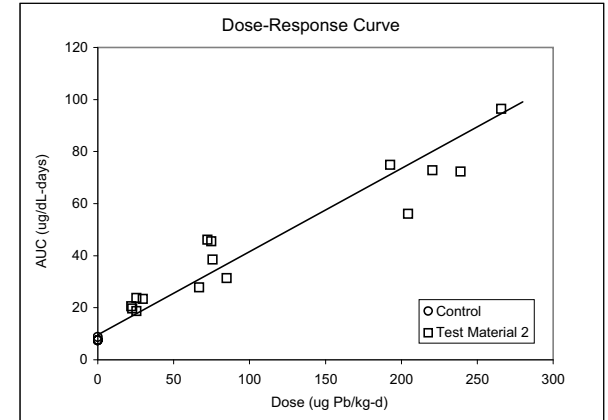
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.61E+00	1.08E+00
b1	5.94E-01	6.90E-02
b2	3.71E-01	3.20E-02
b3	3.20E-01	2.90E-02
Covariance (c1,c2)	0.0930	--
Covariance (c1,c3)	0.1000	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	92.835
p	< 0.001
Adjusted R ²	0.8623
AIC	328.763

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.62	0.54
Lower bound	0.50	0.43
Upper bound	0.80	0.69
Standard Error	0.086	0.075

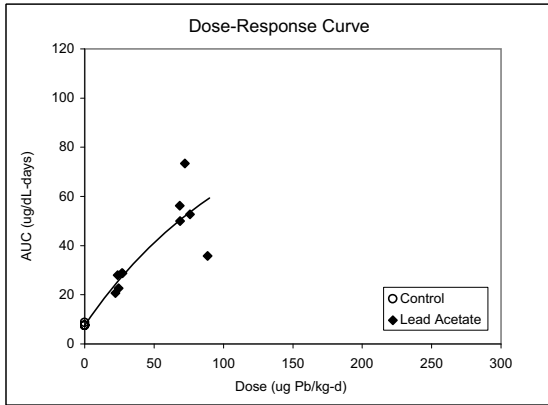
APPENDIX E

Figure 1b - All Data

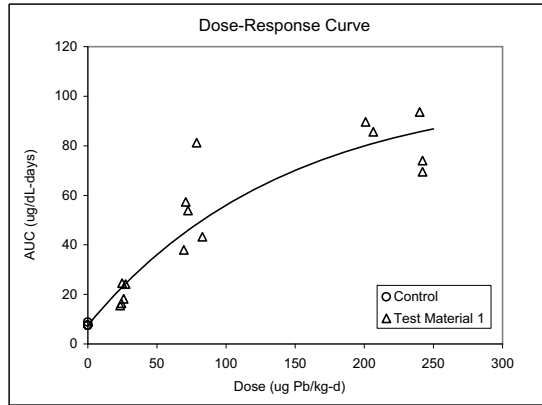
Phase II Experiment 9: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

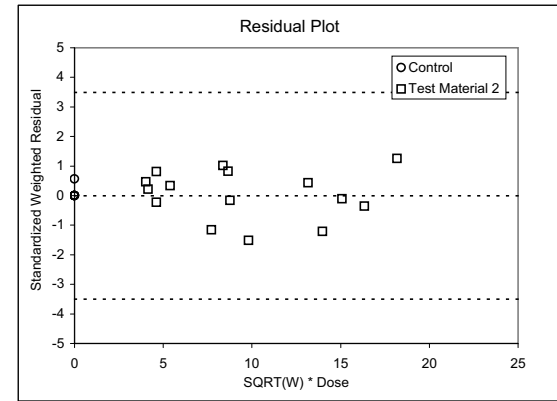
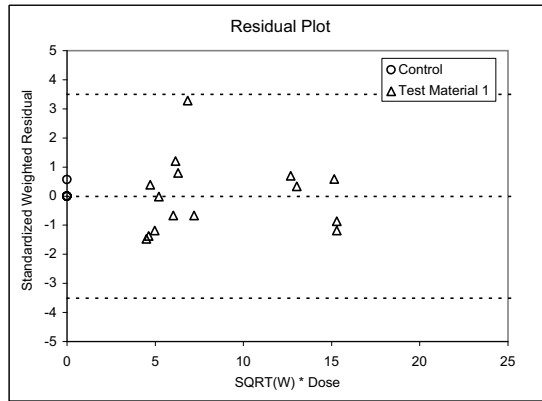
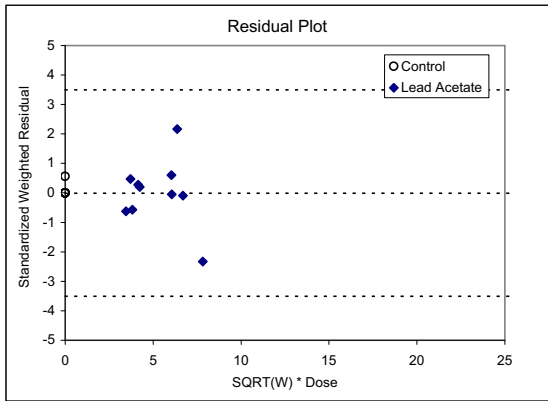
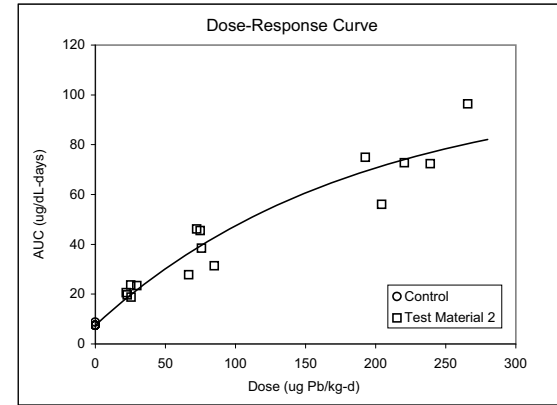
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.51E+00	9.94E-01
b	9.55E+01	1.41E+01
c1	8.68E-03	1.98E-03
c2	7.09E-03	1.78E-03
c3	5.41E-03	1.31E-03
Covariance (c1,c2)	0.8172	--
Covariance (c1,c3)	0.8147	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	111.320
p	< 0.001
Adjusted R ²	0.9093
AIC	312.220

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.82	0.62
Lower bound	0.61	0.47
Upper bound	1.05	0.80
Standard Error	0.119*	0.089*

* $g \geq 0.05$, estimate is uncertain

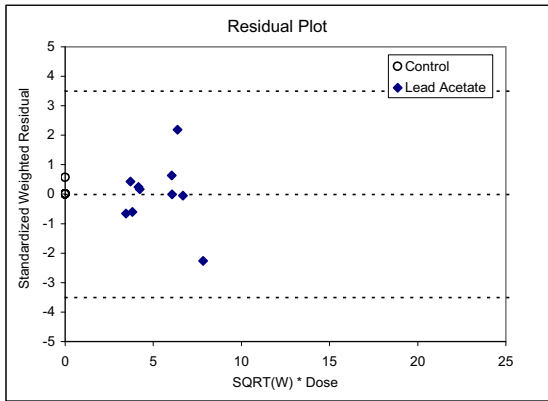
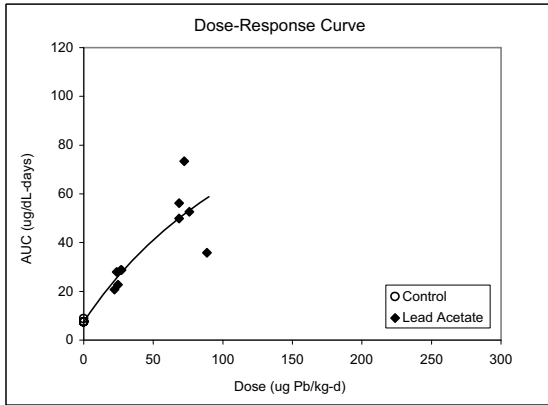
APPENDIX E

Figure 1c - All Data

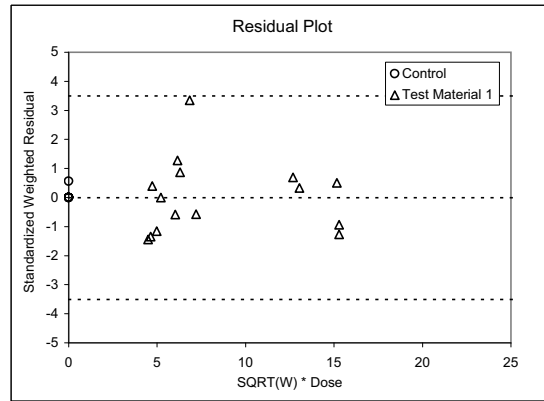
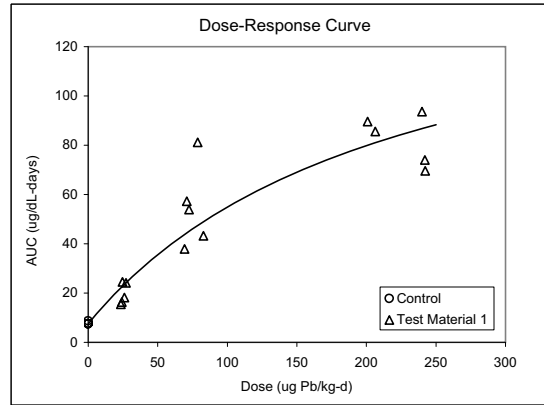
Phase II Experiment 9: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

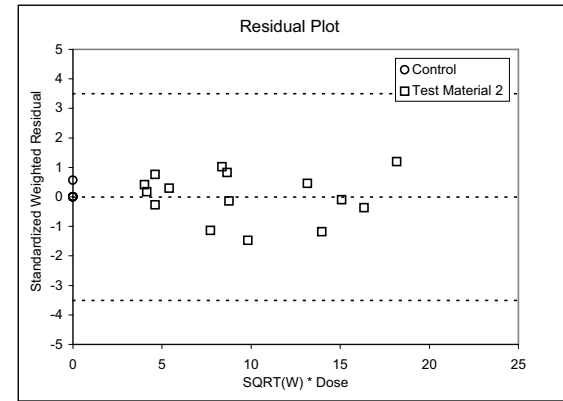
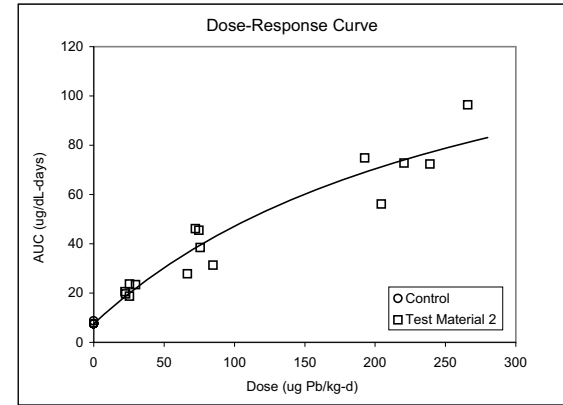
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.50E+00	1.01E+00
b	1.52E+02	2.98E+01
c1	1.77E+02	5.15E+01
c2	2.21E+02	7.00E+01
c3	2.84E+02	8.70E+01
Covariance (c1,c2)	0.8860	--
Covariance (c1,c3)	0.8834	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	109.669
p	< 0.001
Adjusted R ²	0.9081
AIC	312.679

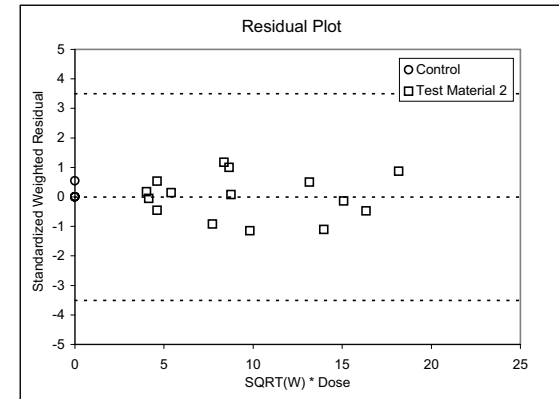
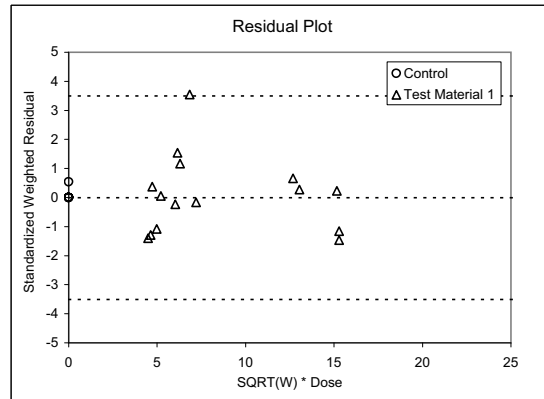
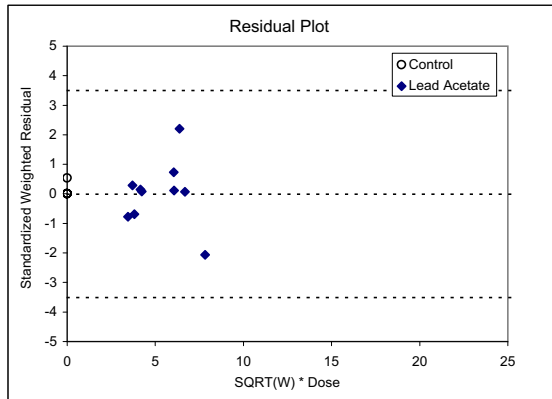
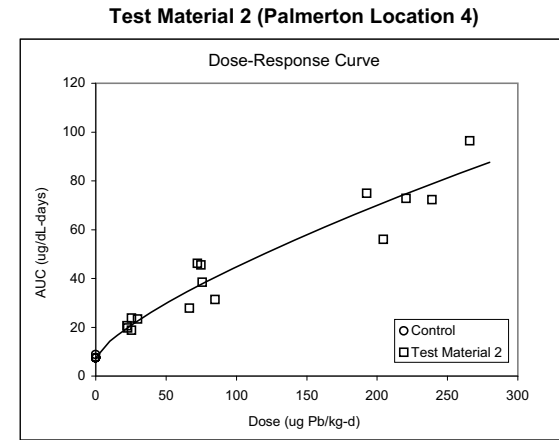
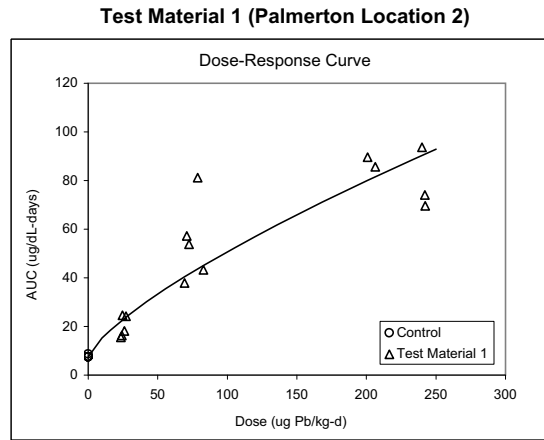
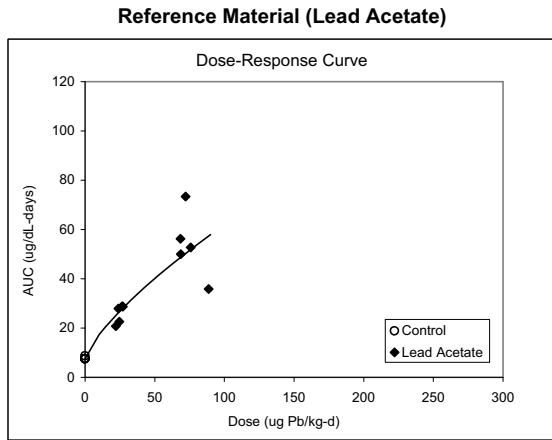
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.80	0.62
Lower bound	0.62	0.48
Upper bound	1.10	0.84
Standard Error	0.118*	0.090*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 9: Blood AUC
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.49E+00	1.08E+00
b1	1.78E+00	4.67E-01
b2	1.41E+00	4.22E-01
b3	1.22E+00	3.68E-01
c	7.43E-01	5.86E-02
Covariance (b1,b2)	0.9184	--
Covariance (b1,b3)	0.9173	--
Degrees of Freedom	40	--

Goodness of Fit

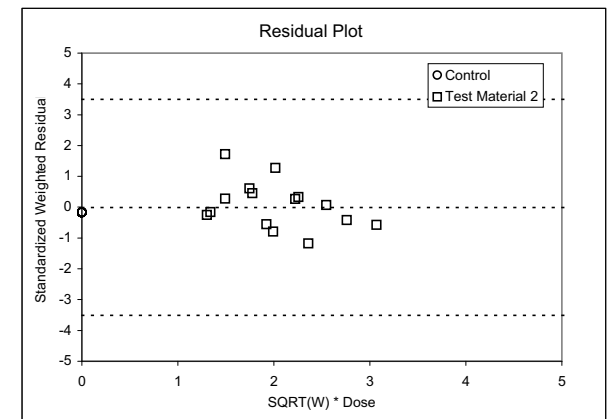
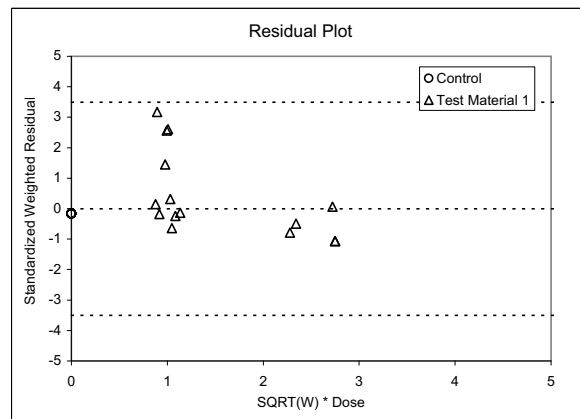
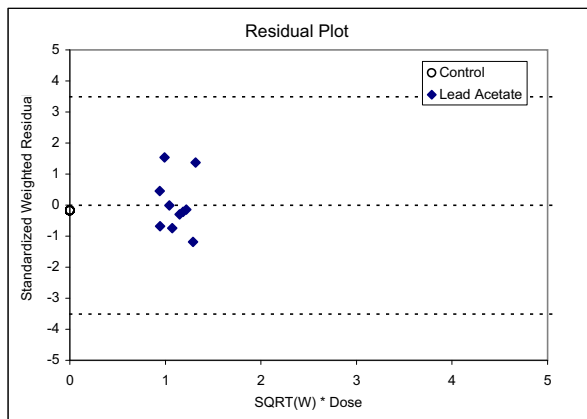
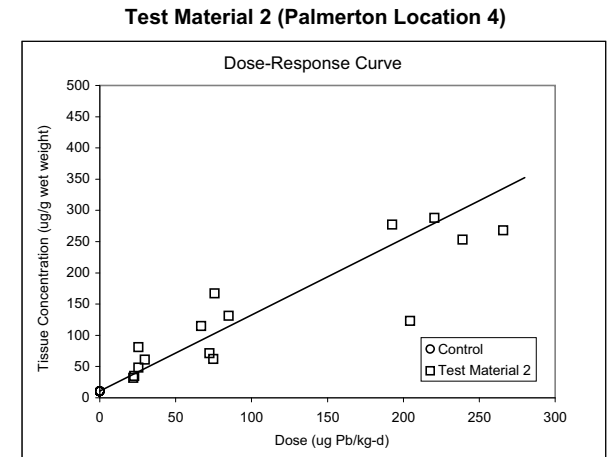
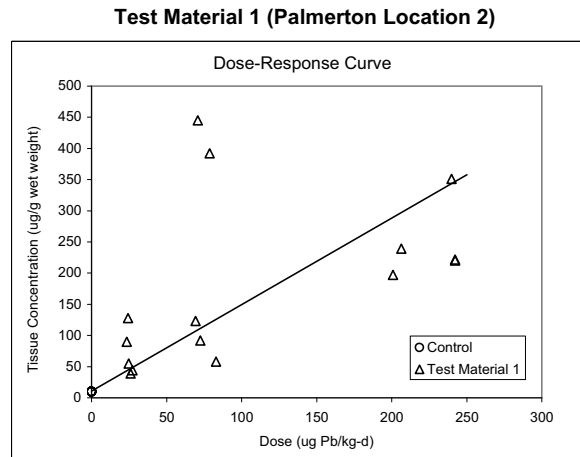
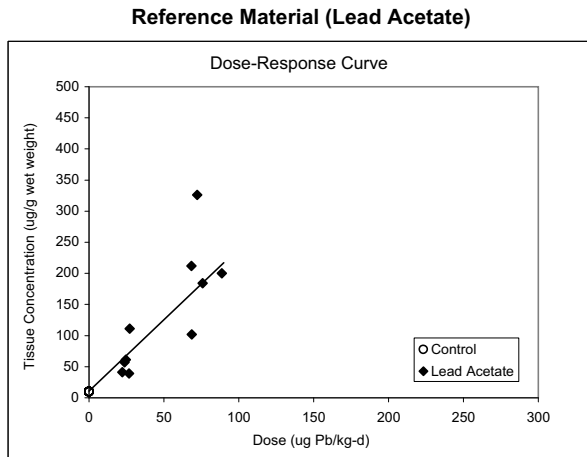
Statistic	Estimate
F	98.378
p	< 0.001
Adjusted R ²	0.8985
AIC	316.197

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.73	0.60
Lower bound	0.51	0.41
Upper bound	0.95	0.78
Standard Error	--	--

APPENDIX E

Figure 2a - All Data
Phase II Experiment 9: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.07E+01	1.88E+00
b1	2.30E+00	3.98E-01
b2	1.39E+00	2.14E-01
b3	1.22E+00	1.75E-01
Covariance (c1,c2)	0.0117	--
Covariance (c1,c3)	0.0189	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	40.132
p	< 0.001
Adjusted R ²	0.7274
AIC	484.924

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.60	0.53
Lower bound	0.41	0.37
Upper bound	0.91	0.79
Standard Error	0.139*	0.119*

* $g \geq 0.05$, estimate is uncertain

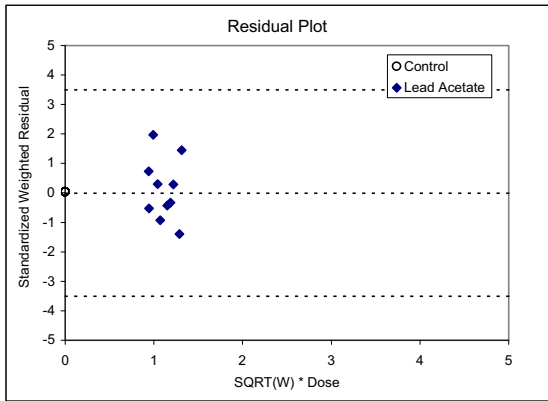
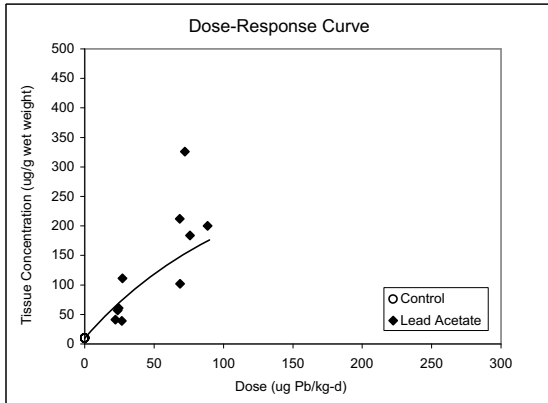
APPENDIX E

Figure 2b - All Data

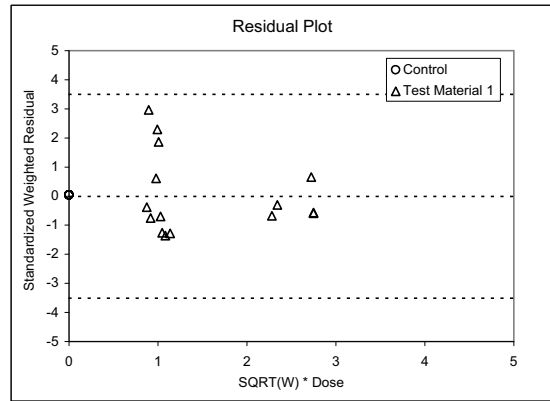
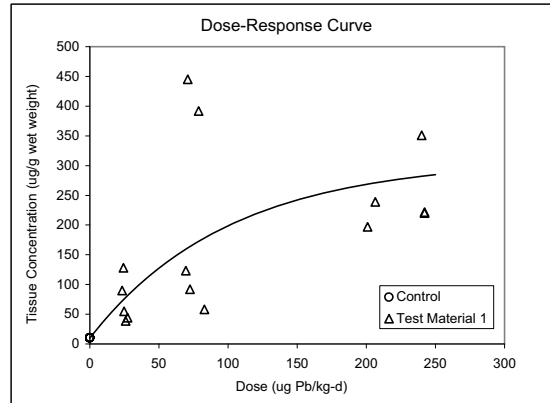
Phase II Experiment 9: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

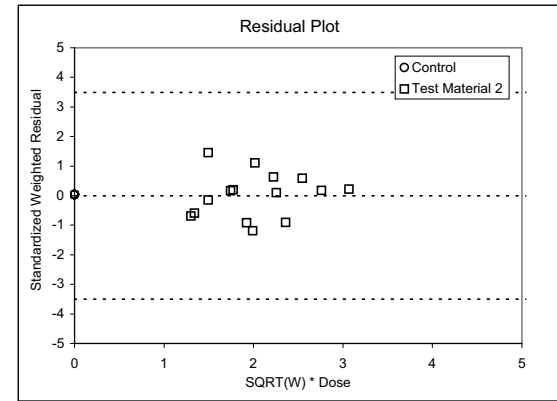
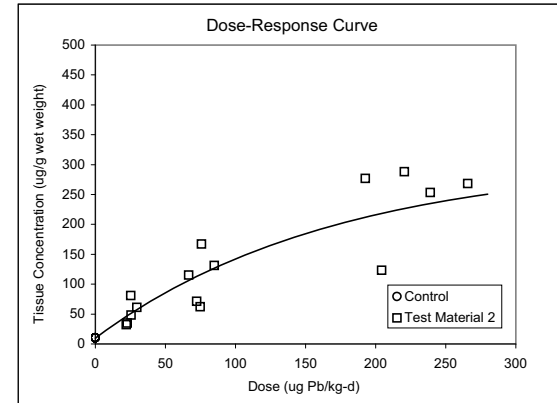
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.87E+00	1.72E+00
b	2.99E+02	7.29E+01
c1	9.01E-03	3.15E-03
c2	9.97E-03	3.96E-03
c3	5.83E-03	2.08E-03
Covariance (c1,c2)	0.7276	--
Covariance (c1,c3)	0.7387	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	39.356
p	< 0.001
Adjusted R ²	0.7771
AIC	470.653

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	1.11	0.65
Lower bound	0.56	0.38
Upper bound	1.86	1.09
Standard Error	0.309*	0.165*

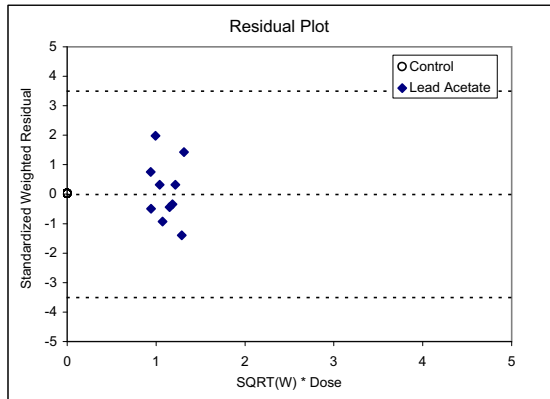
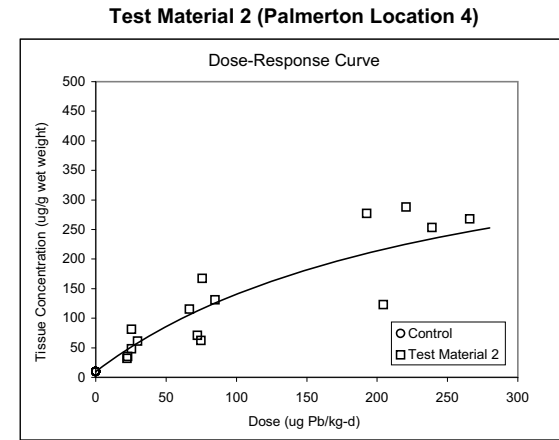
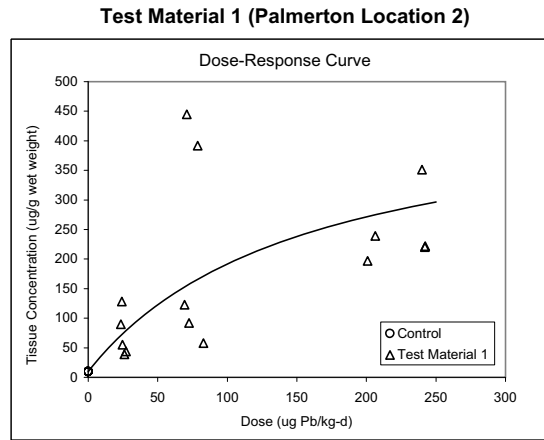
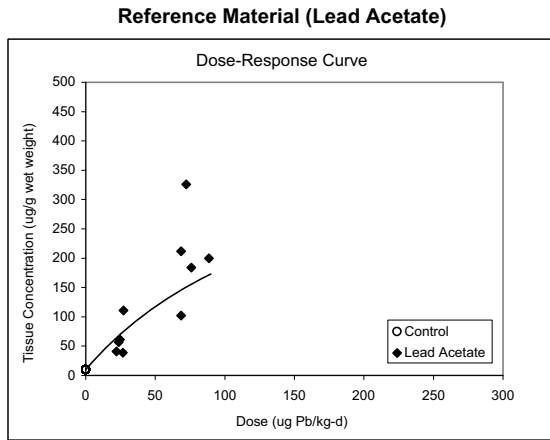
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2c - All Data

Phase II Experiment 9: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.88E+00	1.74E+00
b	4.66E+02	1.53E+02
c1	1.67E+02	7.50E+01
c2	1.56E+02	8.13E+01
c3	2.57E+02	1.19E+02
Covariance (c1,c2)	0.8328	--
Covariance (c1,c3)	0.8354	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	38.613
p	< 0.001
Adjusted R ²	0.7737
AIC	471.634

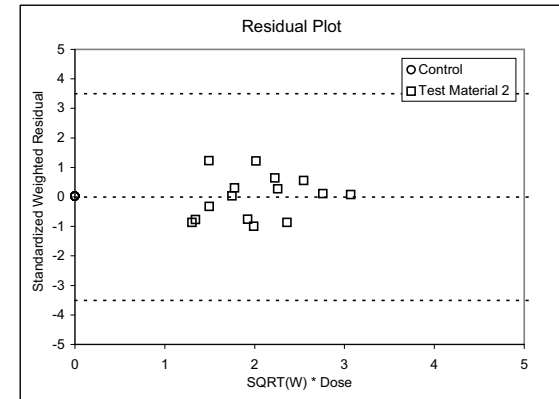
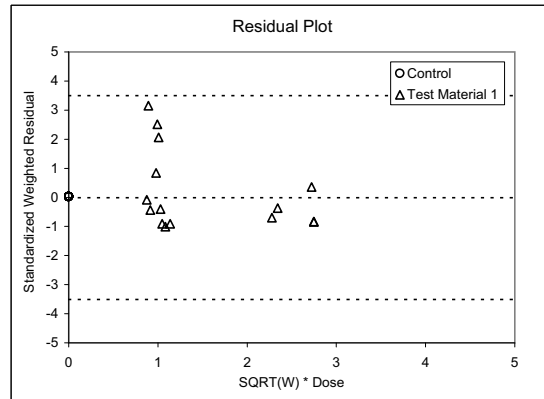
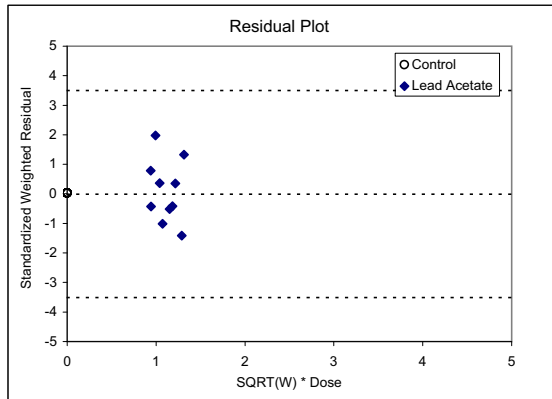
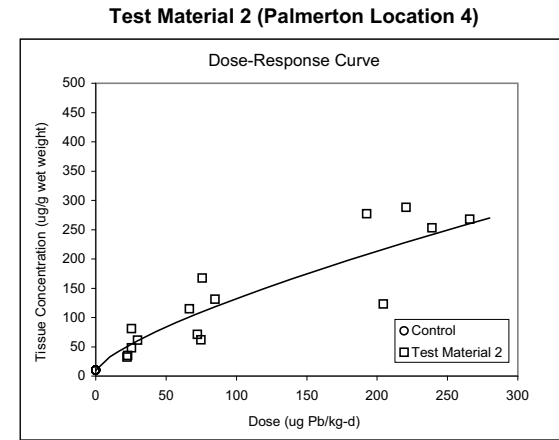
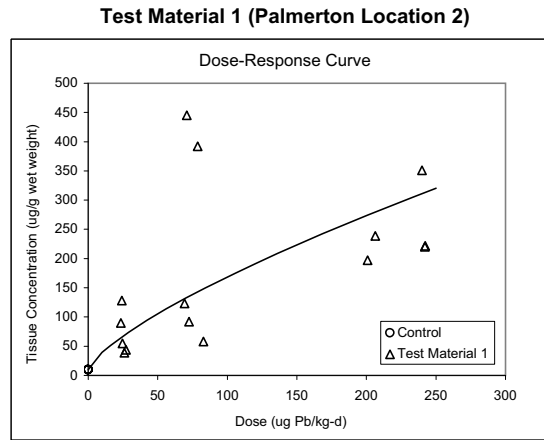
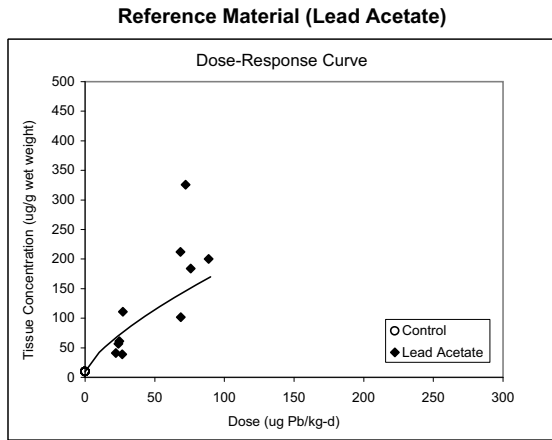
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	1.07	0.65
Lower bound	0.60	0.35
Upper bound	3.55	1.33
Standard Error	0.309*	0.170*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2d - All Data
Phase II Experiment 9: Liver
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.91E+00	1.80E+00
b1	5.94E+00	2.26E+00
b2	5.45E+00	2.53E+00
b3	4.20E+00	1.84E+00
c	7.32E-01	9.60E-02
Covariance (b1,b2)	0.8634	--
Covariance (b1,b3)	0.8614	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	35.748
p	< 0.001
Adjusted R ²	0.7595
AIC	475.710

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.89	0.62
Lower bound	0.29	0.25
Upper bound	1.52	1.08
Standard Error	--	--

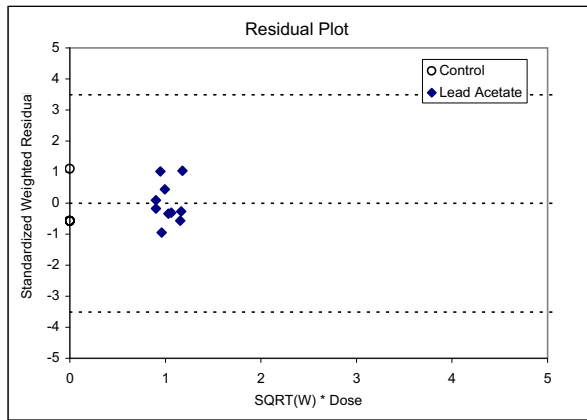
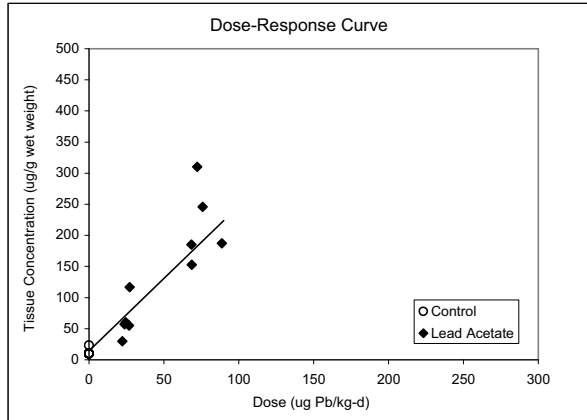
APPENDIX E

Figure 3a - All Data

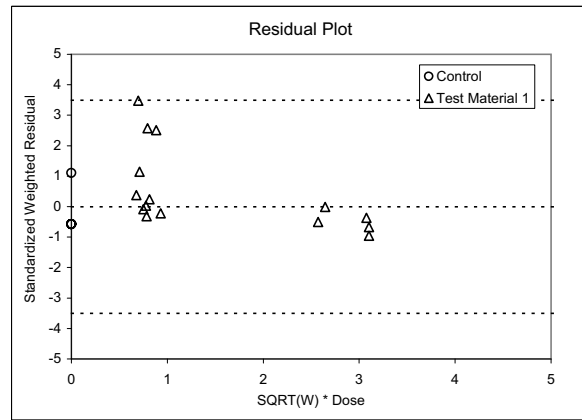
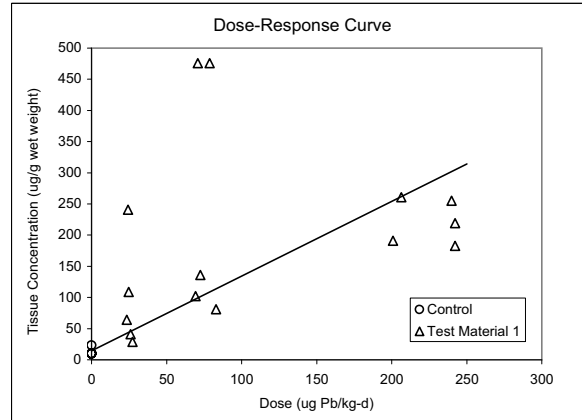
Phase II Experiment 9: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

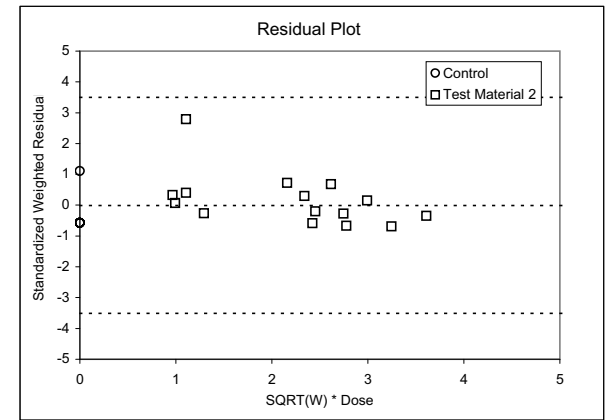
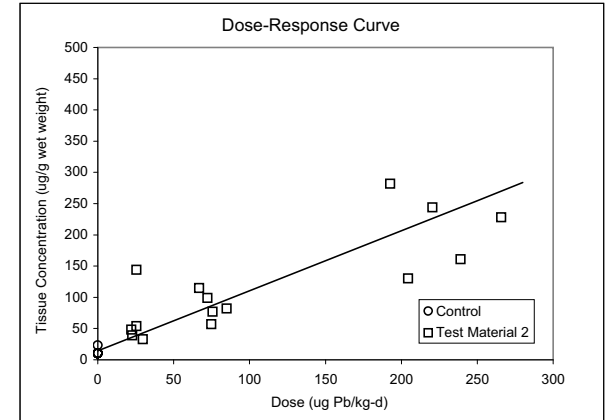
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.45E+01	3.55E+00
b1	2.33E+00	5.37E-01
b2	1.20E+00	2.49E-01
b3	9.61E-01	1.93E-01
Covariance (c1,c2)	0.0182	--
Covariance (c1,c3)	0.0342	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	21.21
p	< 0.001
Adjusted R ²	0.579
AIC	535.863

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.51	0.41
Lower bound	0.30	0.25
Upper bound	0.91	0.72
Standard Error	0.158*	0.124*

* $g \geq 0.05$, estimate is uncertain

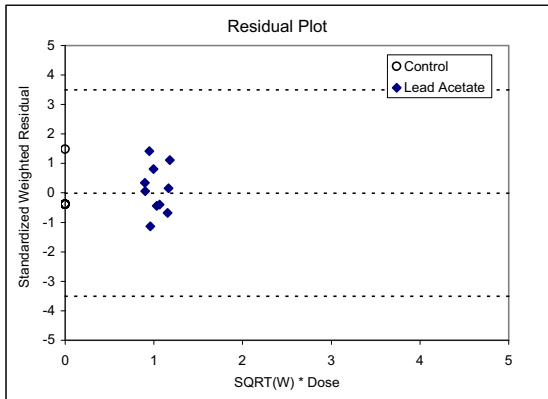
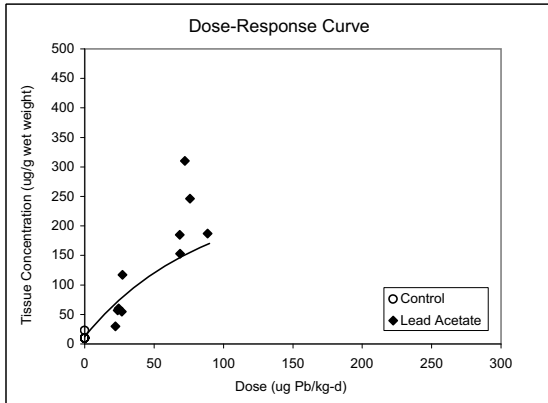
APPENDIX E

Figure 3b - All Data

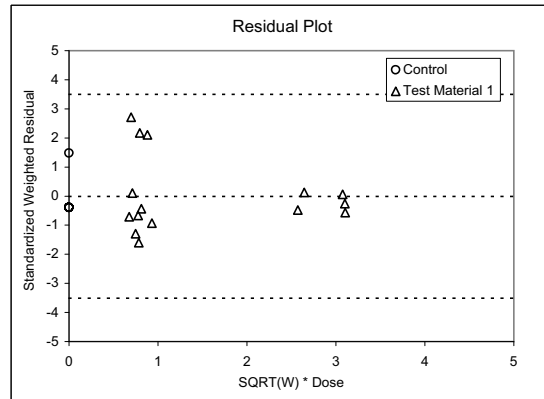
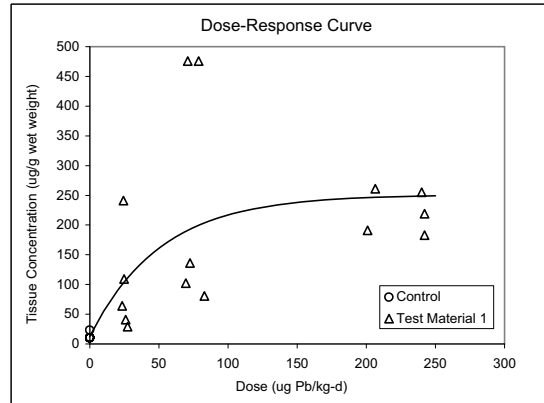
Phase II Experiment 9: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

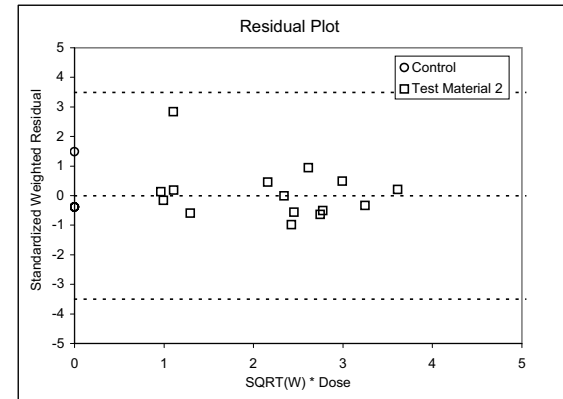
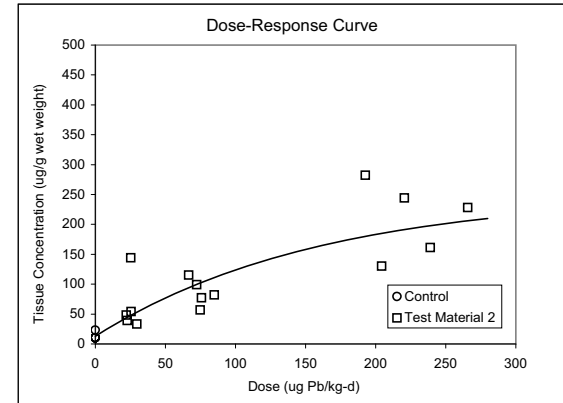
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.27E+01	3.25E+00
b	2.38E+02	5.33E+01
c1	1.20E-02	4.75E-03
c2	1.95E-02	9.03E-03
c3	6.28E-03	2.47E-03
Covariance (c1,c2)	0.5421	--
Covariance (c1,c3)	0.5740	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	22.48
p	< 0.001
Adjusted R ²	0.661
AIC	511.641

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	1.62	0.52
Lower bound	0.50	0.24
Upper bound	3.66	1.16
Standard Error	0.672*	0.190*

* $g \geq 0.05$, estimate is uncertain

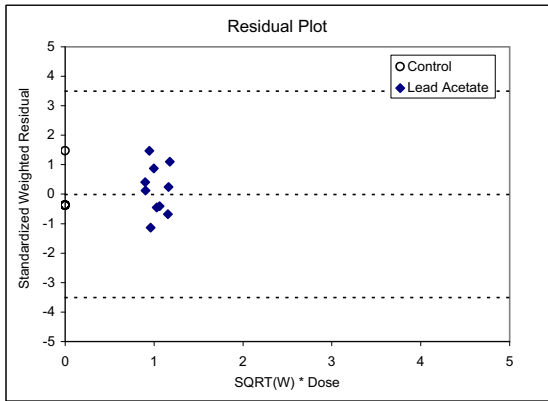
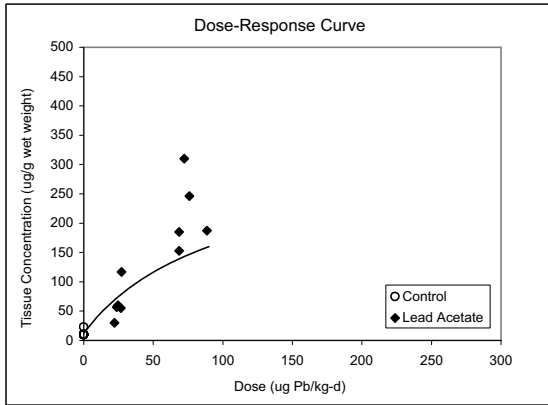
APPENDIX E

Figure 3c - All Data

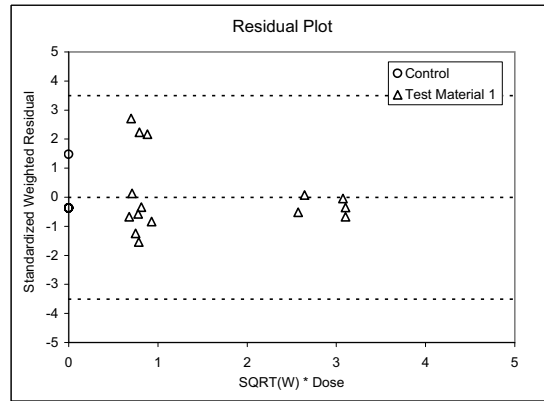
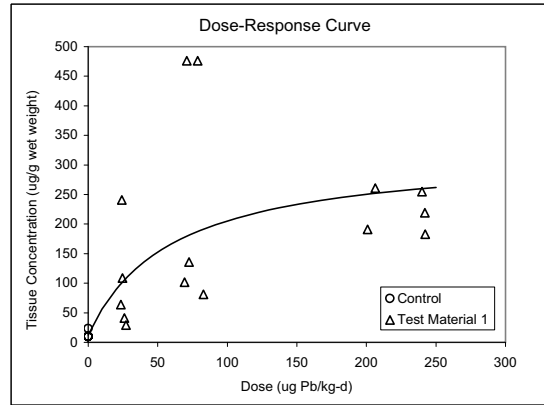
Phase II Experiment 9: Kidney

Michaelis-Menton Model: $y = a + b*x1/(c1+x1) + b*x2/(c2+x2) + b*x3/(c3+x3)$

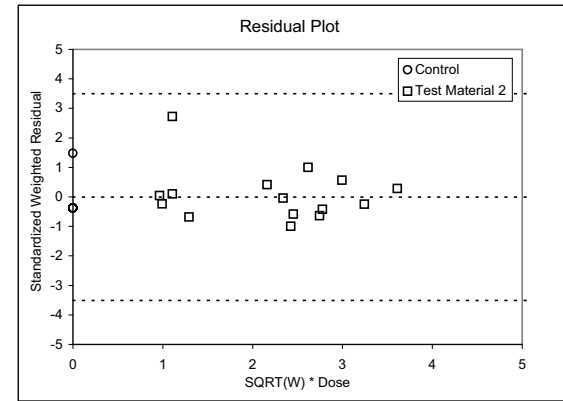
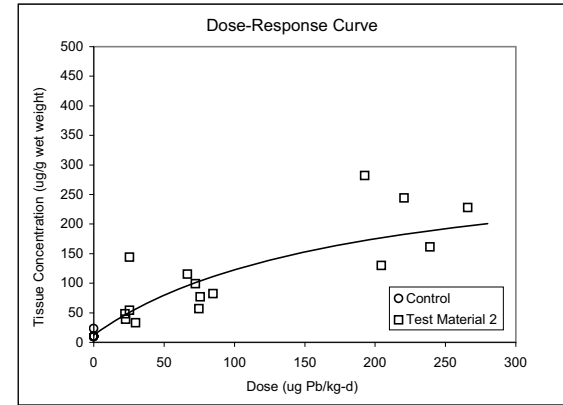
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.26E+01	3.29E+00
b	3.10E+02	9.28E+01
c1	9.94E+01	5.00E+01
c2	6.09E+01	3.95E+01
c3	1.82E+02	9.29E+01
Covariance (c1,c2)	0.6978	--
Covariance (c1,c3)	0.6997	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	21.85
p	< 0.001
Adjusted R ²	0.655
AIC	513.547

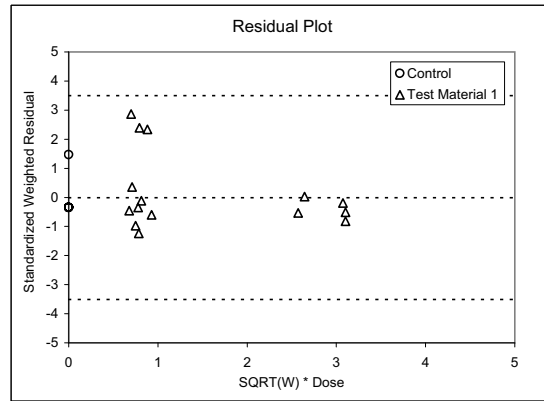
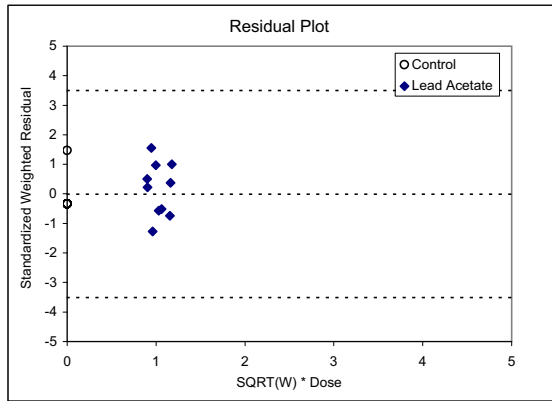
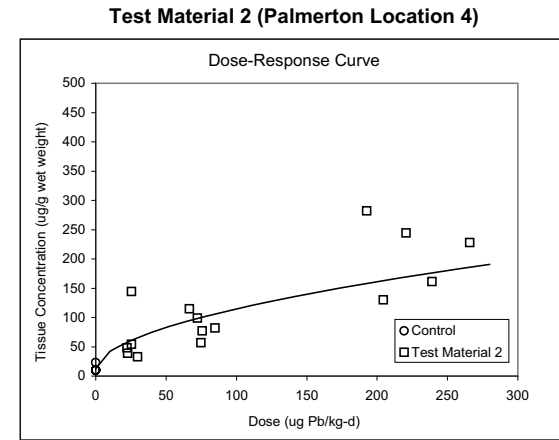
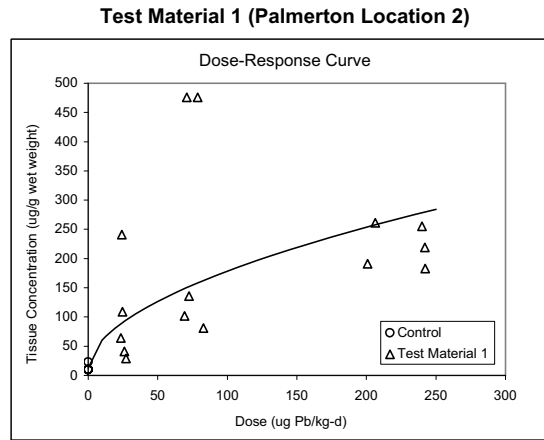
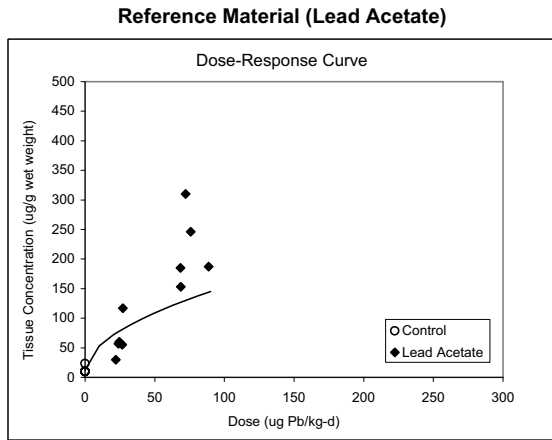
RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	1.63	0.55
Lower bound	0.59	0.17
Upper bound	-6.63	1.89
Standard Error	0.763*	0.215*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3d - All Data
Phase II Experiment 9: Kidney
Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.25E+01	3.39E+00
b1	1.17E+01	5.96E+00
b2	1.38E+01	8.75E+00
b3	8.50E+00	5.09E+00
c	5.40E-01	1.31E-01
Covariance (b1,b2)	0.8697	--
Covariance (b1,b3)	0.8638	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	20.25
p	< 0.001
Adjusted R ²	0.636
AIC	518.750

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	1.36	0.56
Lower bound	?	?
Upper bound	4.22	1.94
Standard Error	--	--

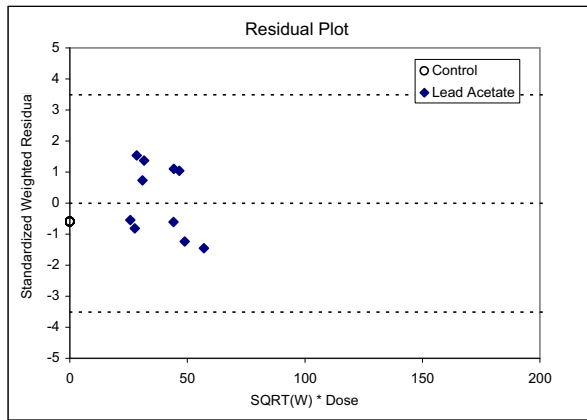
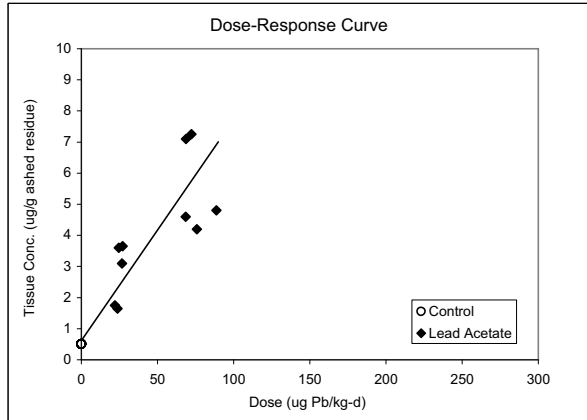
APPENDIX E

Figure 4a - All Data

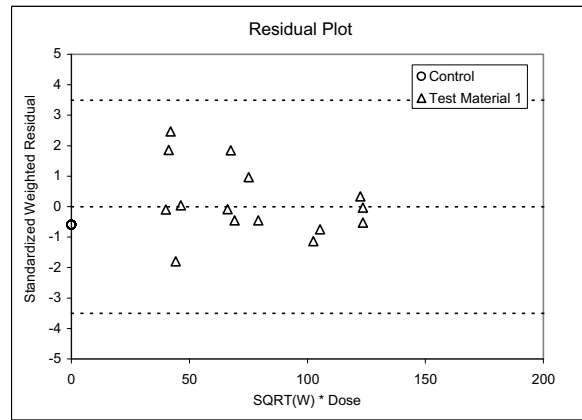
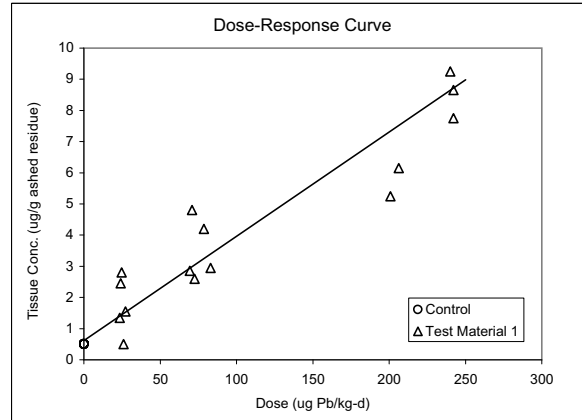
Phase II Experiment 9: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

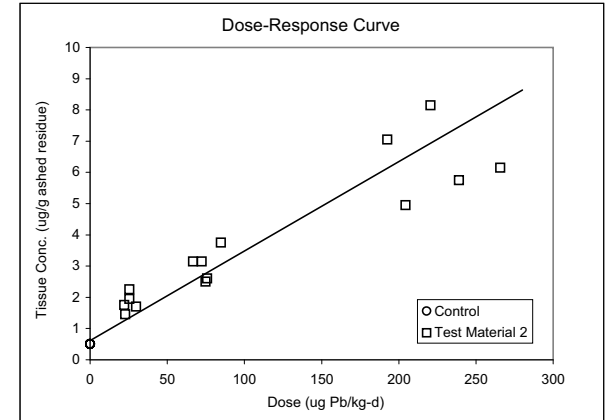
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.17E-01	8.33E-02
b1	7.10E-02	7.90E-03
b2	3.34E-02	3.15E-03
b3	2.87E-02	2.85E-03
Covariance (c1,c2)	0.0554	--
Covariance (c1,c3)	0.0566	--
Degrees of Freedom	41	--

Goodness of Fit

Statistic	Estimate
F	87.669
p	< 0.001
Adjusted R ²	0.8553
AIC	118.621

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.47	0.40
Lower bound	0.37	0.32
Upper bound	0.60	0.52
Standard Error	0.067	0.058

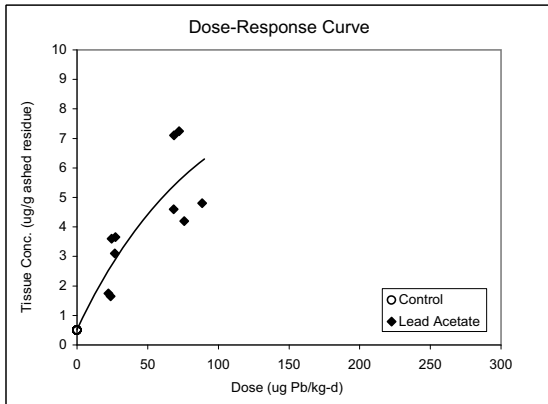
APPENDIX E

Figure 4b - All Data

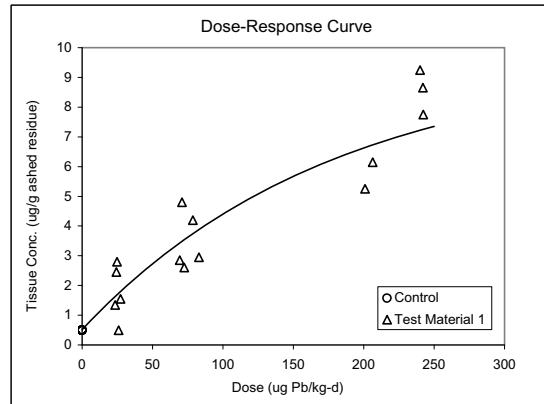
Phase II Experiment 9: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

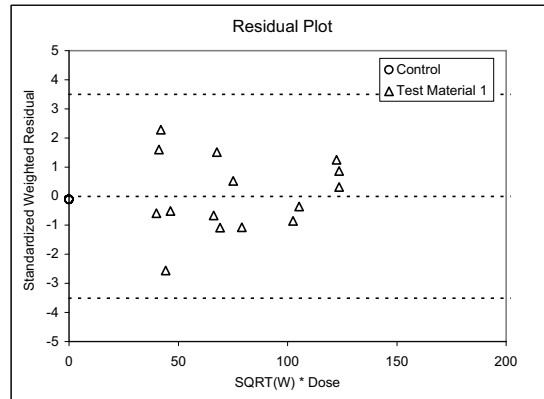
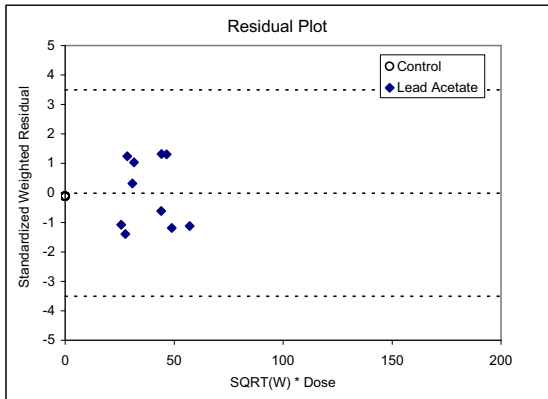
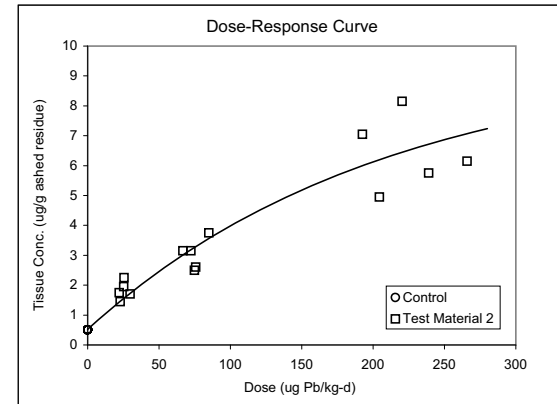
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.20E-01	8.02E-02
b	9.08E+00	2.03E+00
c1	1.12E-02	3.77E-03
c2	5.58E-03	1.87E-03
c3	4.80E-03	1.60E-03
Covariance (c1,c2)	0.8717	--
Covariance (c1,c3)	0.8714	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	84.798
p	< 0.001
Adjusted R ²	0.8840
AIC	112.175

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.50	0.43
Lower bound	0.35	0.30
Upper bound	0.70	0.60
Standard Error	0.084*	0.072*

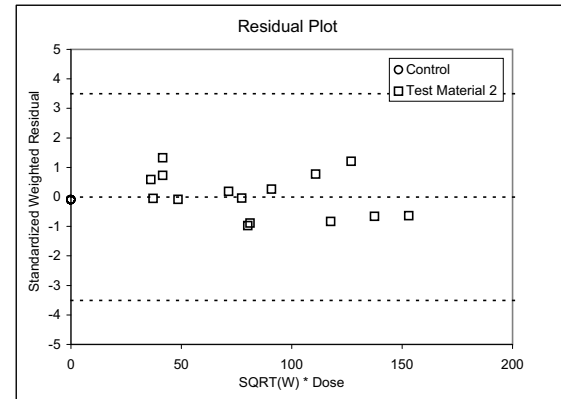
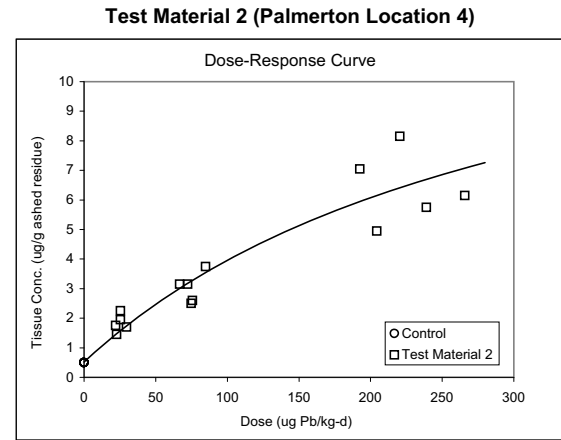
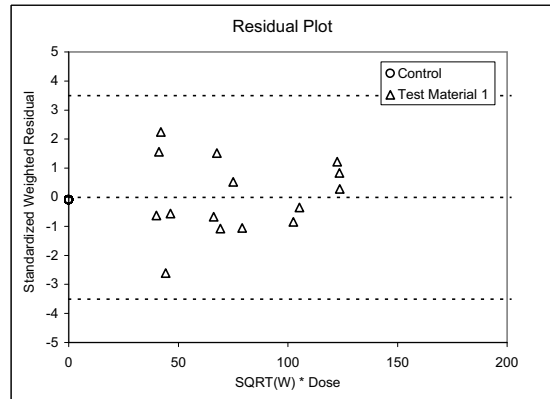
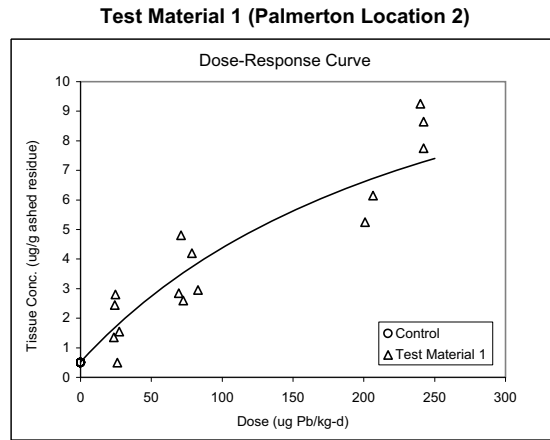
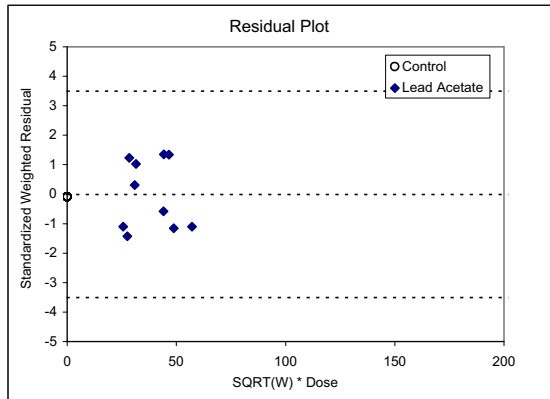
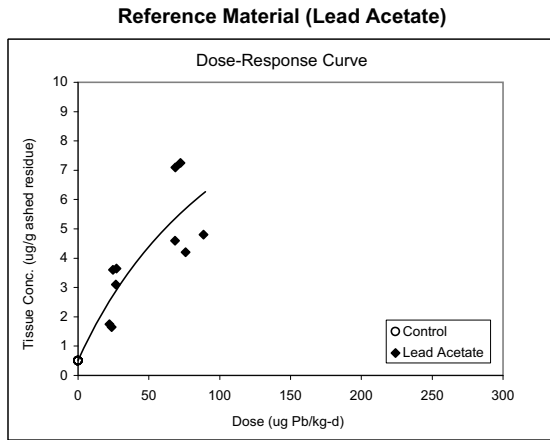
* $g \geq 0.05$, estimate is uncertain

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Figure 4c - All Data

Phase II Experiment 9: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.16E-01	8.03E-02
b	1.45E+01	3.90E+00
c1	1.36E+02	5.41E+01
c2	2.74E+02	1.09E+02
c3	3.20E+02	1.26E+02
Covariance (c1,c2)	0.9096	--
Covariance (c1,c3)	0.9088	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	85.458
p	< 0.001
Adjusted R ²	0.8848
AIC	111.965

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.50	0.43
Lower bound	0.34	0.29
Upper bound	0.72	0.62
Standard Error	0.084*	0.072*

* $g \geq 0.05$, estimate is uncertain

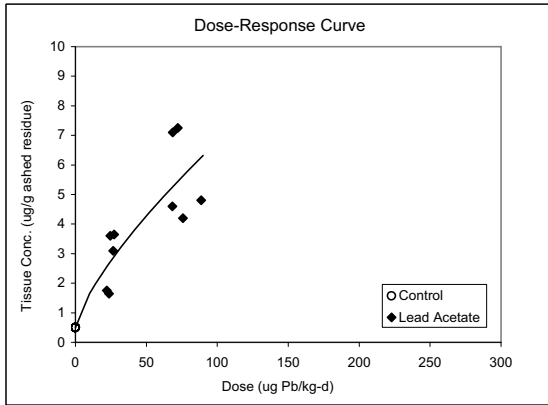
APPENDIX E

Figure 4d - All Data

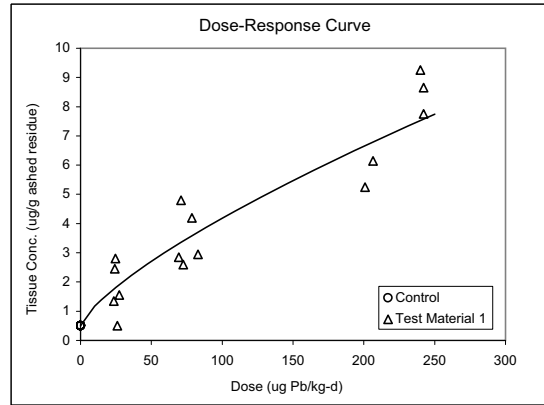
Phase II Experiment 9: Femur

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

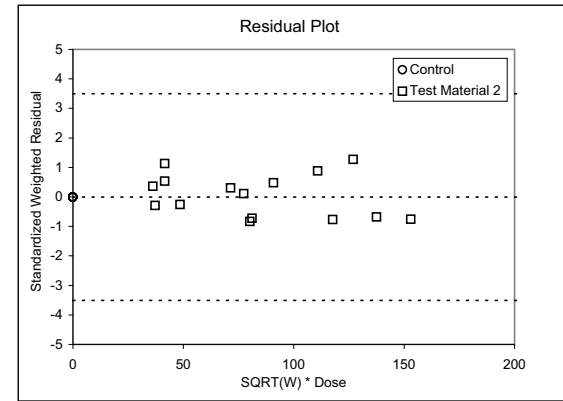
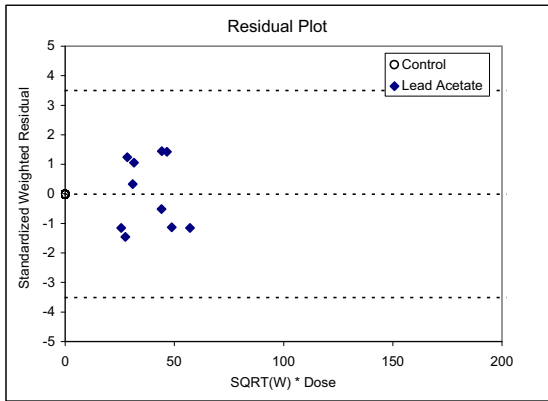
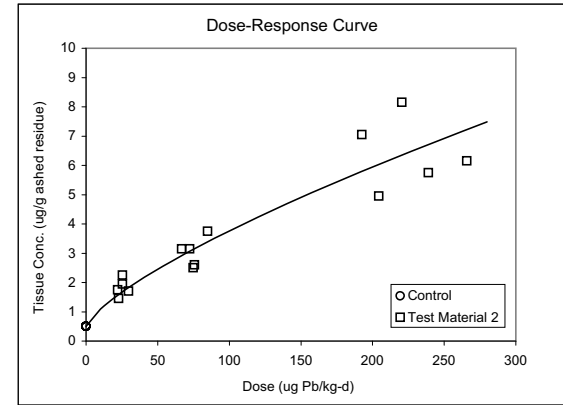
Reference Material (Lead Acetate)



Test Material 1 (Palmerston Location 2)



Test Material 2 (Palmerston Location 4)



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.02E-01	8.02E-02
b1	2.09E-01	5.76E-02
b2	1.22E-01	3.88E-02
b3	1.08E-01	3.51E-02
c	7.40E-01	6.47E-02
Covariance (b1,b2)	0.9159	--
Covariance (b1,b3)	0.9151	--
Degrees of Freedom	40	--

Goodness of Fit

Statistic	Estimate
F	88.101
p	< 0.001
Adjusted R ²	0.8879
AIC	111.154

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.48	0.41
Lower bound	0.32	0.27
Upper bound	0.64	0.55
Standard Error	--	--

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APPENDIX E

EXPERIMENT 11

Test Material 1: Murray Smelter Soil

Test Material 2: NIST Paint

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

- Figure 2a Liver - Linear Model
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

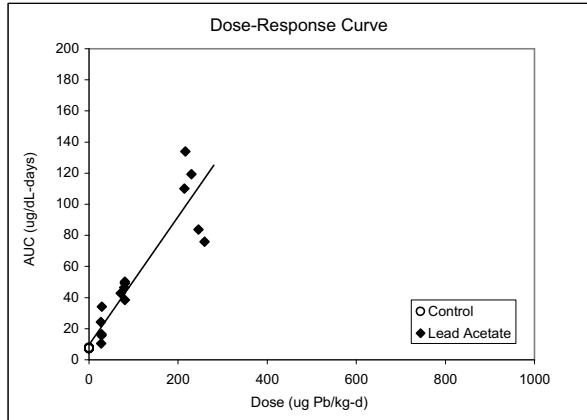
- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

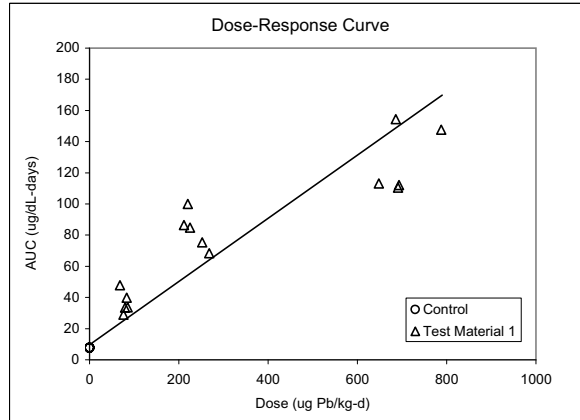
Figure 1a - All Data

Phase II Experiment 11: Blood AUC
 Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

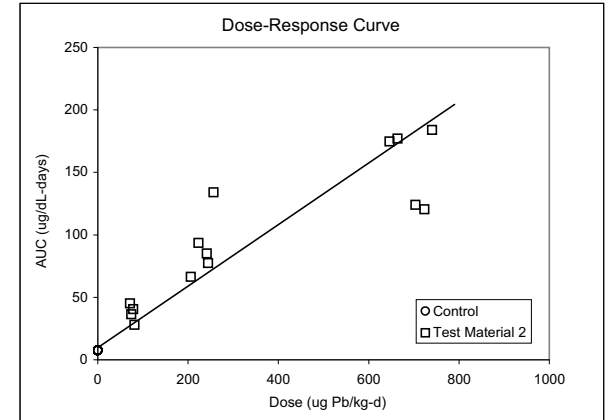
Reference Material (Lead Acetate)



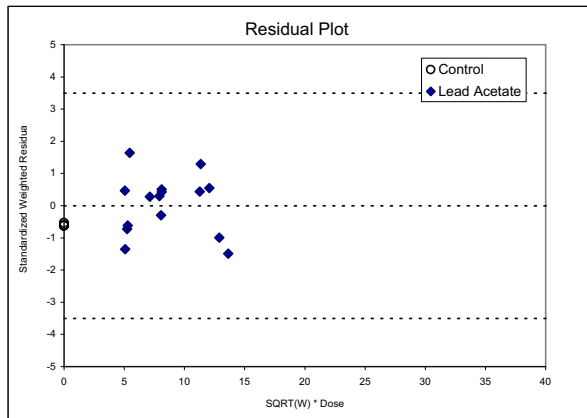
Test Material 1 (Murray Smelter Soil)



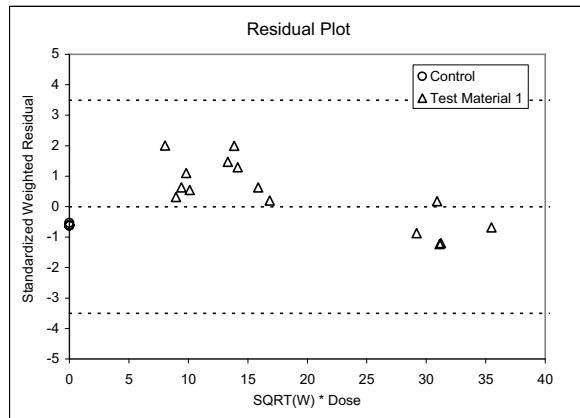
Test Material 2 (NIST Paint)



Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.70E+00	1.48E+00
b1	4.12E-01	4.59E-02
b2	2.03E-01	1.90E-02
b3	2.46E-01	2.20E-02
Covariance (c1,c2)	0.0667	--
Covariance (c1,c3)	0.0600	--
Degrees of Freedom	45	--

Goodness of Fit

Statistic	Estimate
F	96.525
p	< 0.001
Adjusted R ²	0.8565
AIC	436.433

RBA and Uncertainty

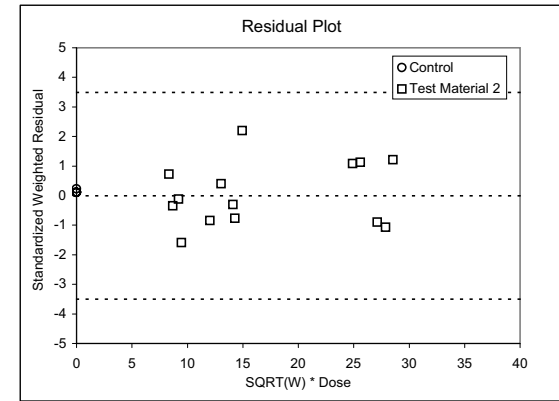
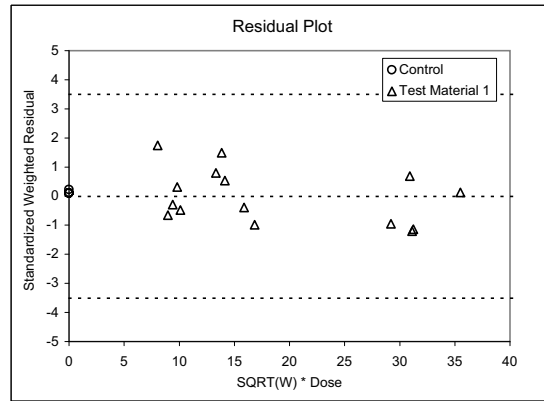
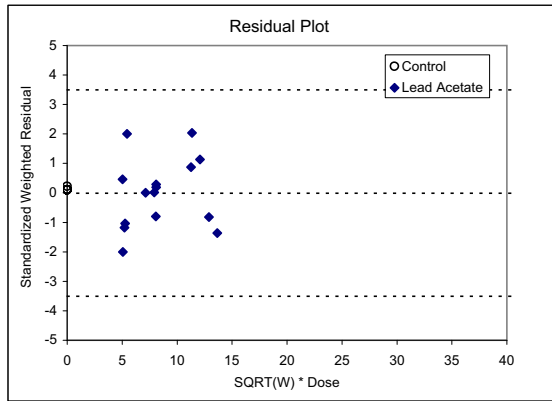
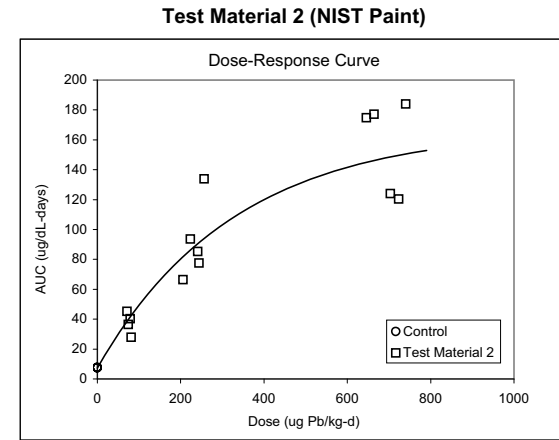
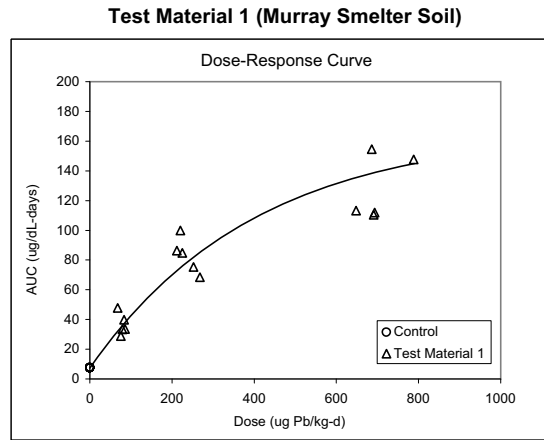
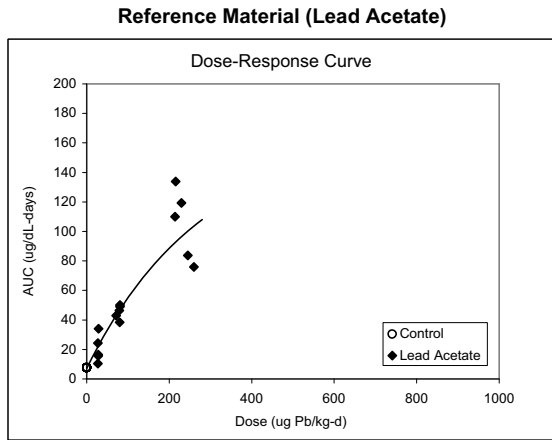
	Test Material 1	Test Material 2
RBA	0.49	0.60
Lower bound	0.39	0.48
Upper bound	0.63	0.76
Standard Error	0.069	0.083

APPENDIX E

Figure 1b - All Data

Phase II Experiment 11: Blood AUC

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.21E+00	1.18E+00
b	1.60E+02	1.75E+01
c1	3.54E-03	6.21E-04
c2	2.49E-03	4.96E-04
c3	3.04E-03	6.15E-04
Covariance (c1,c2)	0.7274	--
Covariance (c1,c3)	0.7186	--
Degrees of Freedom	44	--

Goodness of Fit

Statistic	Estimate
F	143.605
p	< 0.001
Adjusted R ²	0.9224
AIC	390.414

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.70	0.86
Lower bound	0.54	0.66
Upper bound	0.89	1.09
Standard Error	0.098*	0.123*

* $g \geq 0.05$, estimate is uncertain

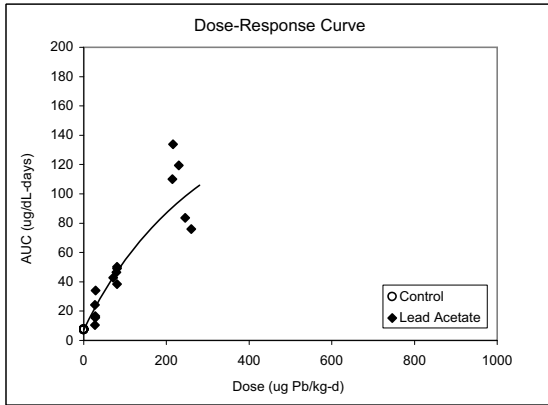
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Figure 1c - All Data

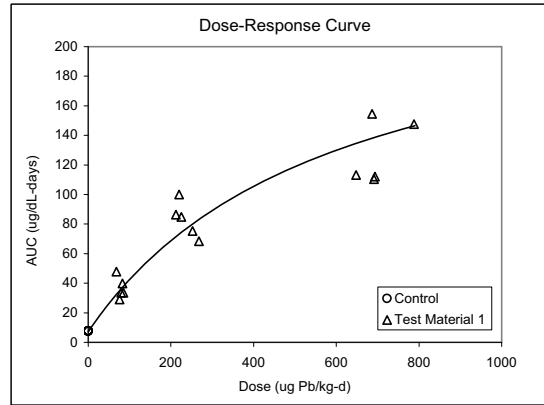
Phase II Experiment 11: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

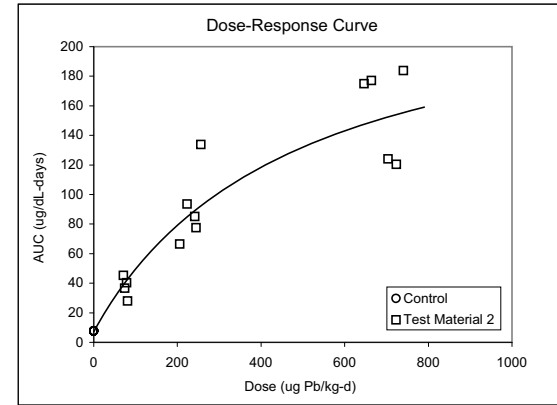
Reference Material (Lead Acetate)



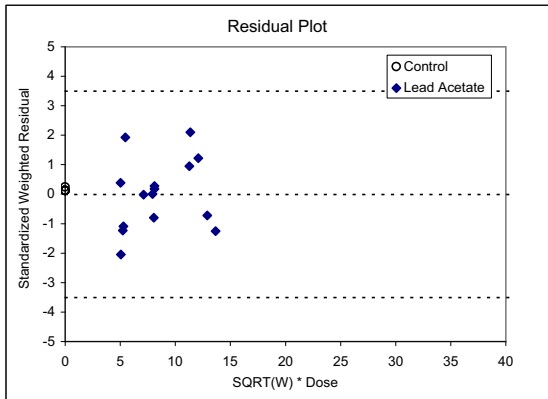
Test Material 1 (Murray Smelter Soil)



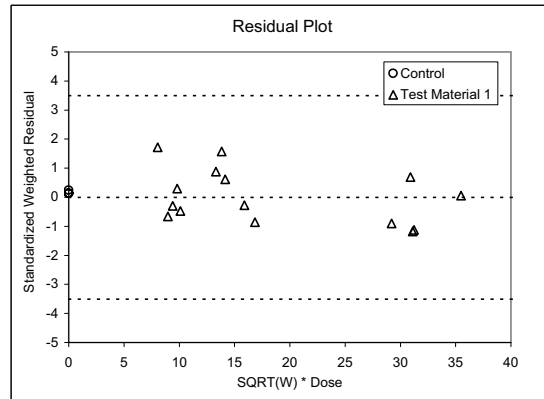
Test Material 2 (NIST Paint)



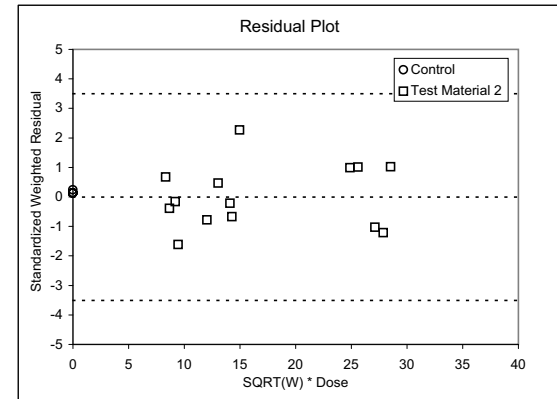
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.16E+00	1.20E+00
b	2.44E+02	3.62E+01
c1	4.11E+02	9.21E+01
c2	5.91E+02	1.50E+02
c3	4.76E+02	1.24E+02
Covariance (c1,c2)	0.8303	--
Covariance (c1,c3)	0.8277	--
Degrees of Freedom	44	--

Goodness of Fit

Statistic	Estimate
F	141.020
p	< 0.001
Adjusted R ²	0.9211
AIC	391.331

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.70	0.86
Lower bound	0.55	0.68
Upper bound	0.93	1.17
Standard Error	0.099*	0.126*

* $g \geq 0.05$, estimate is uncertain

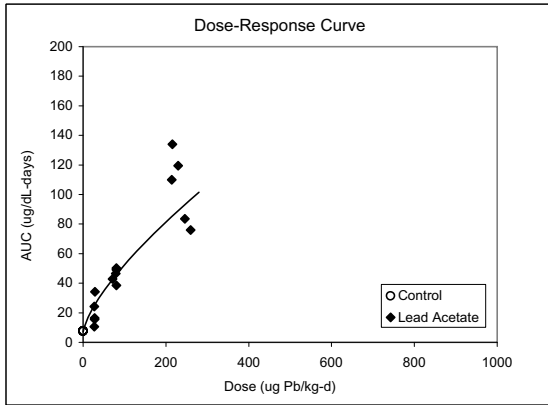
APPENDIX E

Figure 1d - All Data

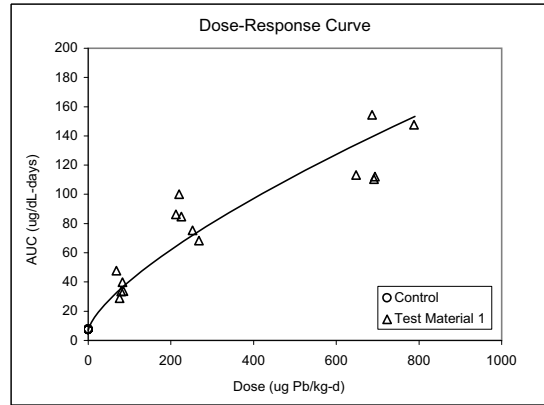
Phase II Experiment 11: Blood AUC

Power Model: $y = a + b_1 \cdot x_1^c + b_2 \cdot x_2^c + b_3 \cdot x_3^c$

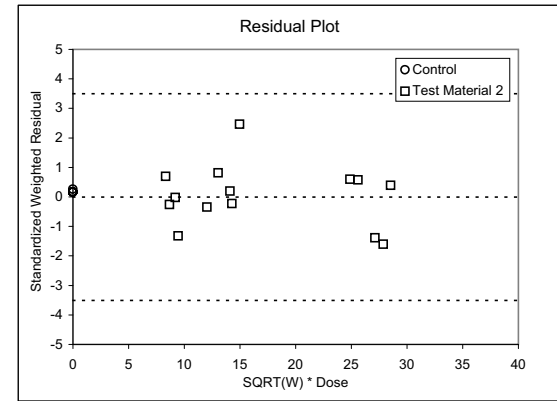
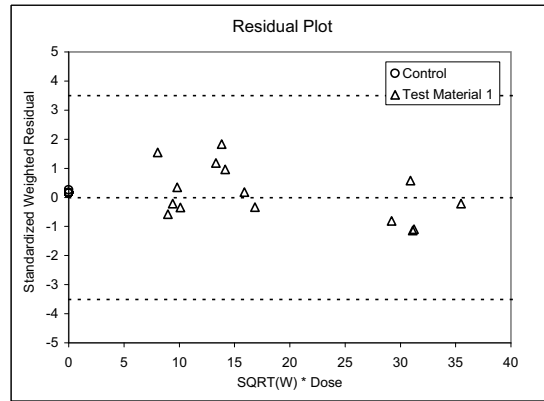
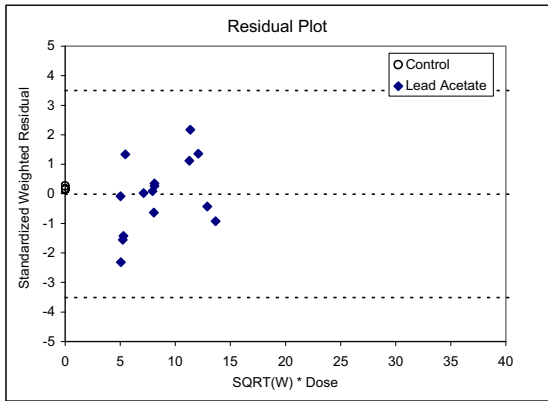
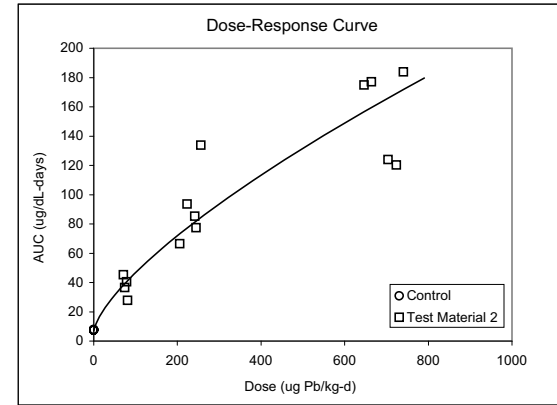
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.04E+00	1.34E+00
b1	1.71E+00	4.52E-01
b2	1.27E+00	4.06E-01
b3	1.49E+00	4.74E-01
c	7.12E-01	5.18E-02
Covariance (b1,b2)	0.9262	--
Covariance (b1,b3)	0.9264	--
Degrees of Freedom	44	--

Goodness of Fit

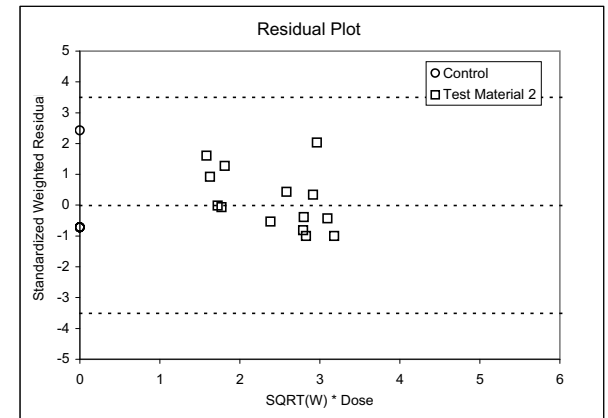
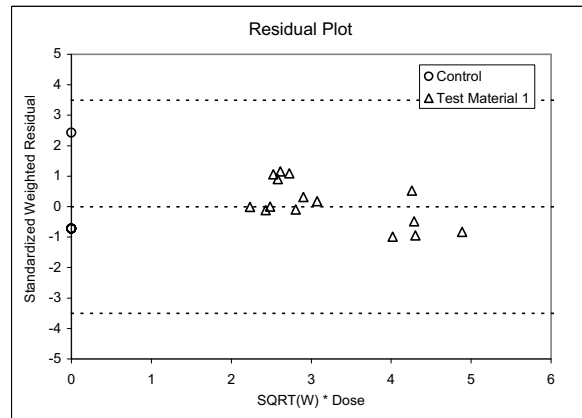
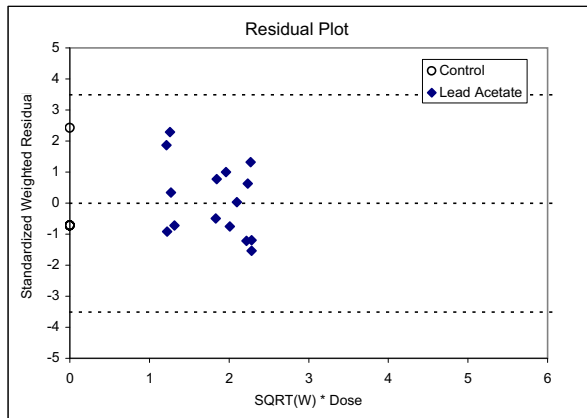
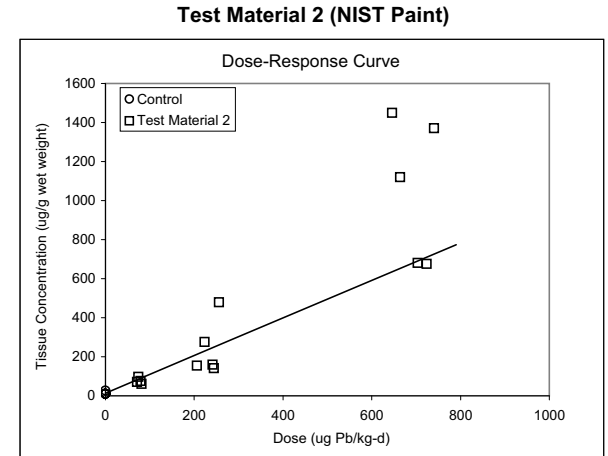
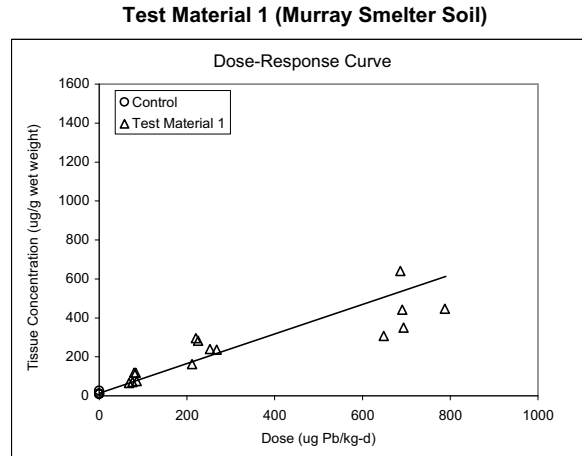
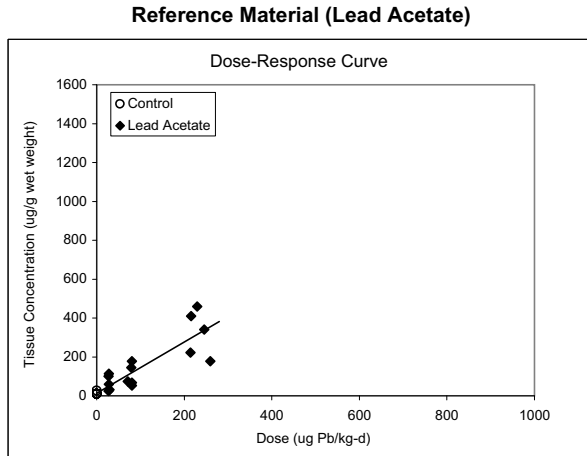
Statistic	Estimate
F	115.506
p	< 0.001
Adjusted R ²	0.9051
AIC	402.393

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.66	0.83
Lower bound	0.42	0.54
Upper bound	0.85	1.07
Standard Error	--	--

APPENDIX E

Figure 2a - All Data
Phase II Experiment 11: Liver
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.37E+01	2.30E+00
b1	1.31E+00	1.80E-01
b2	7.59E-01	1.00E-01
b3	9.62E-01	1.41E-01
Covariance (c1,c2)	0.0165	--
Covariance (c1,c3)	0.0209	--
Degrees of Freedom	44	--

Goodness of Fit

Statistic	Estimate
F	50.849
p	< 0.001
Adjusted R ²	0.7570
AIC	561.444

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.58	0.73
Lower bound	0.42	0.52
Upper bound	0.80	1.03
Standard Error	0.109*	0.145*

* $g \geq 0.05$, estimate is uncertain

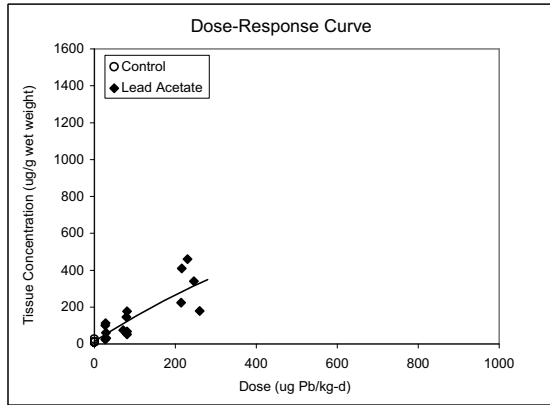
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Figure 2b - All Data

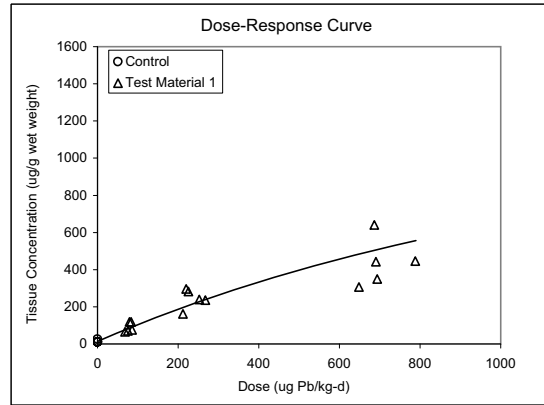
Phase II Experiment 11: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

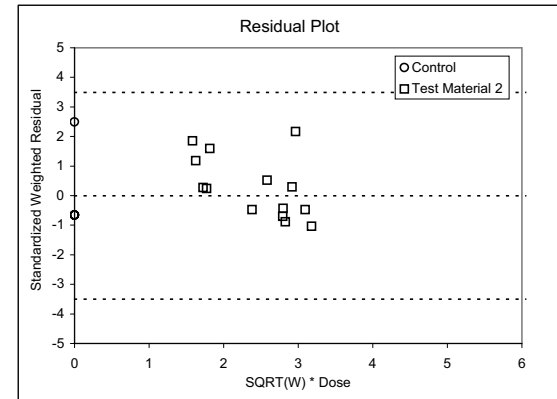
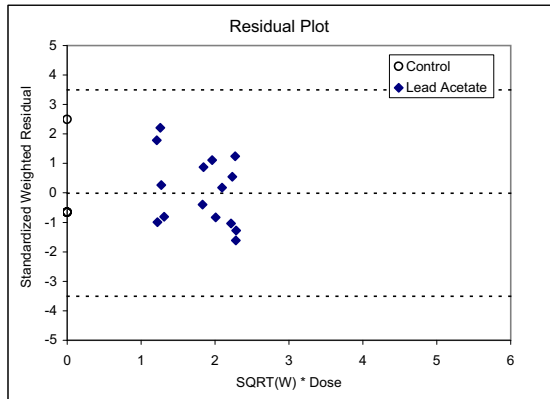
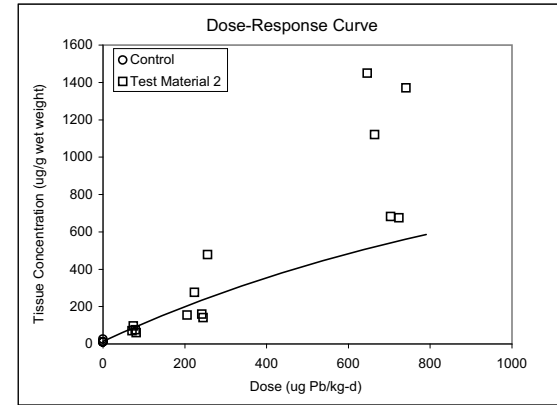
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.34E+01	2.33E+00
b	1.11E+03	9.46E+02
c1	1.29E-03	1.21E-03
c2	8.53E-04	8.65E-04
c3	9.21E-04	8.71E-04
Covariance (c1,c2)	0.9770	--
Covariance (c1,c3)	0.9728	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	50.761
p	< 0.001
Adjusted R ²	0.7567
AIC	561.591

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.66	0.71
Lower bound	?	?
Upper bound	?	?
Standard Error	0.147*	0.156*

* $g \geq 0.05$, estimate is uncertain

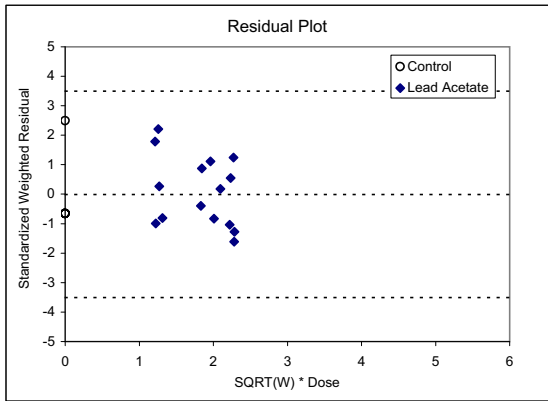
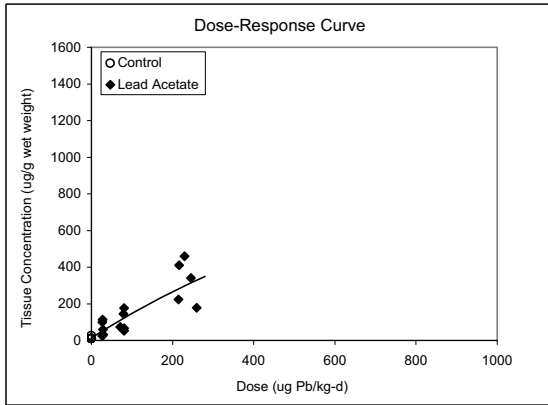
APPENDIX E

Figure 2c - All Data

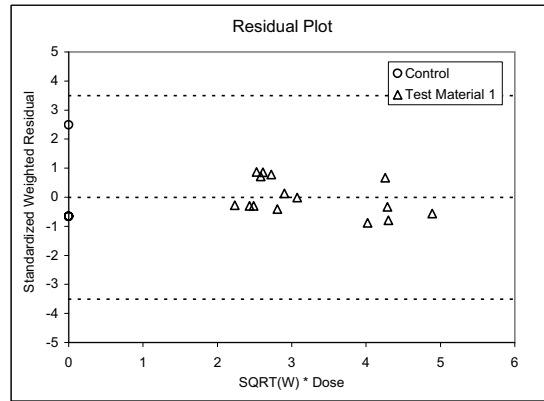
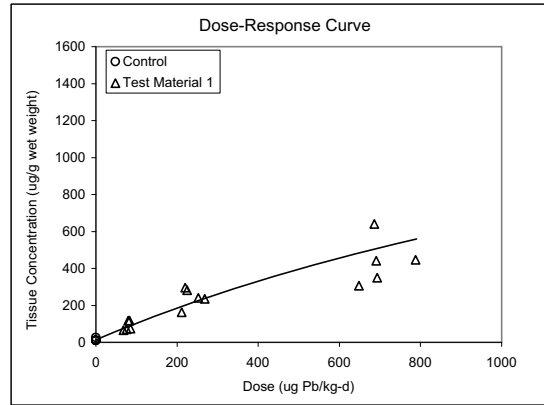
Phase II Experiment 11: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$

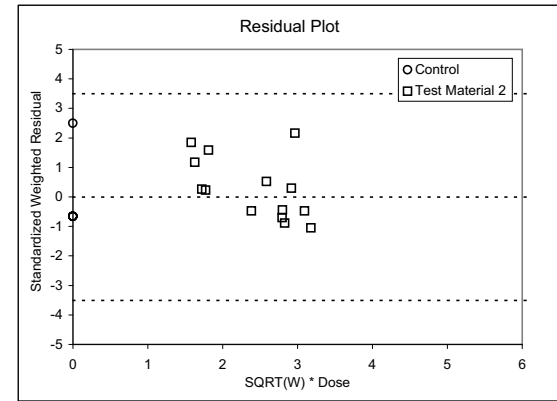
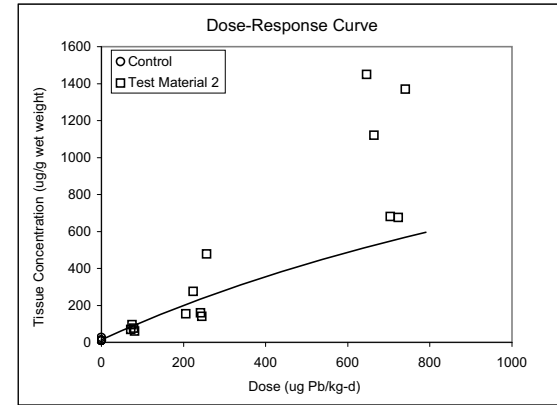
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.34E+01	2.34E+00
b	2.07E+03	2.04E+03
c1	1.44E+03	1.55E+03
c2	2.21E+03	2.54E+03
c3	2.02E+03	2.19E+03
Covariance (c1,c2)	0.9824	--
Covariance (c1,c3)	0.9793	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	50.798
p	< 0.001
Adjusted R ²	0.7568
AIC	561.543

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.65	0.71
Lower bound	?	?
Upper bound	?	?
Standard Error	0.146*	0.157*

* g ≥ 0.05, estimate is uncertain

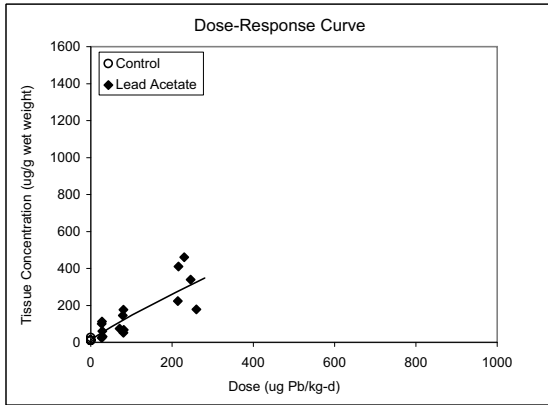
APPENDIX E

Figure 2d - All Data

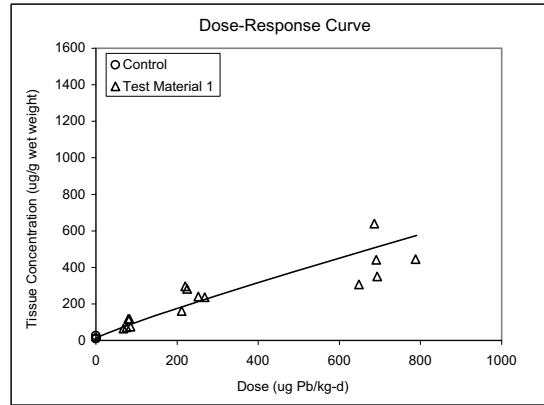
Phase II Experiment 11: Liver

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

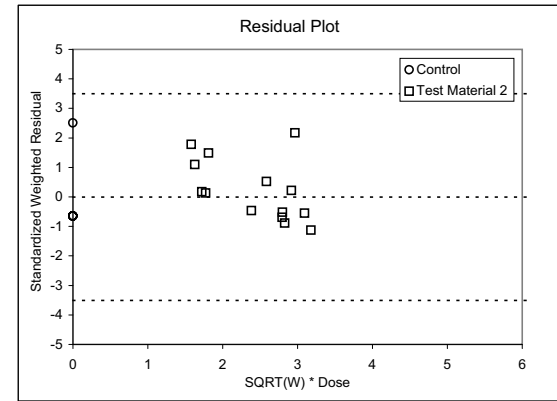
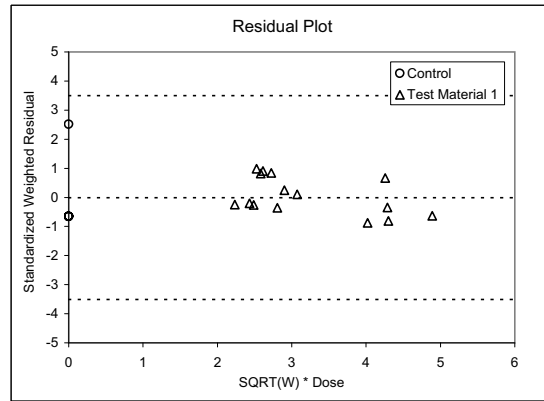
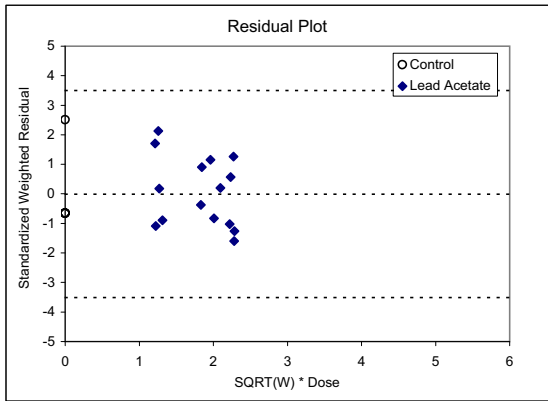
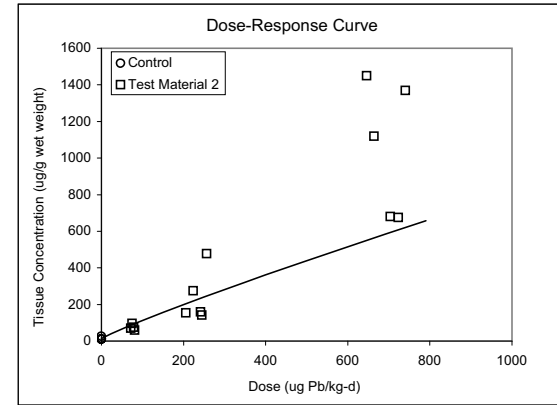
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.33E+01	2.34E+00
b1	2.05E+00	9.53E-01
b2	1.34E+00	7.73E-01
b3	1.54E+00	7.93E-01
c	9.05E-01	9.76E-02
Covariance (b1,b2)	0.9327	--
Covariance (b1,b3)	0.9175	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	51.275
p	< 0.001
Adjusted R ²	0.7586
AIC	560.976

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.63	0.73
Lower bound	0.06	0.28
Upper bound	0.91	1.17
Standard Error	--	--

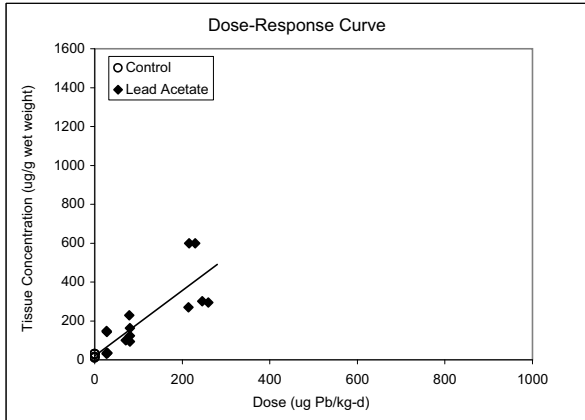
APPENDIX E

Figure 3a - All Data

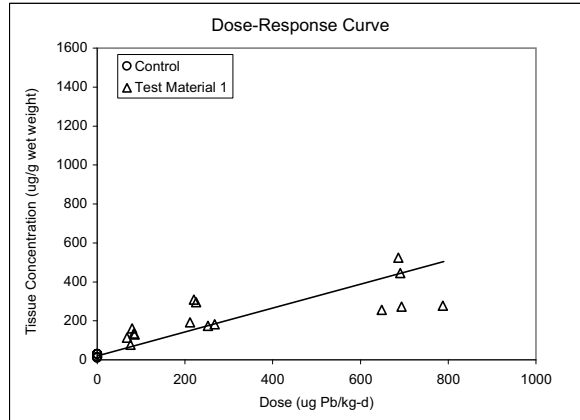
Phase II Experiment 11: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

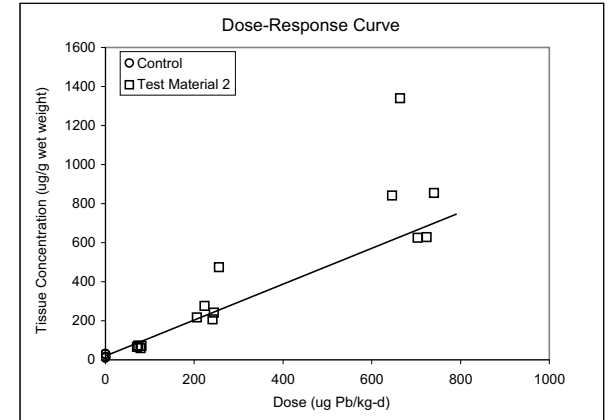
Reference Material (Lead Acetate)



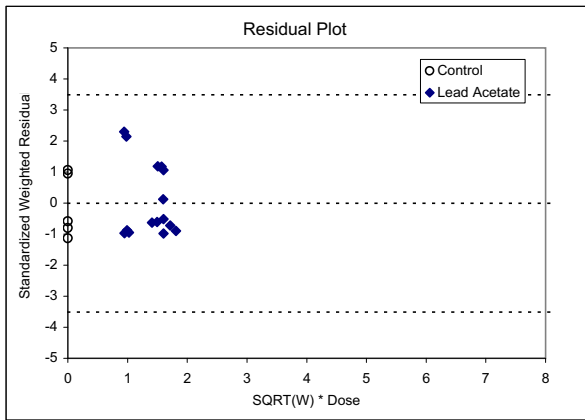
Test Material 1 (Murray Smelter Soil)



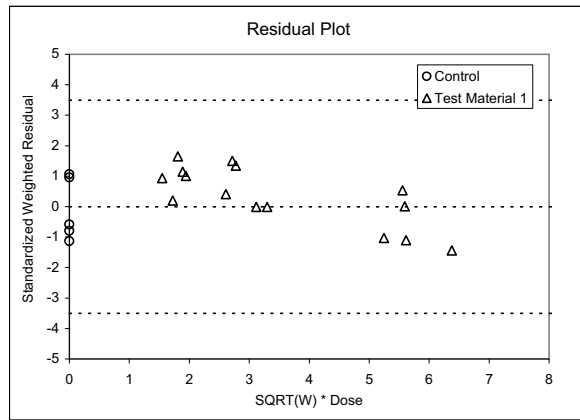
Test Material 2 (NIST Paint)



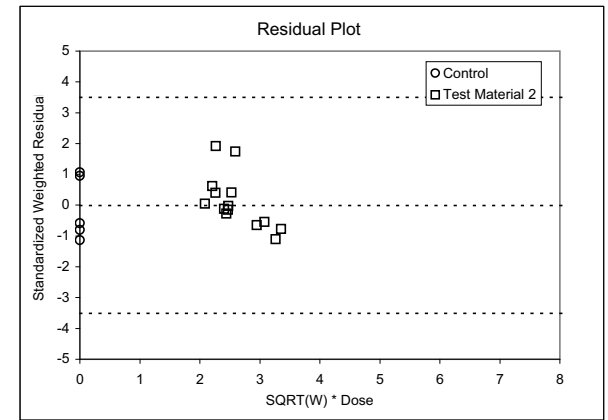
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	2.03E+01	4.13E+00
b1	1.68E+00	2.48E-01
b2	6.12E-01	9.05E-02
b3	9.18E-01	1.44E-01
Covariance (c1,c2)	0.0267	--
Covariance (c1,c3)	0.0454	--
Degrees of Freedom	44	--

Goodness of Fit

Statistic	Estimate
F	43.248
p	< 0.001
Adjusted R ²	0.7253
AIC	576.648

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.36	0.55
Lower bound	0.25	0.38
Upper bound	0.52	0.78
Standard Error	0.075*	0.115*

* $g \geq 0.05$, estimate is uncertain

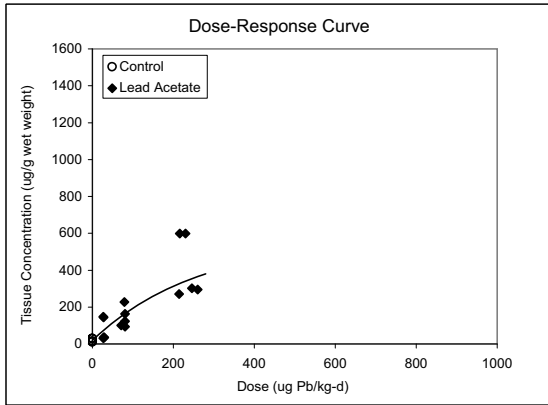
APPENDIX E

Figure 3b - All Data

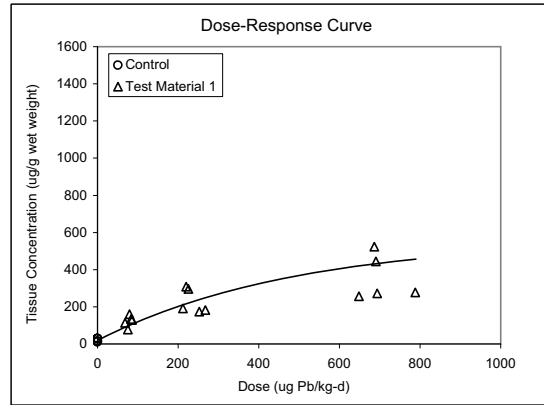
Phase II Experiment 11: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

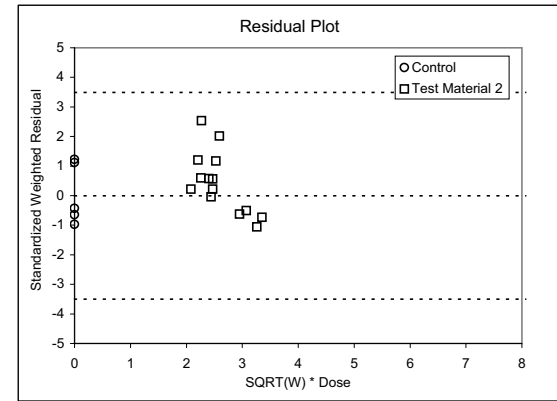
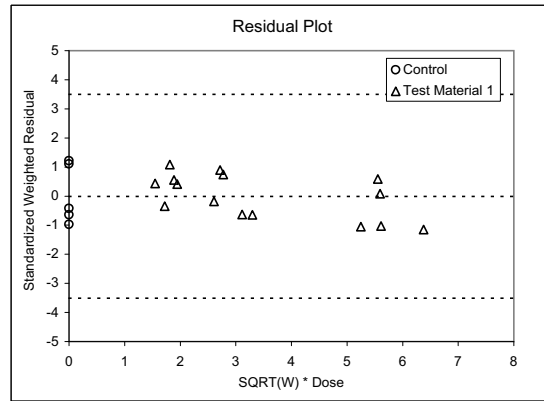
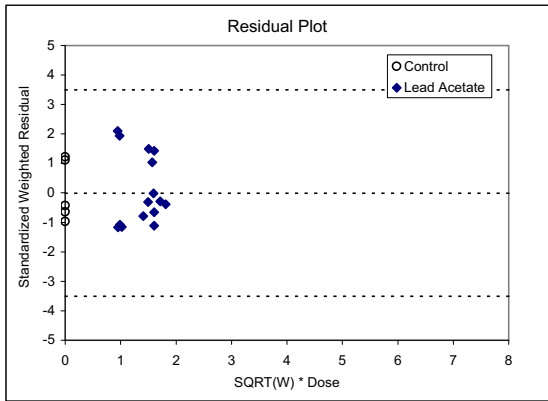
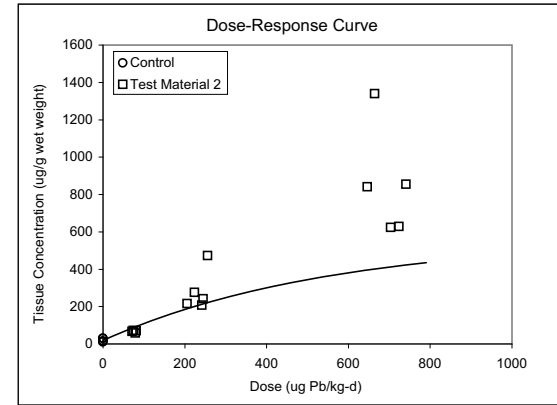
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.89E+01	4.24E+00
b	5.49E+02	2.04E+02
c1	3.83E-03	1.88E-03
c2	2.03E-03	1.17E-03
c3	1.80E-03	8.67E-04
Covariance (c1,c2)	0.8761	--
Covariance (c1,c3)	0.8456	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	31.501
p	< 0.001
Adjusted R ²	0.7177
AIC	578.650

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.53	0.47
Lower bound	0.05	0.22
Upper bound	0.93	1.04
Standard Error	0.148*	0.127*

* $g \geq 0.05$, estimate is uncertain

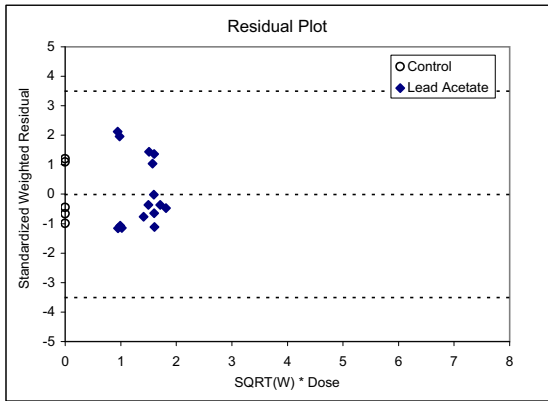
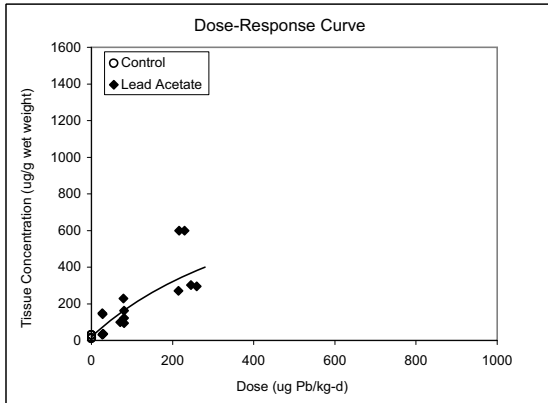
APPENDIX E

Figure 3c - All Data

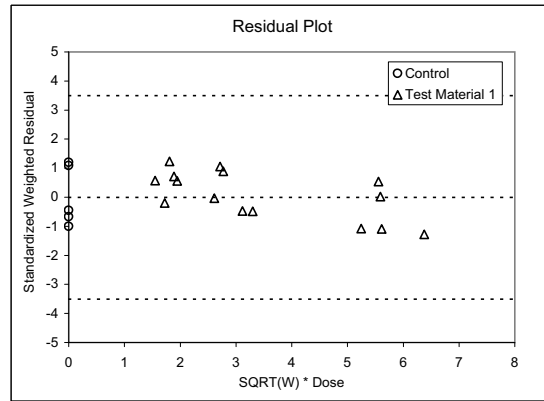
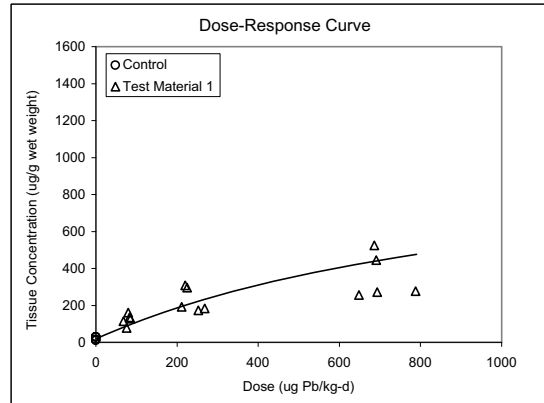
Phase II Experiment 11: Kidney

Michaelis-Menton Model: $y = a + b \cdot x1 / (c1 + x1) + b \cdot x2 / (c2 + x2) + b \cdot x3 / (c3 + x3)$

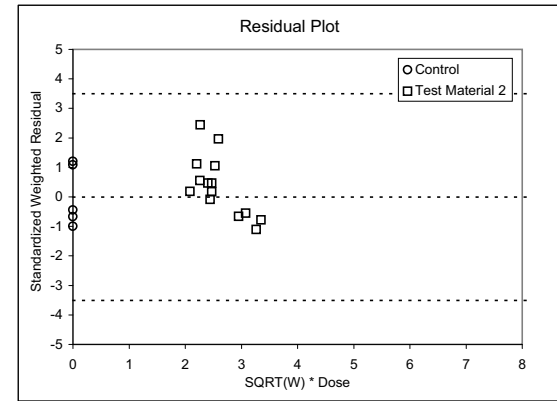
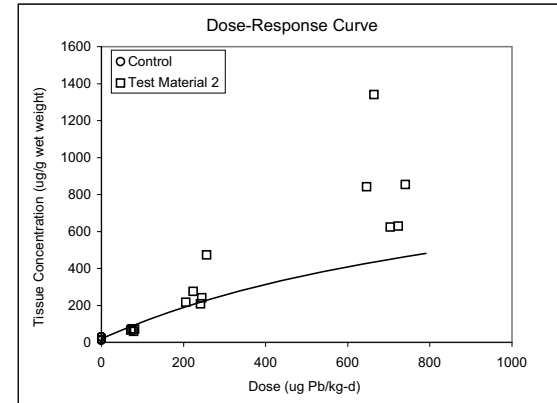
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.91E+01	4.26E+00
b	1.11E+03	6.56E+02
c1	5.34E+02	3.90E+02
c2	1.12E+03	9.29E+02
c3	1.11E+03	7.91E+02
Covariance (c1,c2)	0.9475	--
Covariance (c1,c3)	0.9350	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	31.472
p	< 0.001
Adjusted R ²	0.7175
AIC	578.702

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.48	0.48
Lower bound	?	?
Upper bound	?	?
Standard Error	0.128*	0.126*

* $g \geq 0.05$, estimate is uncertain

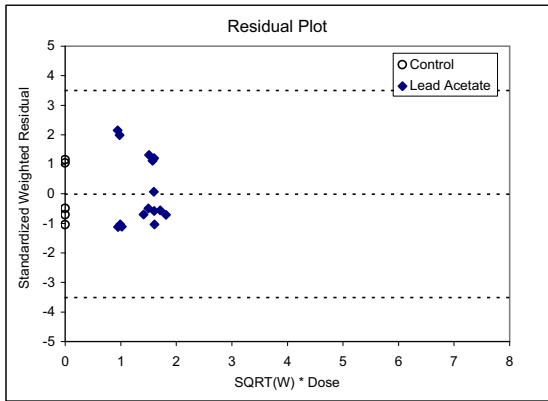
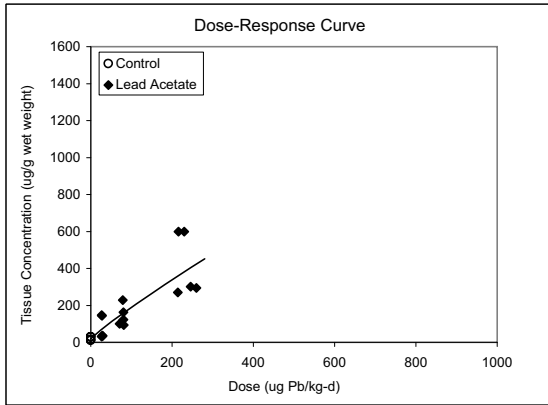
APPENDIX E

Figure 3d - All Data

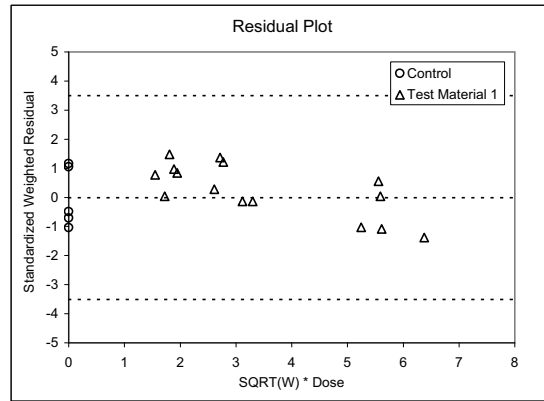
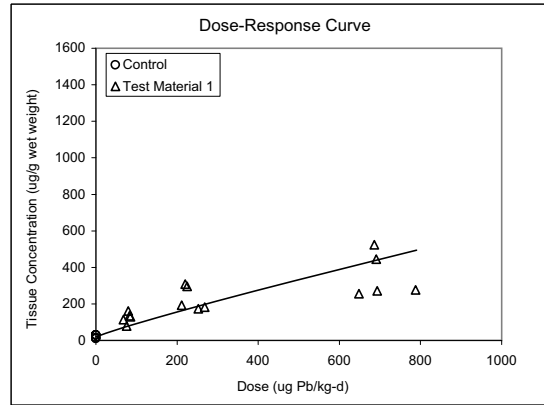
Phase II Experiment 11: Kidney

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

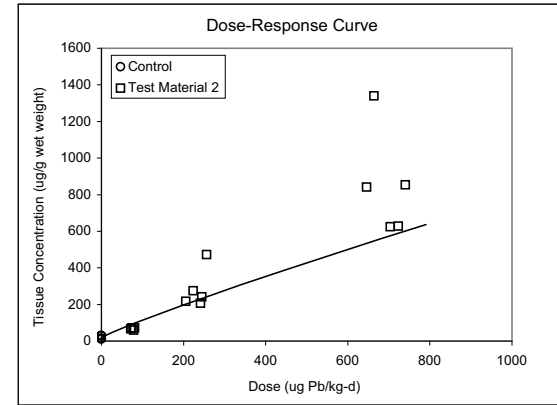
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.95E+01	4.30E+00
b1	2.61E+00	1.40E+00
b2	1.12E+00	7.79E-01
b3	1.46E+00	8.67E-01
c	9.07E-01	1.11E-01
Covariance (b1,b2)	0.9422	--
Covariance (b1,b3)	0.9294	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	31.801
p	< 0.001
Adjusted R ²	0.7196
AIC	578.247

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.39	0.52
Lower bound	?	?
Upper bound	0.58	0.96
Standard Error	--	--

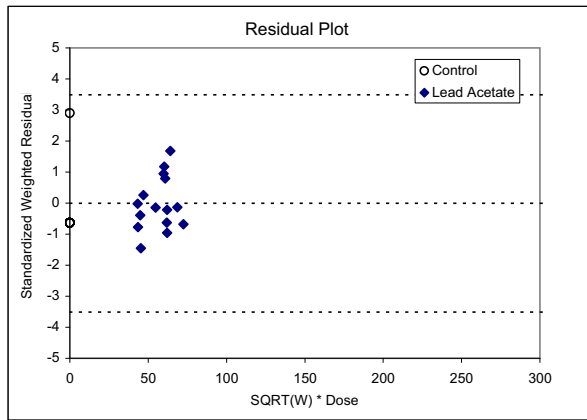
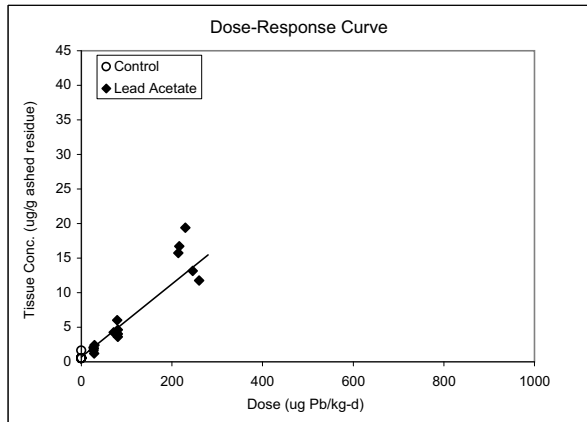
APPENDIX E

Figure 4a - All Data

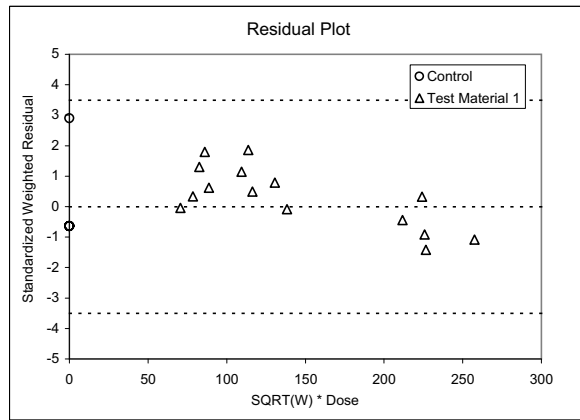
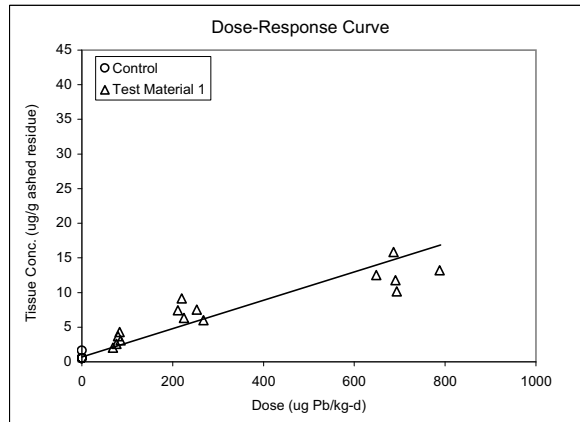
Phase II Experiment 11: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$

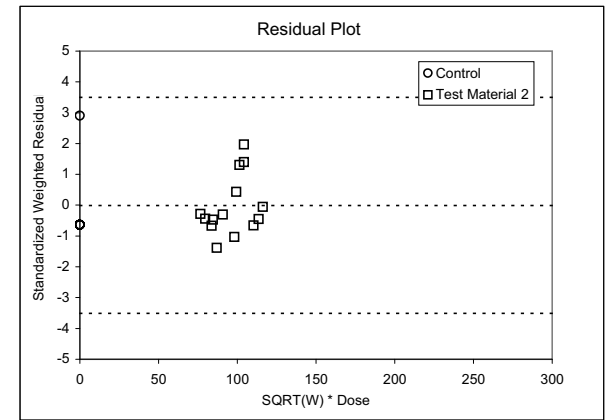
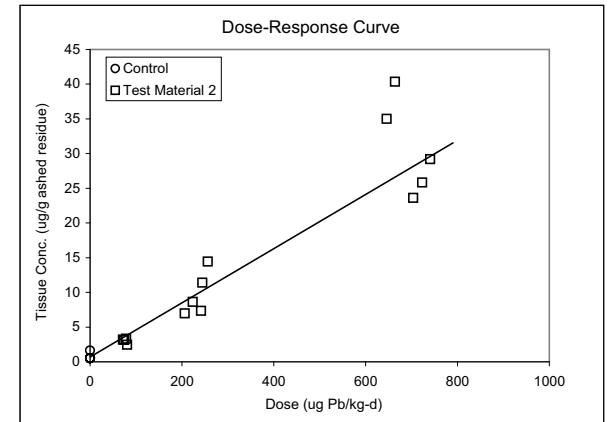
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



Summary of Fitting

Parameter	Estimate	Standard Error
a	6.98E-01	1.32E-01
b1	5.28E-02	5.46E-03
b2	2.05E-02	1.92E-03
b3	3.90E-02	3.39E-03
Covariance (c1,c2)	0.0688	--
Covariance (c1,c3)	0.0673	--
Degrees of Freedom	44	--

Goodness of Fit

Statistic	Estimate
F	108.800
p	< 0.001
Adjusted R ²	0.8708
AIC	198.208

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.39	0.74
Lower bound	0.31	0.59
Upper bound	0.49	0.93
Standard Error	0.052	0.096

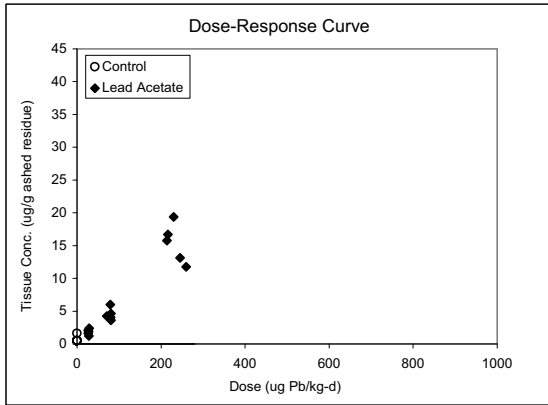
APPENDIX E

Figure 4b - All Data

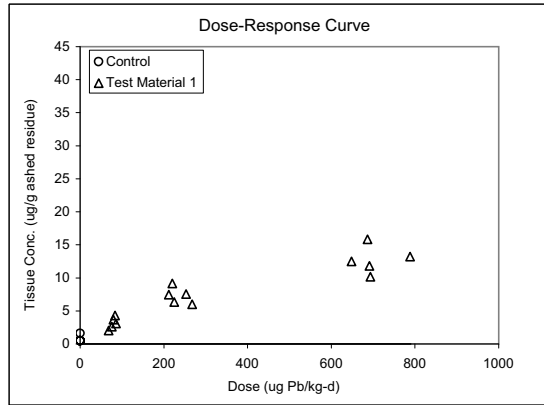
Phase II Experiment 11: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1)) + b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$

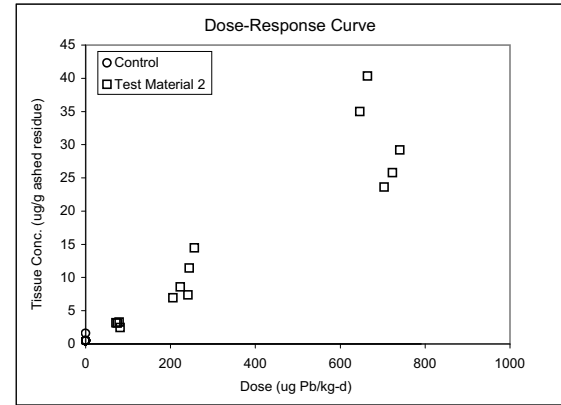
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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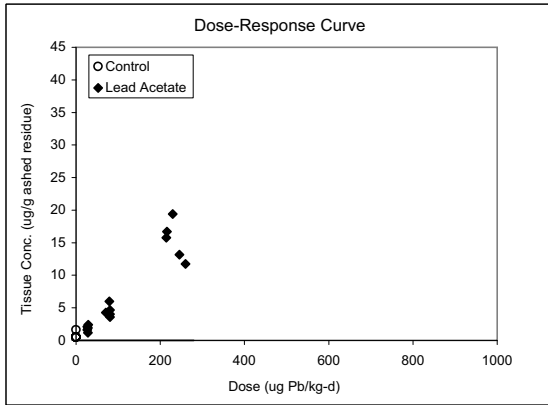
APPENDIX E

Figure 4c - All Data

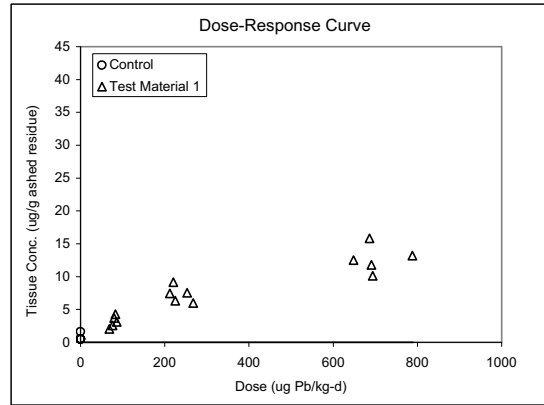
Phase II Experiment 11: Femur

Michaelis-Menton Model: $y = a + b \cdot x1 / (c1 + x1) + b \cdot x2 / (c2 + x2) + b \cdot x3 / (c3 + x3)$

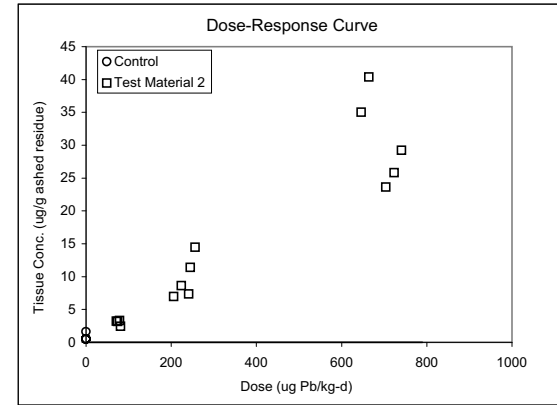
Reference Material (Lead Acetate)



Test Material 1 (Murray Smelter Soil)



Test Material 2 (NIST Paint)



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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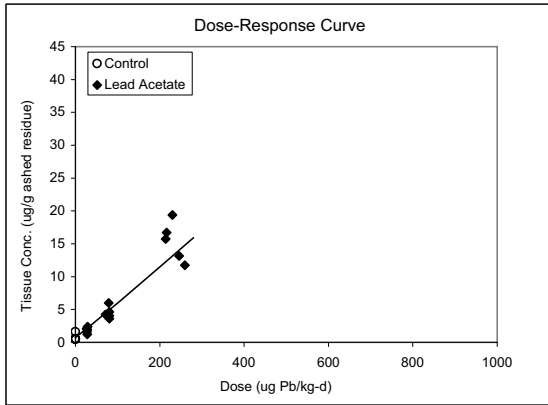
APPENDIX E

Figure 4d - All Data

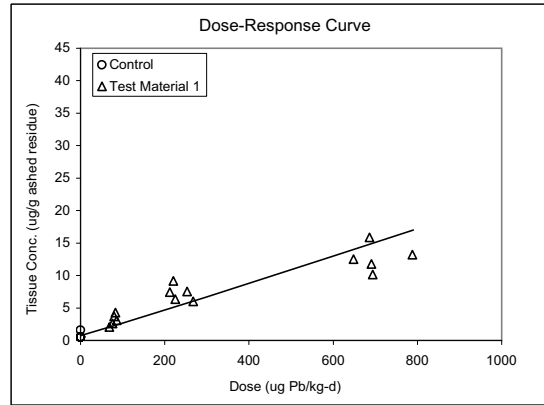
Phase II Experiment 11: Femur

Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$

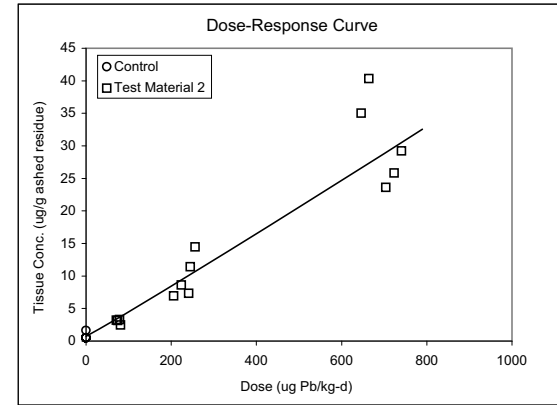
Reference Material (Lead Acetate)



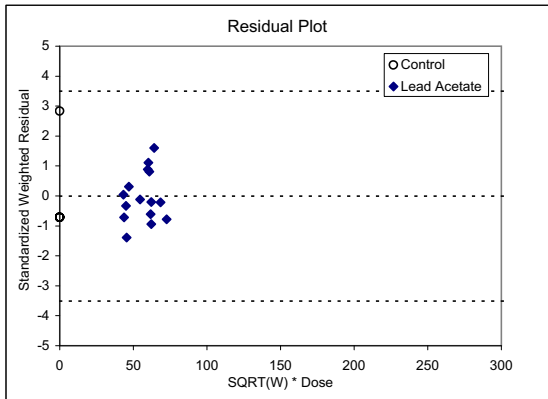
Test Material 1 (Murray Smelter Soil)



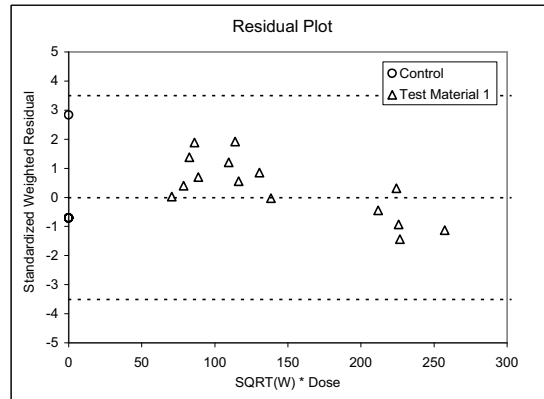
Test Material 2 (NIST Paint)



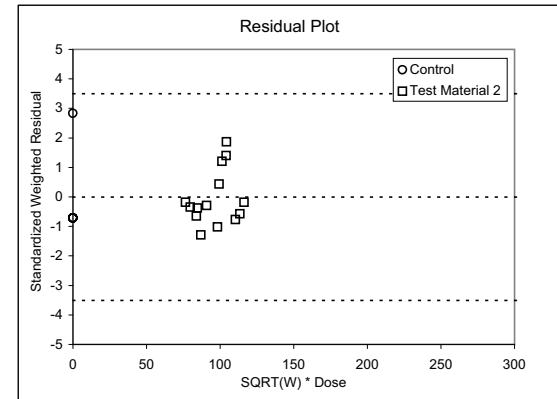
Residual Plot



Residual Plot



Residual Plot



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.21E-01	1.44E-01
b1	4.56E-02	1.71E-02
b2	1.67E-02	7.95E-03
b3	3.27E-02	1.43E-02
c	1.03E+00	7.40E-02
Covariance (b1,b2)	0.9444	--
Covariance (b1,b3)	0.9443	--
Degrees of Freedom	43	--

Goodness of Fit

Statistic	Estimate
F	80.328
p	< 0.001
Adjusted R ²	0.8686
AIC	200.024

RBA and Uncertainty

	Test Material 1	Test Material 2
RBA	0.38	0.73
Lower bound	0.18	0.45
Upper bound	0.48	0.91
Standard Error	--	--

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APPENDIX E

EXPERIMENT 12

Test Material 1: Galena-enriched Soil

Test Material 2: Palmerton Location 2 (Reproducibility Study)

Test Material 3: California Gulch Oregon Gulch Tailings

- Figure 1a Blood AUC - Linear Model
- Figure 1b Blood AUC - Exponential Model
- Figure 1c Blood AUC - Michaelis-Menton Model
- Figure 1d Blood AUC - Power Model

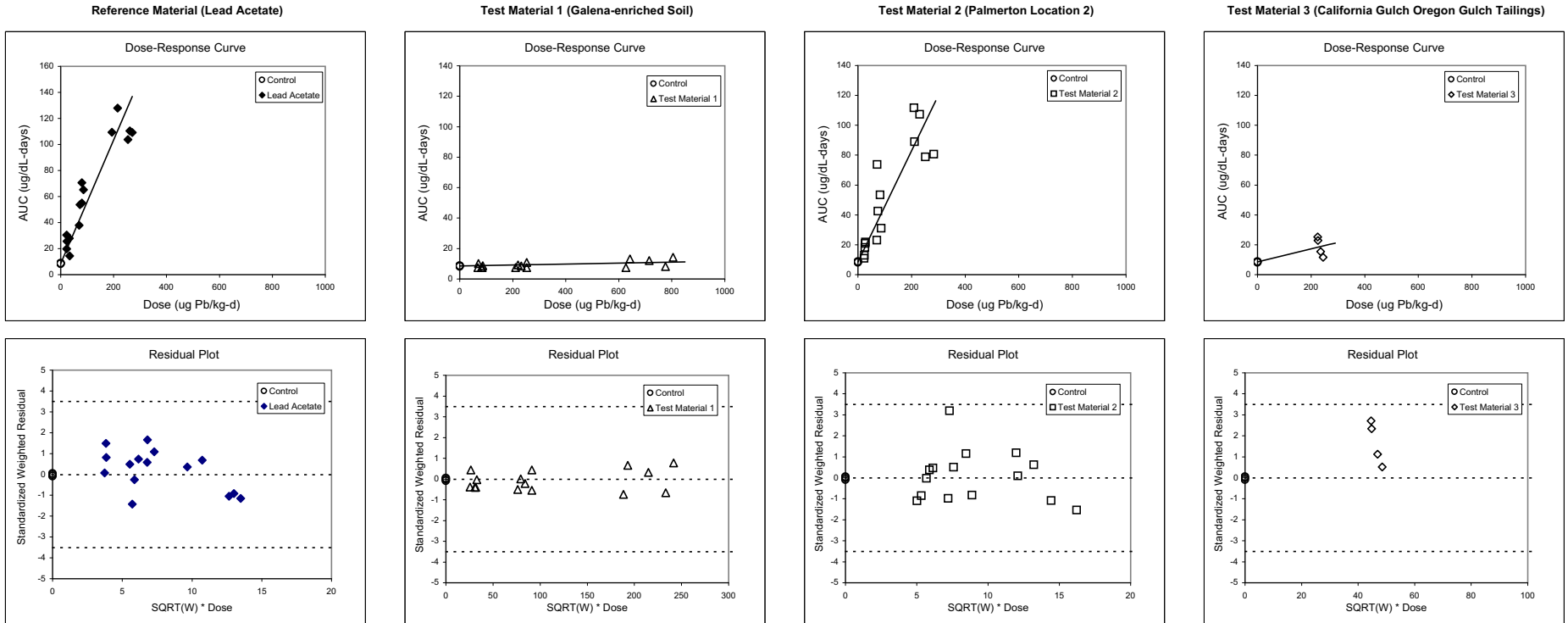
- Figure 2a Liver - Linear Model
- Figure 2b Liver - Exponential Model
- Figure 2c Liver - Michaelis-Menton Model
- Figure 2d Liver - Power Model

- Figure 3a Kidney - Linear Model (All Data)
- Figure 3a Kidney - Linear Model (Outliers Excluded)
- Figure 3b Kidney - Exponential Model
- Figure 3c Kidney - Michaelis-Menton Model
- Figure 3d Kidney - Power Model

- Figure 4a Femur - Linear Model
- Figure 4b Femur - Exponential Model
- Figure 4c Femur - Michaelis-Menton Model
- Figure 4d Femur - Power Model

APPENDIX E

Figure 1a - All Data
 Phase II Experiment 12: Blood AUC
 Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.55E+00	9.63E-01
b1	4.76E-01	3.69E-02
b2	3.10E-03	2.91E-03
b3	3.72E-01	3.24E-02
b4	4.34E-02	1.32E-02
Covariance (c1,c2)	0.1535	--
Covariance (c1,c3)	0.0703	--
Covariance (c1,c4)	0.0746	--
Degrees of Freedom	47	--

Goodness of Fit

Statistic	Estimate
F	124.227
p	< 0.001
Adjusted R ²	0.9062
AIC	375.135

RBA and Uncertainty

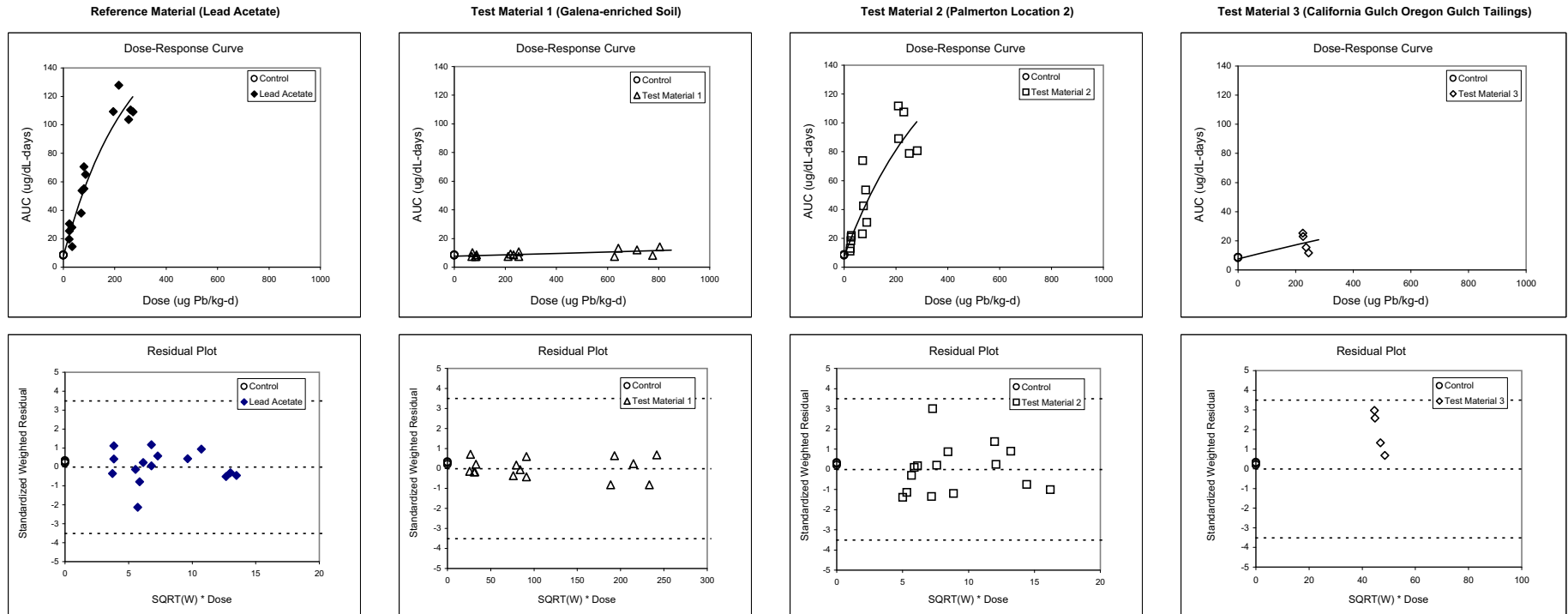
	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.78	0.09
Lower bound	0.00	0.64	0.04
Upper bound	0.02	0.94	0.14
Standard Error	0.006	0.088	0.028

APPENDIX E

Figure 1b - All Data

Phase II Experiment 12: Blood AUC

Exponential Model: $y = a + b \cdot (1 - \exp(-c_1 \cdot x_1)) + b \cdot (1 - \exp(-c_2 \cdot x_2)) + b \cdot (1 - \exp(-c_3 \cdot x_3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.62E+00	9.62E-01
b	1.69E+02	4.82E+01
c1	4.02E-03	1.59E-03
c2	2.93E-05	2.00E-05
c3	2.86E-03	1.07E-03
Covariance (c1,c2)	0.5770	--
Covariance (c1,c3)	0.9418	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	104.665
p	< 0.001
Adjusted R ²	0.9104
AIC	370.380

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.71	0.07
Lower bound	0.00	0.55	0.04
Upper bound	0.02	0.99	0.13
Standard Error	0.004*	0.094*	0.020*

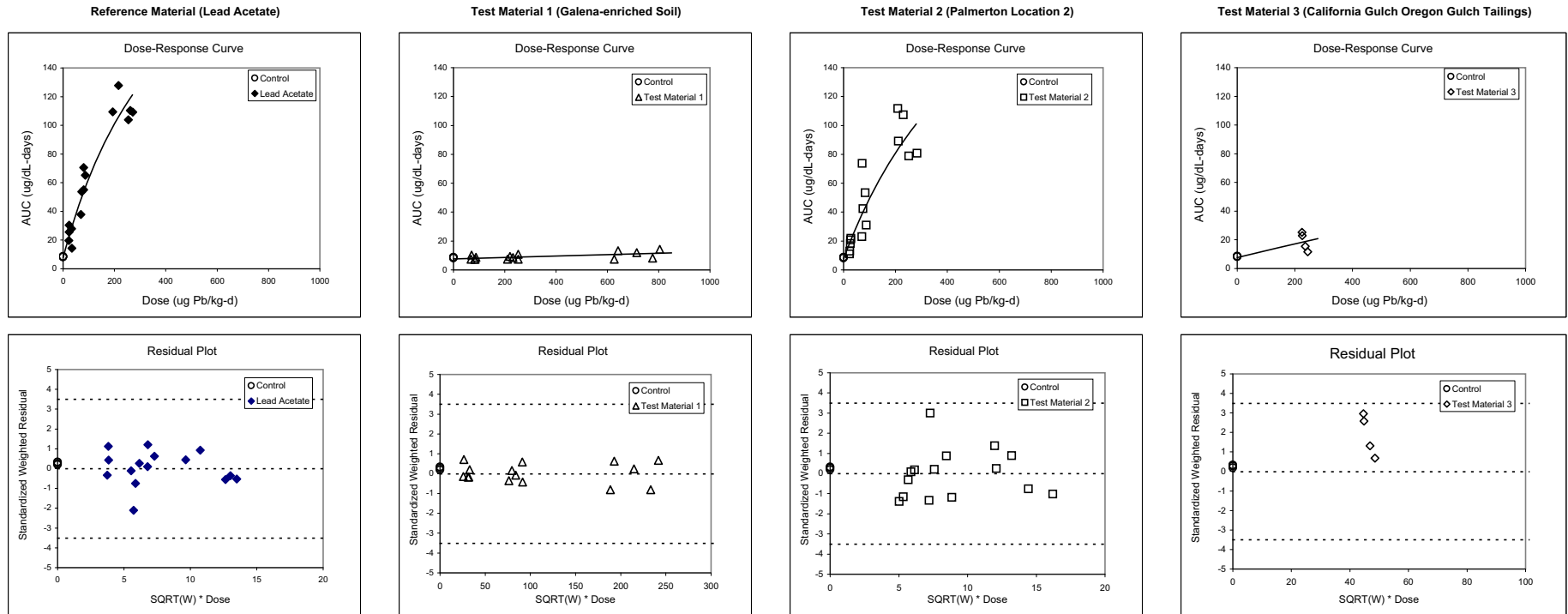
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1c - All Data

Phase II Experiment 12: Blood AUC

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.64E+00	9.71E-01
b	2.98E+02	1.06E+02
c1	4.38E+02	2.08E+02
c2	6.04E+04	4.45E+04
c3	6.12E+02	2.78E+02
Covariance (c1,c2)	0.6443	--
Covariance (c1,c3)	0.9615	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	104.126
p	< 0.001
Adjusted R ²	0.9100
AIC	370.760

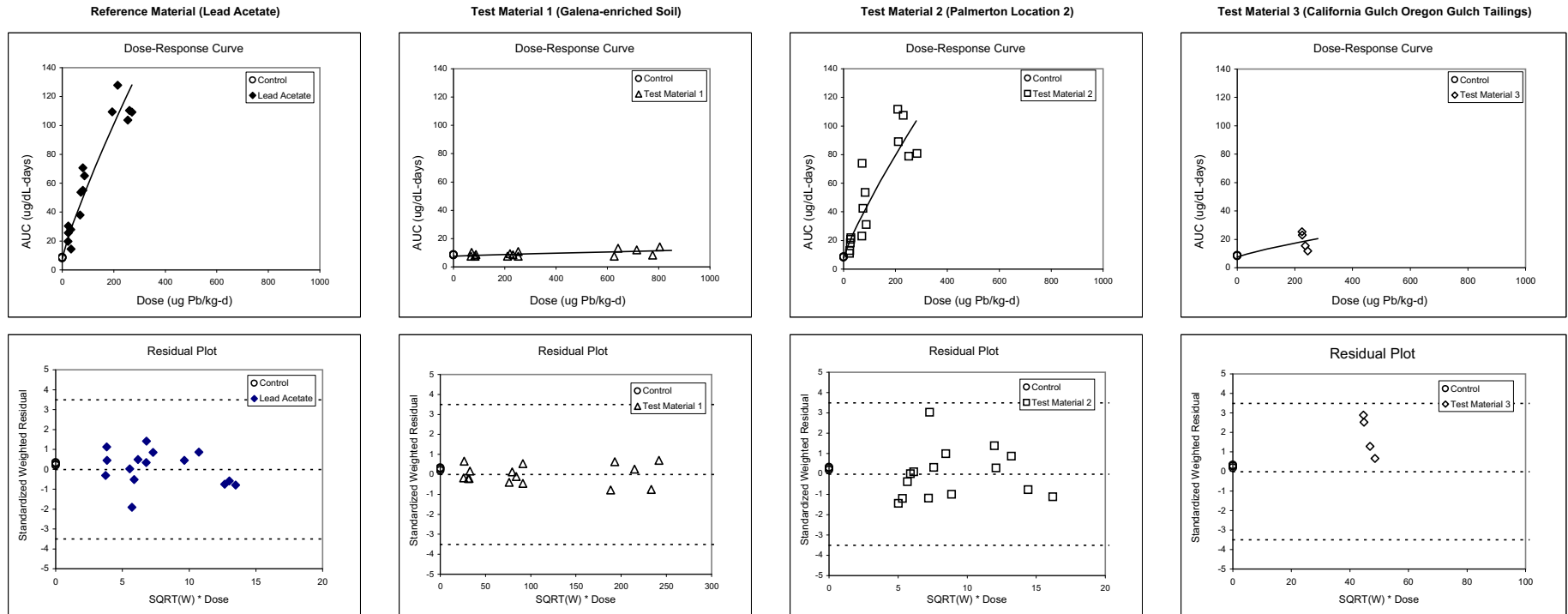
RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.72	0.07
Lower bound	0.00	0.46	0.03
Upper bound	-0.01	0.95	0.16
Standard Error	0.004*	0.094*	0.021*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 1d - All Data
Phase II Experiment 12: Blood AUC
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.61E+00	1.10E+00
b1	1.01E+00	3.55E-01
b2	1.24E-02	1.09E-02
b3	7.78E-01	2.75E-01
c	8.55E-01	5.23E-02
Covariance (b1,b2)	0.7381	--
Covariance (b1,b3)	0.9551	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	98.107
p	< 0.001
Adjusted R ²	0.9049
AIC	374.839

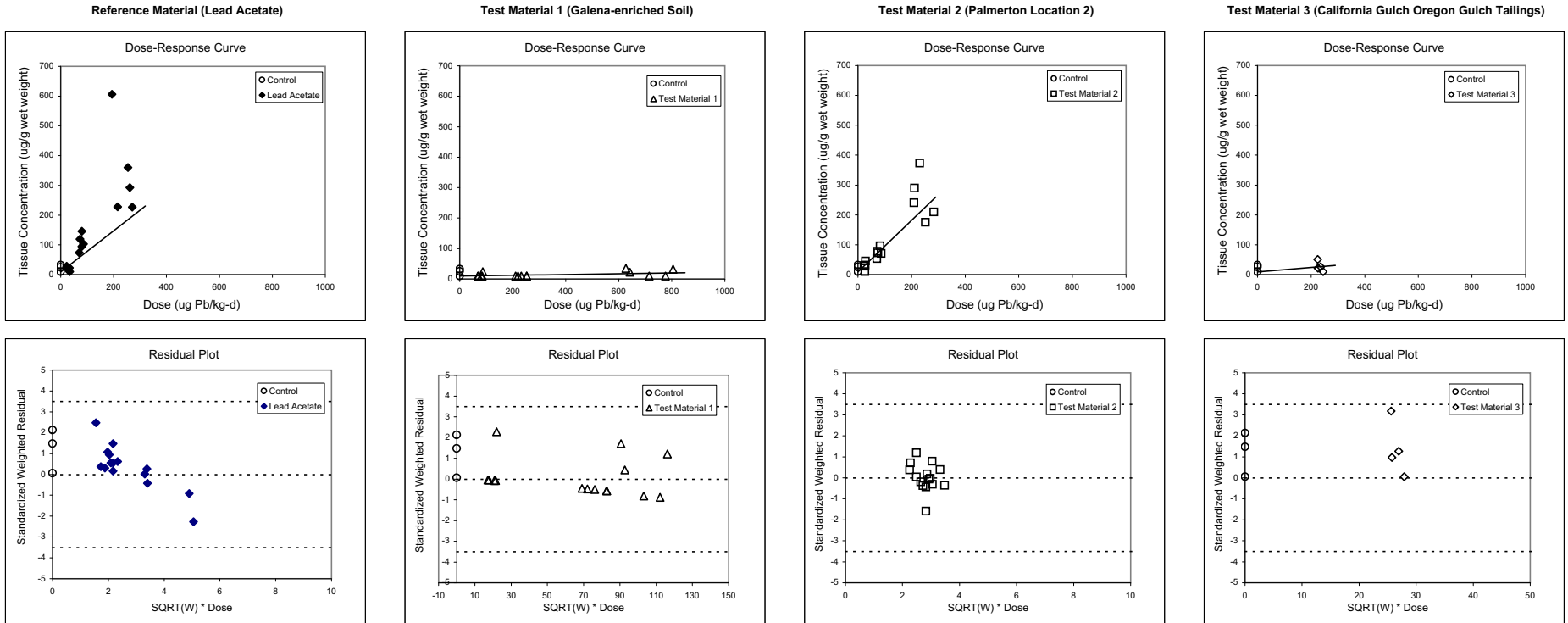
RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.74	0.07
Lower bound	?	0.57	?
Upper bound	0.01	0.95	0.12
Standard Error	--	--	--

APPENDIX E

Figure 2a - All Data

Phase II Experiment 12: Liver
 Linear Model: $y = a + b_1*x_1 + b_2*x_2 + b_3*x_3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	9.38E+00	2.21E+00
b1	6.90E-01	1.49E-01
b2	1.26E-02	7.84E-03
b3	8.63E-01	1.45E-01
b4	7.51E-02	3.01E-02
Covariance (c1,c2)	0.2961	--
Covariance (c1,c3)	0.1132	--
Covariance (c1,c4)	0.1251	--
Degrees of Freedom	47	--

Goodness of Fit

Statistic	Estimate
F	33.199
p	< 0.001
Adjusted R ²	0.7163
AIC	506.975

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.02	1.25	0.11
Lower bound	0.00	0.82	0.04
Upper bound	0.04	2.03	0.21
Standard Error	0.011*	0.322*	0.047*

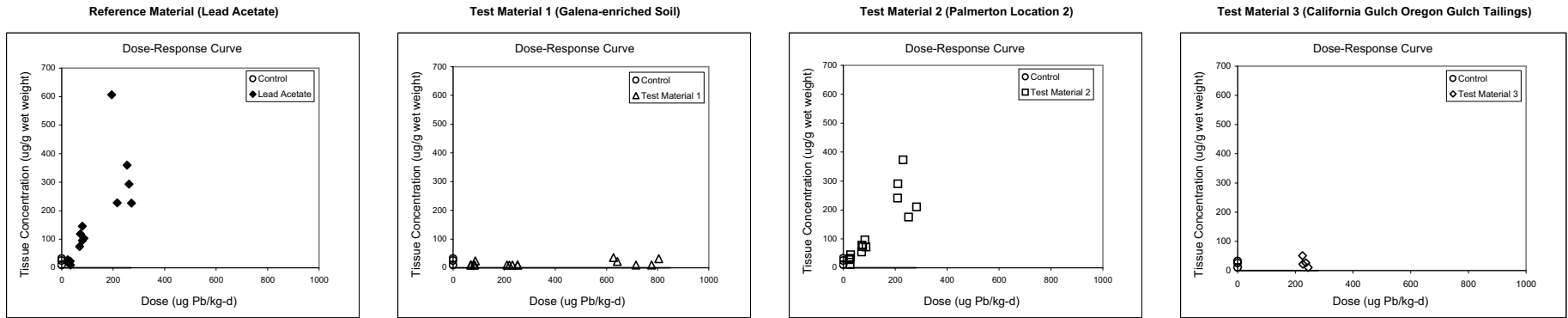
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 2b - All Data

Phase II Experiment 12: Liver

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

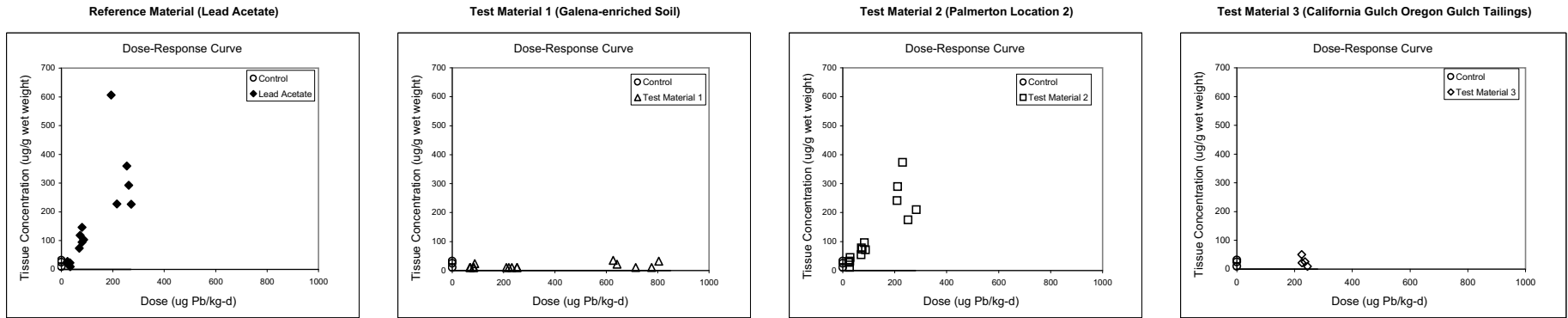
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APPENDIX E

Figure 2c - All Data

Phase II Experiment 12: Liver

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



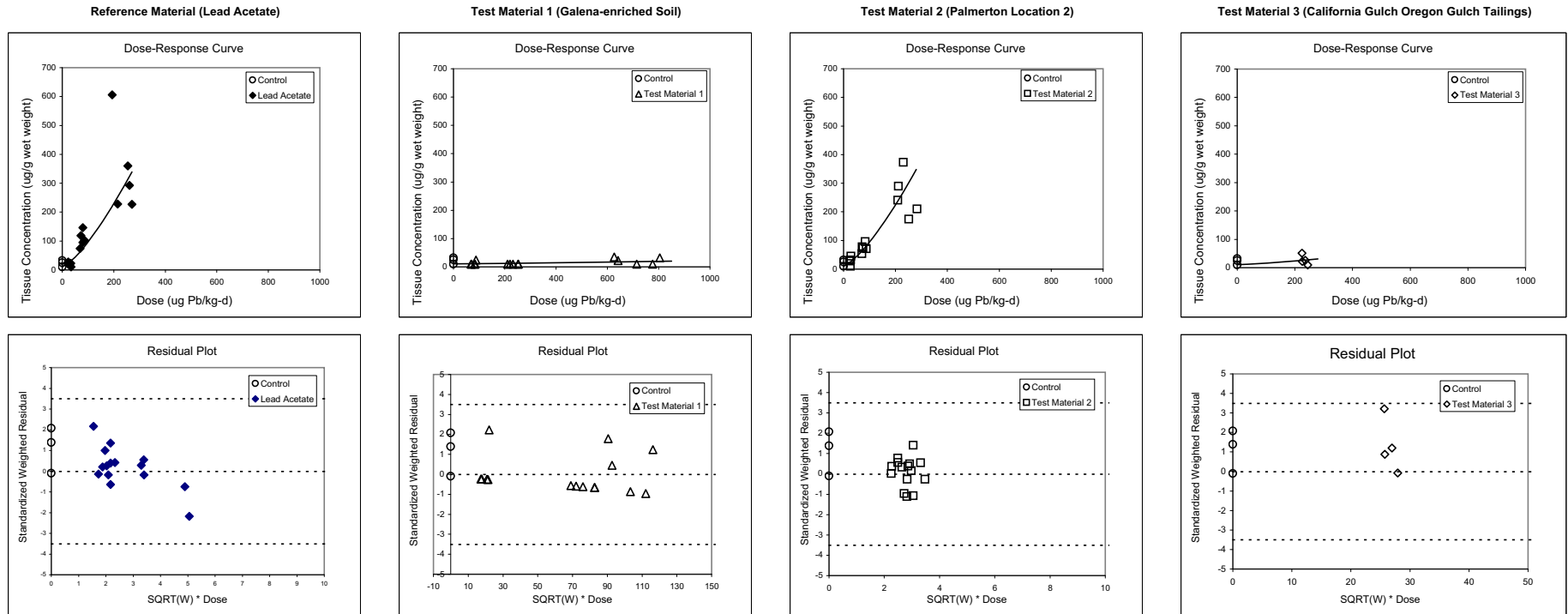
NO SOLUTION

The software could not find a solution,
or the solution was unstable and/or had unrealistic parameter estimates.

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APPENDIX E

Figure 2d - All Data
Phase II Experiment 12: Liver
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	1.10E+01	1.94E+00
b1	1.67E-01	1.21E-01
b2	1.03E-03	1.38E-03
b3	1.64E-01	1.25E-01
c	1.35E+00	1.52E-01
Covariance (b1,b2)	0.8593	--
Covariance (b1,b3)	0.9467	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	31.031
p	< 0.001
Adjusted R ²	0.7465
AIC	493.797

RBA and Uncertainty

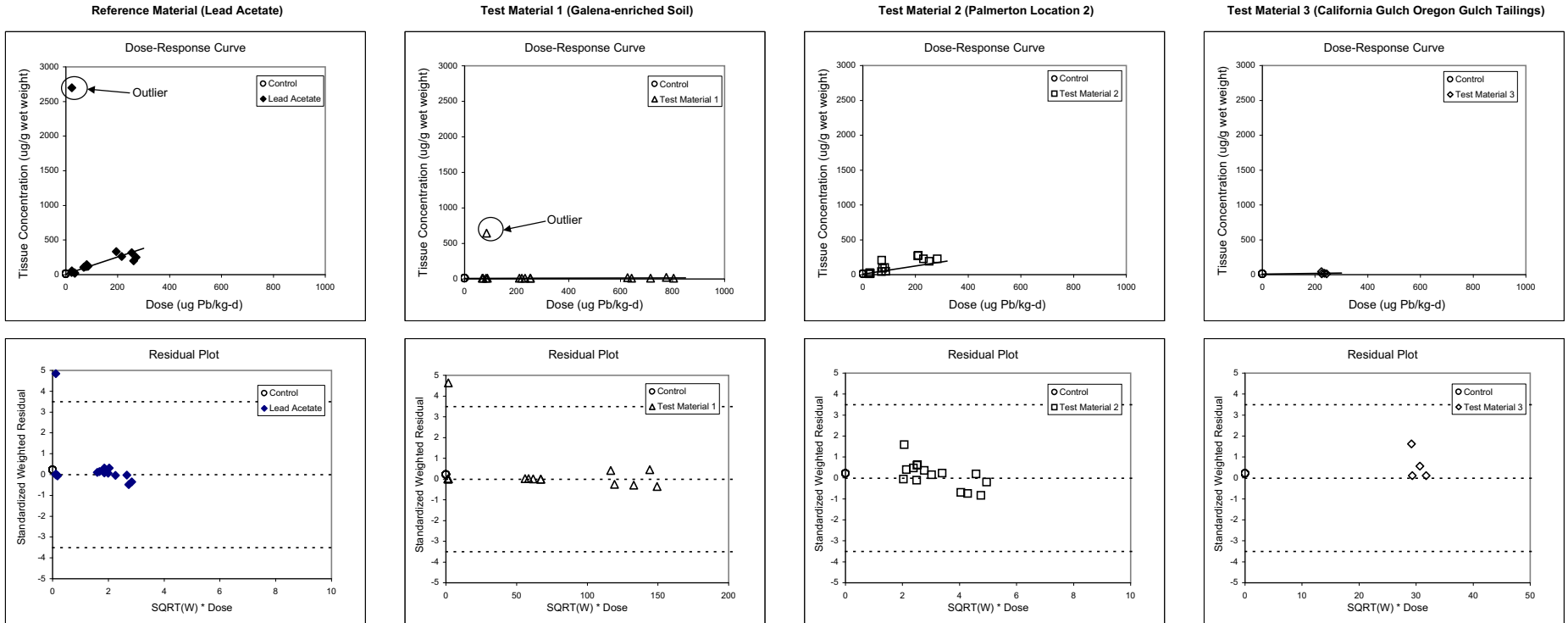
	Test Material 1	Test Material 2	Test Material 3
RBA	0.02	0.98	0.12
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	--	--	--

APPENDIX E

Figure 3a - All Data

Phase II Experiment 12: Kidney

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.71E+00	4.83E+00
b1	1.24E+00	4.35E-01
b2	9.56E-03	1.30E-02
b3	5.80E-01	2.64E-01
b4	5.49E-02	5.39E-02
Covariance (c1,c2)	0.0560	--
Covariance (c1,c3)	0.0379	--
Covariance (c1,c4)	0.0304	--
Degrees of Freedom	47	--

Goodness of Fit

Statistic	Estimate
F	7.238
p	< 0.001
Adjusted R ²	0.3285
AIC	868.907

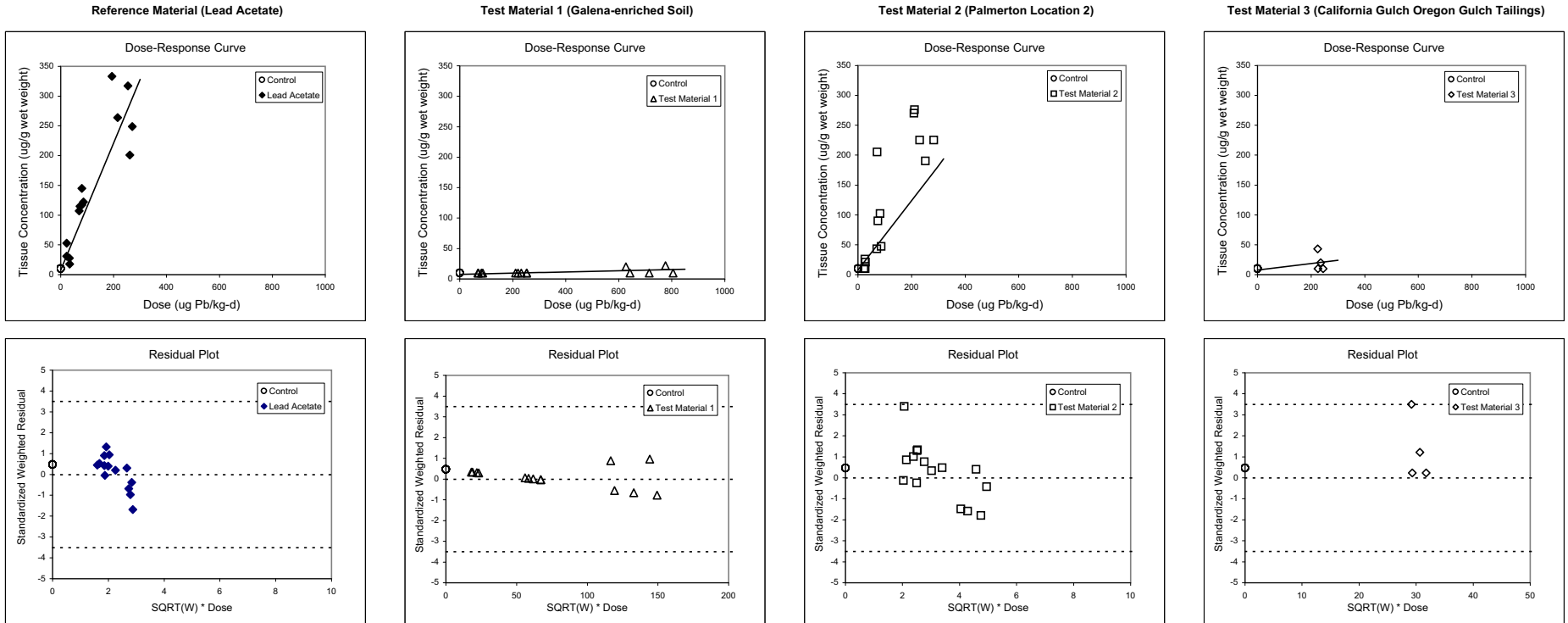
RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.47	0.04
Lower bound	-0.01	0.11	-0.03
Upper bound	0.03	1.30	0.16
Standard Error	0.011*	0.264*	0.046*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3a - Outliers Excluded
Phase II Experiment 12: Kidney
Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.68E+00	1.72E+00
b1	1.07E+00	1.60E-01
b2	9.72E-03	5.37E-03
b3	5.81E-01	1.12E-01
b4	5.51E-02	2.32E-02
Covariance (c1,c2)	0.1129	--
Covariance (c1,c3)	0.0686	--
Covariance (c1,c4)	0.0542	--
Degrees of Freedom	45	--

Goodness of Fit

Statistic	Estimate
F	37.309
p	< 0.001
Adjusted R ²	0.7477
AIC	458.069

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.54	0.05
Lower bound	< 0.001	0.35	0.02
Upper bound	0.02	0.80	0.09
Standard Error	0.005*	0.128*	0.023*

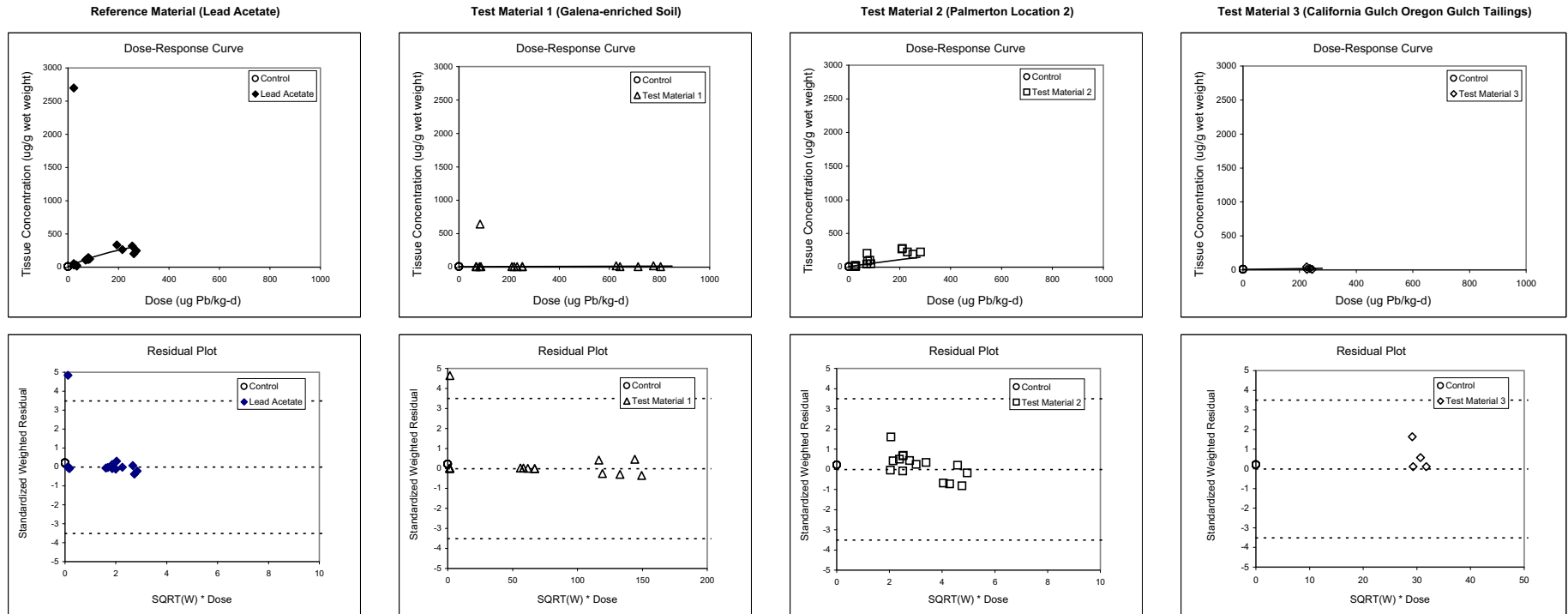
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3b - All Data

Phase II Experiment 12: Kidney

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.72E+00	4.99E+00
b	4.89E+02	1.01E+03
c1	3.53E-03	9.63E-03
c2	1.96E-05	5.03E-05
c3	1.19E-03	2.63E-03
Covariance (c1,c2)	0.8332	--
Covariance (c1,c3)	0.9615	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	5.696
p	< 0.001
Adjusted R ²	0.3152
AIC	870.070

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.34	0.03
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	0.009*	0.285*	0.040*

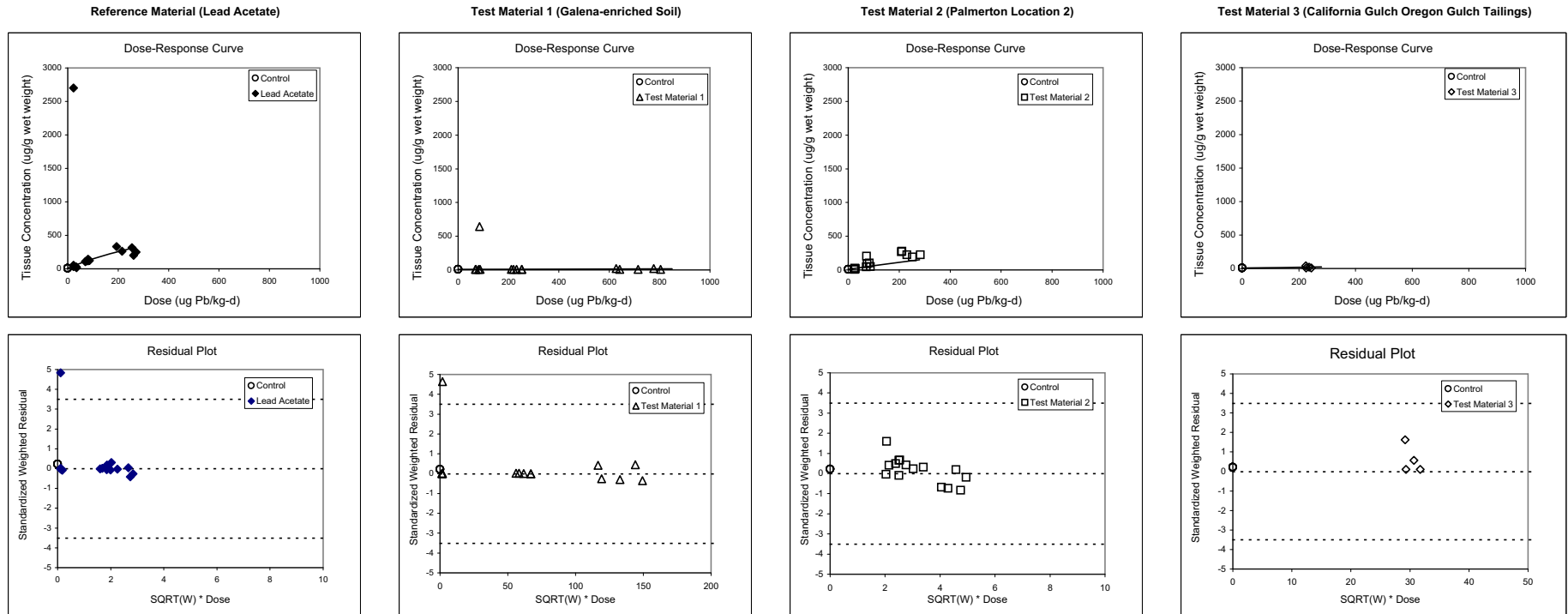
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3c - All Data

Phase II Experiment 12: Kidney

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	7.72E+00	4.99E+00
b	1.08E+03	3.46E+03
c1	6.69E+02	2.65E+03
c2	1.13E+05	4.07E+05
c3	1.86E+03	6.31E+03
Covariance (c1,c2)	0.9197	--
Covariance (c1,c3)	0.9839	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	5.687
p	< 0.001
Adjusted R ²	0.3148
AIC	870.320

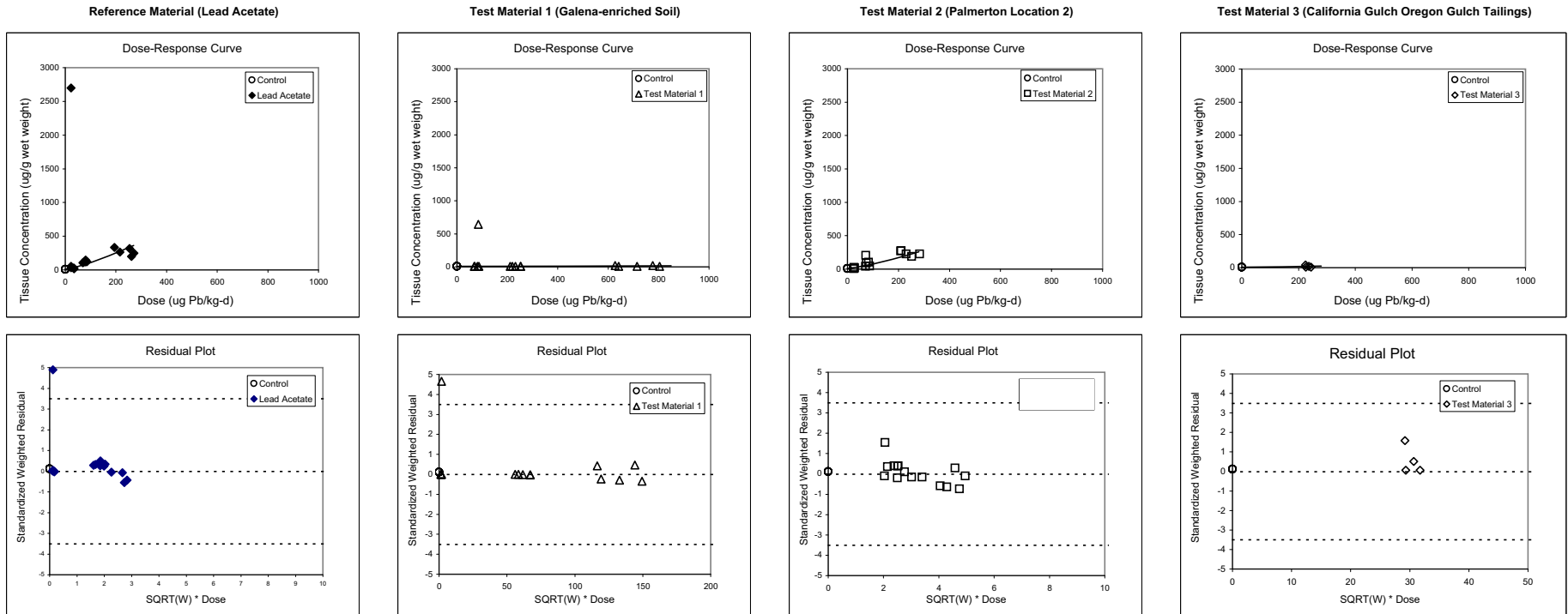
RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.36	0.03
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	0.009*	0.315*	0.044*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 3d - All Data
Phase II Experiment 12: Kidney
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	8.77E+00	4.86E+00
b1	2.98E-01	5.94E-01
b2	1.36E-03	4.51E-03
b3	1.99E-01	3.56E-01
c	1.26E+00	3.71E-01
Covariance (b1,b2)	0.8626	--
Covariance (b1,b3)	0.9574	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	5.929
p	< 0.001
Adjusted R ²	0.3258
AIC	864.518

RBA and Uncertainty

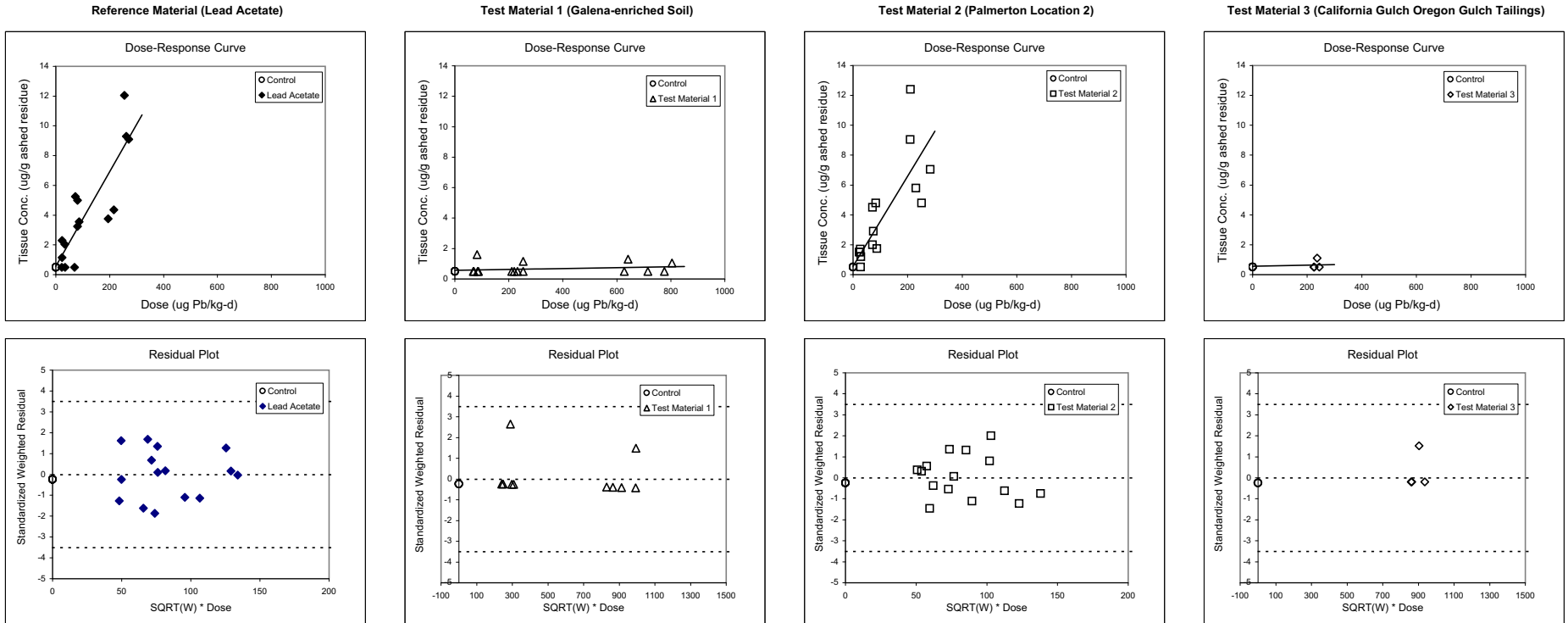
	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.73	0.08
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	--	--	--

APPENDIX E

Figure 4a - All Data

Phase II Experiment 12: Femur

Linear Model: $y = a + b1*x1 + b2*x2 + b3*x3$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.69E-01	1.05E-01
b1	3.18E-02	4.24E-03
b2	3.01E-04	3.12E-04
b3	3.01E-02	4.25E-03
b4	3.58E-04	9.00E-04
Covariance (c1,c2)	0.1724	--
Covariance (c1,c3)	0.0760	--
Covariance (c1,c4)	0.1361	--
Degrees of Freedom	47	--

Goodness of Fit

Statistic	Estimate
F	82.424
p	< 0.001
Adjusted R ²	0.8646
AIC	137.166

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.95	0.01
Lower bound	-0.01	0.69	-0.04
Upper bound	0.03	1.30	0.06
Standard Error	0.010*	0.177*	0.028*

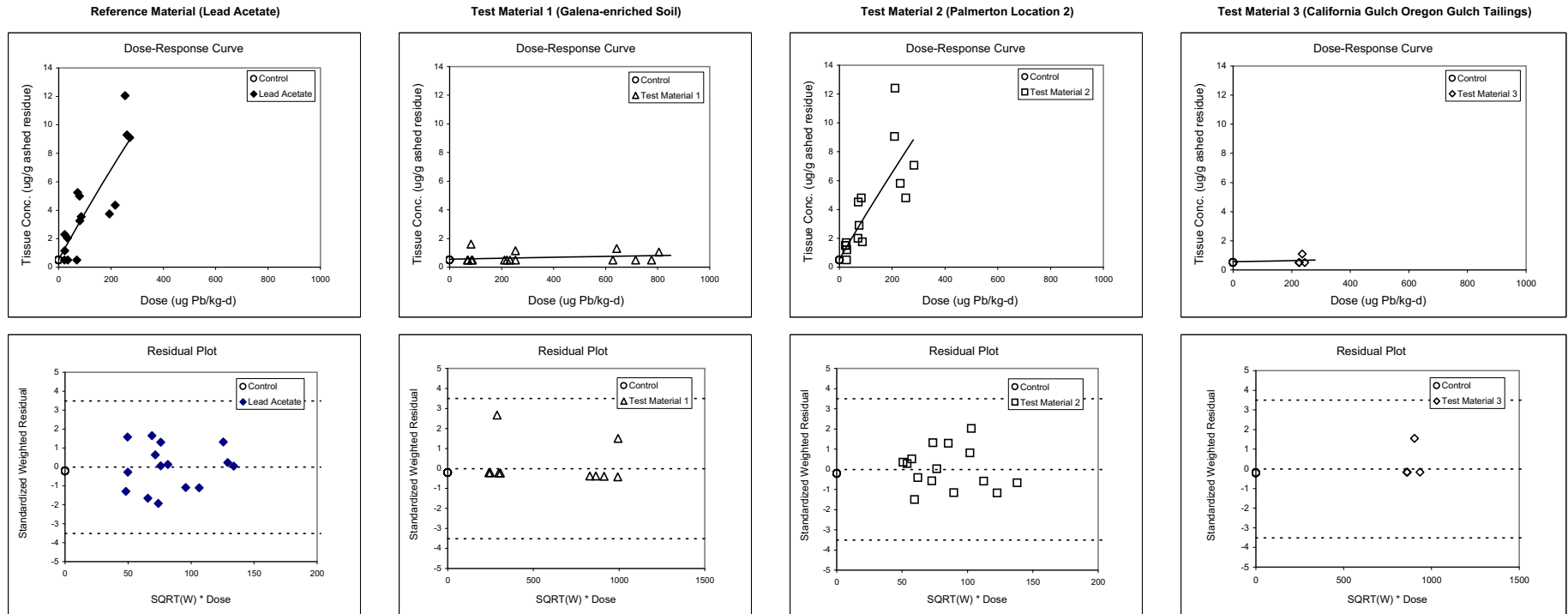
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4b - All Data

Phase II Experiment 12: Femur

Exponential Model: $y = a + b*(1-\exp(-c1*x1))+b*(1-\exp(-c2*x2)) + b*(1-\exp(-c3*x3))$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.60E-01	1.13E-01
b	6.55E+01	2.73E+02
c1	5.07E-04	2.21E-03
c2	4.87E-06	2.19E-05
c3	4.82E-04	2.09E-03
Covariance (c1,c2)	0.9760	--
Covariance (c1,c3)	0.9990	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	61.801
p	< 0.001
Adjusted R ²	0.8563
AIC	139.150

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.95	0.01
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	0.009*	0.185*	0.027*

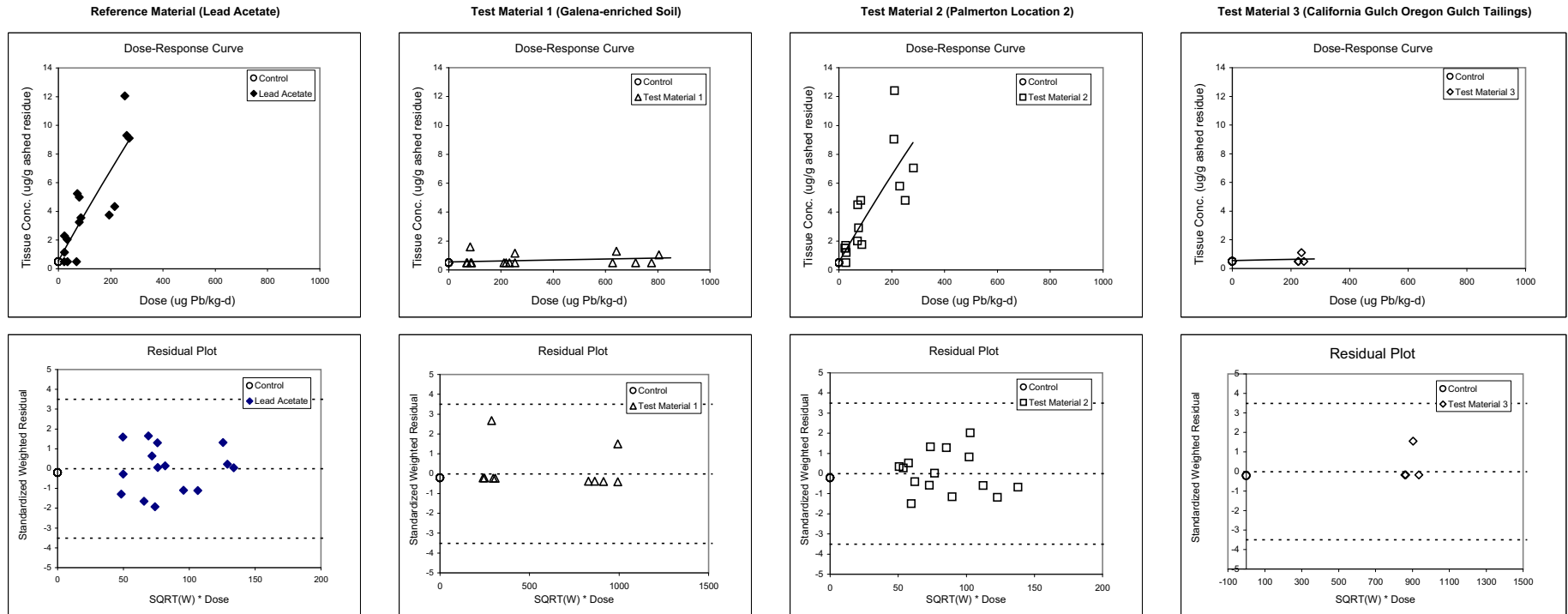
* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4c - All Data

Phase II Experiment 12: Femur

Michaelis-Menton Model: $y = a + b \cdot x_1 / (c_1 + x_1) + b \cdot x_2 / (c_2 + x_2) + b \cdot x_3 / (c_3 + x_3)$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.60E-01	1.13E-01
b	1.31E+02	5.71E+02
c1	3.94E+03	1.80E+04
c2	4.10E+05	1.93E+06
c3	4.15E+03	1.89E+04
Covariance (c1,c2)	0.9781	--
Covariance (c1,c3)	0.9991	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	61.857
p	< 0.001
Adjusted R ²	0.8565
AIC	139.151

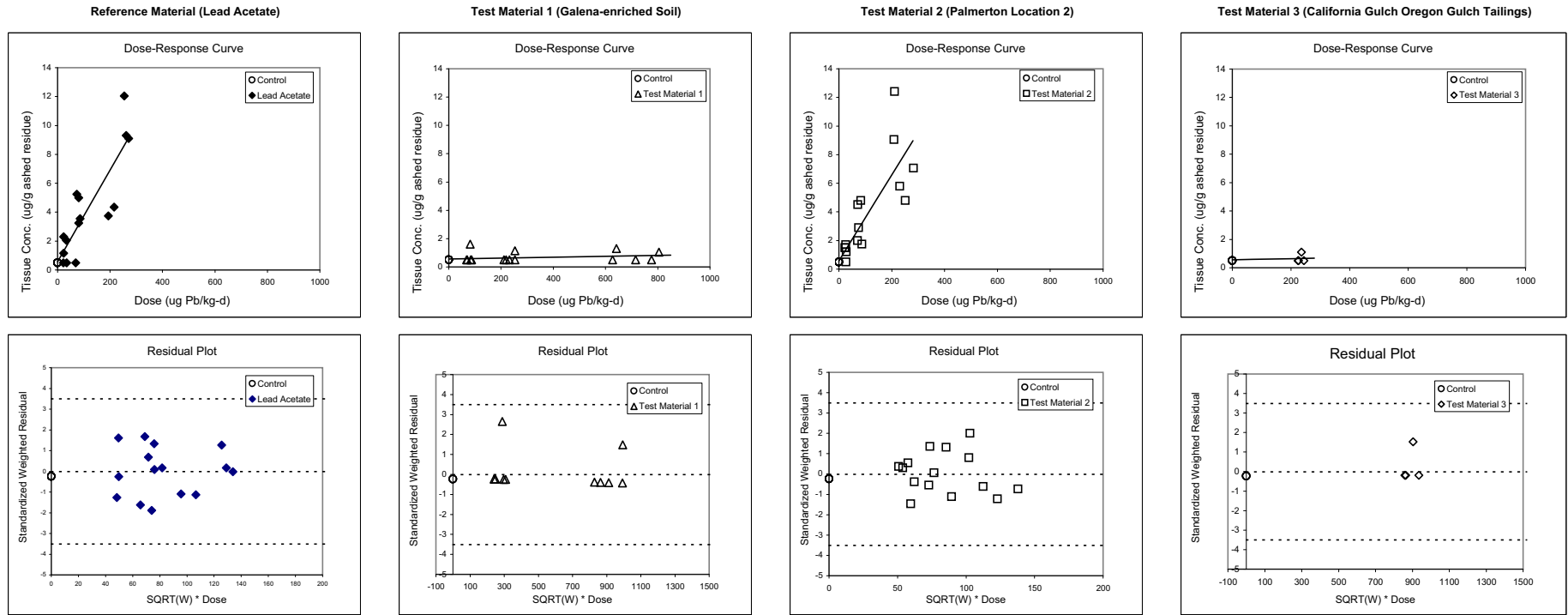
RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.95	0.01
Lower bound	?	?	?
Upper bound	?	?	?
Standard Error	0.009*	0.184*	0.027*

* $g \geq 0.05$, estimate is uncertain

APPENDIX E

Figure 4d - All Data
Phase II Experiment 12: Femur
Power Model: $y = a + b1*x1^c + b2*x2^c + b3*x3^c$



Summary of Fitting

Parameter	Estimate	Standard Error
a	5.67E-01	1.18E-01
b1	3.25E-02	2.13E-02
b2	3.14E-04	4.82E-04
b3	3.08E-02	2.01E-02
c	9.95E-01	1.27E-01
Covariance (b1,b2)	0.7455	--
Covariance (b1,b3)	0.9584	--
Degrees of Freedom	46	--

Goodness of Fit

Statistic	Estimate
F	63.930
p	< 0.001
Adjusted R ²	0.8605
AIC	139.183

RBA and Uncertainty

	Test Material 1	Test Material 2	Test Material 3
RBA	0.01	0.95	0.01
Lower bound	0.06	?	?
Upper bound	0.04	?	?
Standard Error	--	--	--

APPENDIX F

**DETAILED LEAD SPECIATION DATA
FOR TEST MATERIALS**

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APPENDIX F

METAL CONTENT OF TEST MATERIALS

Experiment	Test Material	Concentration (ppm)																							
		Al	As	Au	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn	
2	Bingham Creek Residential	10,600	51.2	4.1	143	0.71	13,600	4.2	7.5	16.6	691	16,100	-	4,340	7,020	466	362	15.0	1,590	10 U	<17	<17	20.8	903	
	Bingham Creek Channel Soil	10,100	149.0	17.2	152	0.73	8,500	8.7	7.9	17.9	1,720	22,500	-	4,150	5,970	376	314	15.1	6,330	18.7	<17	<17	22.0	-	
3	Jasper County High Lead Smelter	8,850	25.1	1.3	284	1.70	45,800	33.7	19.3	23.8	94	40,200	0.64	1,490	7,860	784	399	44.8	10,800	4.90	1.0U	1.4U	22.5	10,000	
	Jasper County Low Lead Yard	4,370	10.7	0.6	94	1.00	81,800	188.0	6.4	15.2	144	18,000	1.30	927	1,390	240	403	30.1	4,050	1.0 U	1.0U	1.80	14.8	50,000	
4	Murray Smelter Slag	9,370	710	18.3	2,140	0.86	89,600	30.9	45.4	34.0	2,100	170,000	1.00	2,430	11,200	2,640	836	16.7	11,700	55.7	43.90	12.60	73.6	49,500	
	Jasper County High Lead Mill	9,380	16.4	18.8	211	1.40	19,900	139.0	34.3	64.6	96	26,600	12.10	1,400	2,280	1,270	339	110.0	6,940	1.0 U	1.0U	1.4U	23.0	17,200	
5	Aspen Berm	5,070	66.9	92.3	1,640	1.30	37,200	41.9	17.1	7.7	145	33,700	0.77	1,090	14,300	2,220	249	29.8	14,200	5.20	2.00	1.80	11.5	6,580	
	Aspen Residential	8,440	16.7	18.9	1,030	0.82	17,300	47.4	11.1	10.4	52	23,000	0.23	2,140	6,890	934	114	21.9	3,870	11.4	0.38	0.27	16.0	4,110	
6	Midvale Slag	10,500	619	.11U	637	0.58	93,200	24.5	33.0	142.0	1,330	202,000	0.74	4,250	6,180	1,640	7,910	.31U	8,170	71.9	39.70	8.10	10.1U	33,300	
	Butte Soil	7,540	226	40.5	134	0.56	15,700	42.2	9.2	6.9	838	48,500	2.20	3,560	2,950	12,800	530	8.0	8,530	10.60	0.27	1.80	27.0	12,100	
7	California Gulch Phase I Residential Soil	8,670	203	43.0	605	0.60	20,100	59.9	2.0	9.1	657	68,120	1.26	1,500	9,521	7,090	6,560	5.6	7,510	1.80	1.90	<0.5	33.7	13,738	
	California Gulch Fe/Mn PbO	11,900	110	16.7	266	1.00	3,930	38.5	6.9	7.5	165	27,500	4.90	1,770	2,520	1,190	279	7.5	4,320	6.00	0.80	3.70	17.9	2,650	
8	California Gulch AV Slag	20,800	1,050	21.2	2,430	1.20	117,000	12.8	53.8	43.1	2,080	207,000	0.11	7,390	6,360	6,910	4,080	7.1	10,600	57.2	61.30	1.80	37.2	67,300	
9	Palmerton Location 2	7,750	110	9.5	6,850	1.40	1,160	195.0	18.8	30.3	462	25,900	1.70	515	725	6,320	667	15.0	3,230	6.00	11.80	1.90	53.1	6,500	
	Palmerton Location 4	7,850	134.0	5.1	1,090	2.00	2,480	319.0	17.4	26.6	350	26,700	1.10	512	684	9,230	2,100	26.8	2,150	7.40	6.90	0.85	49.8	19,100	
11	Murray Smelter Soil	6,520	310	11.1	584	0.48b	69,000	23.8	11.5	16.4	856	38,700	0.52	2,040	15,000	863	532.0b	10.4	3,200	20.0	6.80	4.80	28.3	10,400	
	NIST Paint	5,850	4.8	0.63U	1,320	0.47b	11,800	4.0	8.3	20.8	12	8,890	0.92	1,360	2,900	272	81.9b	5.80b	8,350	8.7 U	0.61U	0.87U	11.6	1,880	
12	Galena-enriched Soil	6,340	4.9	0.63U	112	0.49b	2,650	0.8	3.1	10.2	11	10,000	0.06b	1,460	2,790	293	31.20b	3.80b	11,200	8.70	0.61U	0.87U	12.60b	107	
	California Gulch Oregon Gulch Tailings	248	1,290	41.7	14	2.00	8,290	4.0	10.1	8.0	350	391,000	0.24	451	118	126	34	28.2	1,270	74.4	0.53	0.86	47.7	441	

All samples were analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES) in accord with USEPA Method 200.7.

APPENDIX F

EXPERIMENT 2 - BINGHAM CREEK RESIDENTIAL

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Cerussite	2	2	4	2	5	1.0%	1.0%	0.28%	0.28%	6.6	0.776	1.8%	1.8%
Fe-Pb Oxide	30	30	15	2	75	15.1%	15.1%	17.93%	17.93%	4	0.052	4.6%	4.6%
Fe-Pb Silicate*	14	14	10	8	20	7.0%	7.0%	5.52%	5.52%	3.5	0.052	1.2%	1.2%
Mn-Pb Oxide	21	21	22	2	110	10.6%	10.6%	18.13%	18.13%	5.1	0.159	18.1%	18.1%
Pb-As Oxide	3	3	4	2	8	1.5%	1.5%	0.52%	0.52%	6	0.5	1.9%	1.9%
Pb Phosphate	43	43	13	1	110	21.6%	21.6%	21.70%	21.70%	5.1	0.37	50.4%	50.4%
Fe-Pb Sulfate	86	86	10	1	120	43.2%	43.2%	35.91%	35.91%	3.7	0.134	21.9%	21.9%
TOTAL	199	199	13			100.0%	100.0%	100.00%	100.00%			100.0%	100.0%

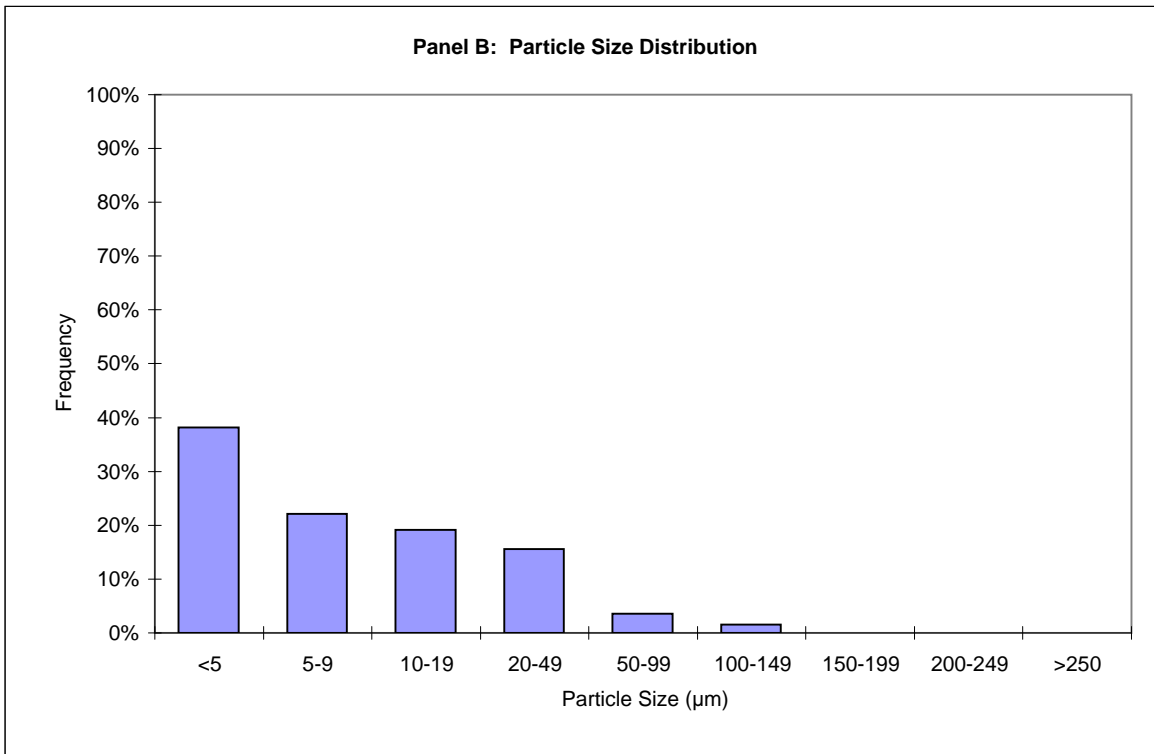
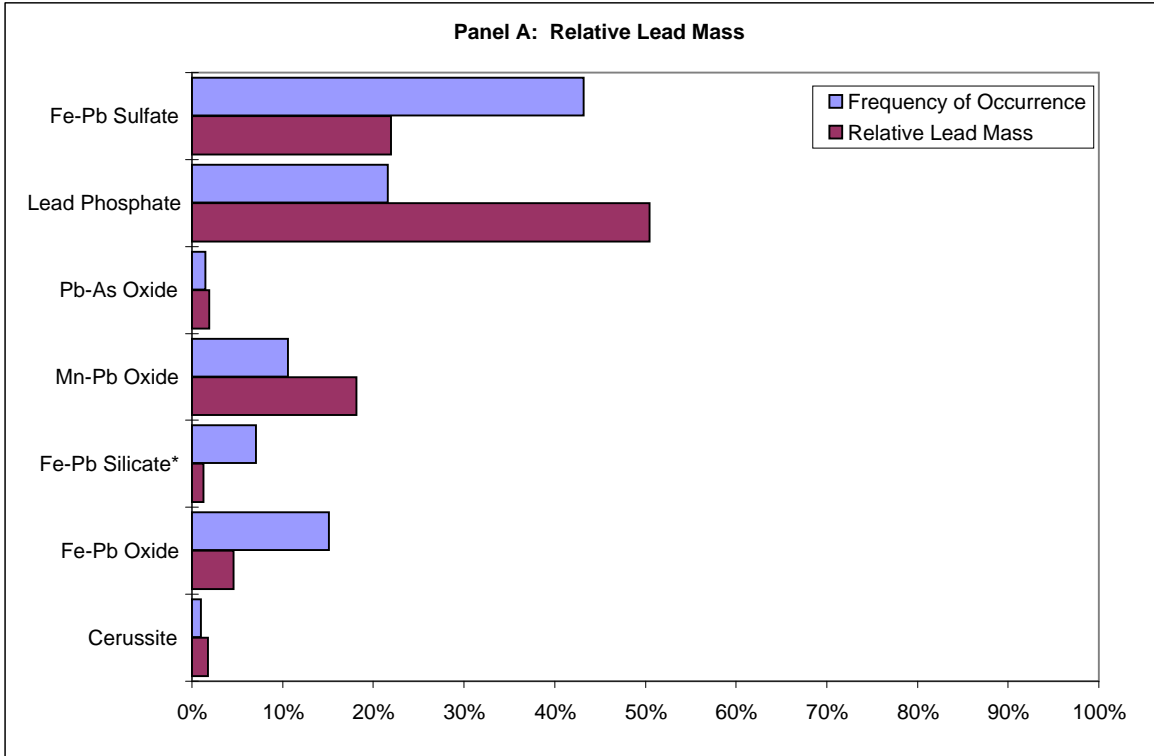
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	38.2%	38.2%	8.2%	8.2%
5-9	22.1%	22.1%	12.2%	12.2%
10-19	19.1%	19.1%	13.0%	13.0%
20-49	15.6%	15.6%	30.3%	30.3%
50-99	3.5%	3.5%	18.8%	18.8%
100-149	1.5%	1.5%	17.6%	17.6%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	100%	100%	100%

EXPERIMENT 2 - BINGHAM CREEK RESIDENTIAL

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 2 - BINGHAM CREEK CHANNEL SOIL

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	57	56	4	1	30	11.6%	11.4%	6.26%	6.23%	6.3	0.684	28.4%	28.3%
Cerussite	1	1	2	2	2	0.2%	0.2%	0.05%	0.05%	6.6	0.776	0.3%	0.3%
Fe-Pb Oxide	25	25	17	4	60	5.1%	5.1%	10.88%	10.88%	4.0	0.053	2.4%	2.4%
FeSbO	1	1	5	5	5	0.2%	0.2%	0.13%	0.13%			0.0%	0.0%
Fe-Pb Silicate*	4	4	15	10	20	0.8%	0.8%	1.56%	1.56%	3.5	0.057	0.3%	0.3%
Galena	1	1	50	50	50	0.2%	0.2%	1.30%	1.30%	7.5	0.866	8.9%	8.9%
Mn-Pb Oxide	5	5	21	5	50	1.0%	1.0%	2.67%	2.67%	5.1	0.159	2.3%	2.3%
Lead Organic	2	2	105	100	110	0.4%	0.4%	5.45%	5.45%	1.3	0.037	0.3%	0.3%
Pb-As Oxide	3	3	4	1	8	0.6%	0.6%	0.29%	0.29%	6.0	0.500	0.9%	0.9%
Lead Barite	1	1	10	10	10	0.2%	0.2%	0.26%	0.26%	4.5	0.031	0.0%	0.0%
Lead Phosphate	42	42	12	1	100	8.6%	8.6%	13.01%	13.01%	5.1	0.370	25.8%	25.8%
Fe-Pb Sulfate	349	349	6	1	110	71.1%	71.1%	58.15%	58.15%	3.7	0.134	30.4%	30.4%
TOTAL	491	490	8			100.0%	99.8%	100.00%	99.97%			100.0%	99.9%

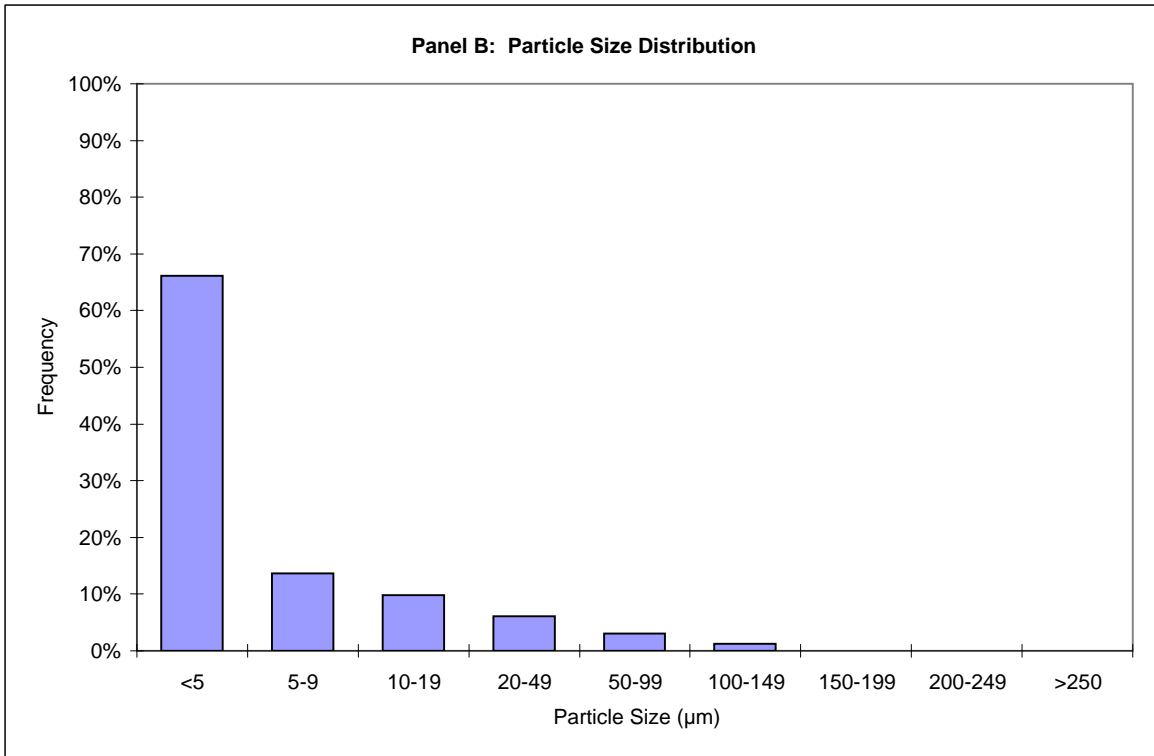
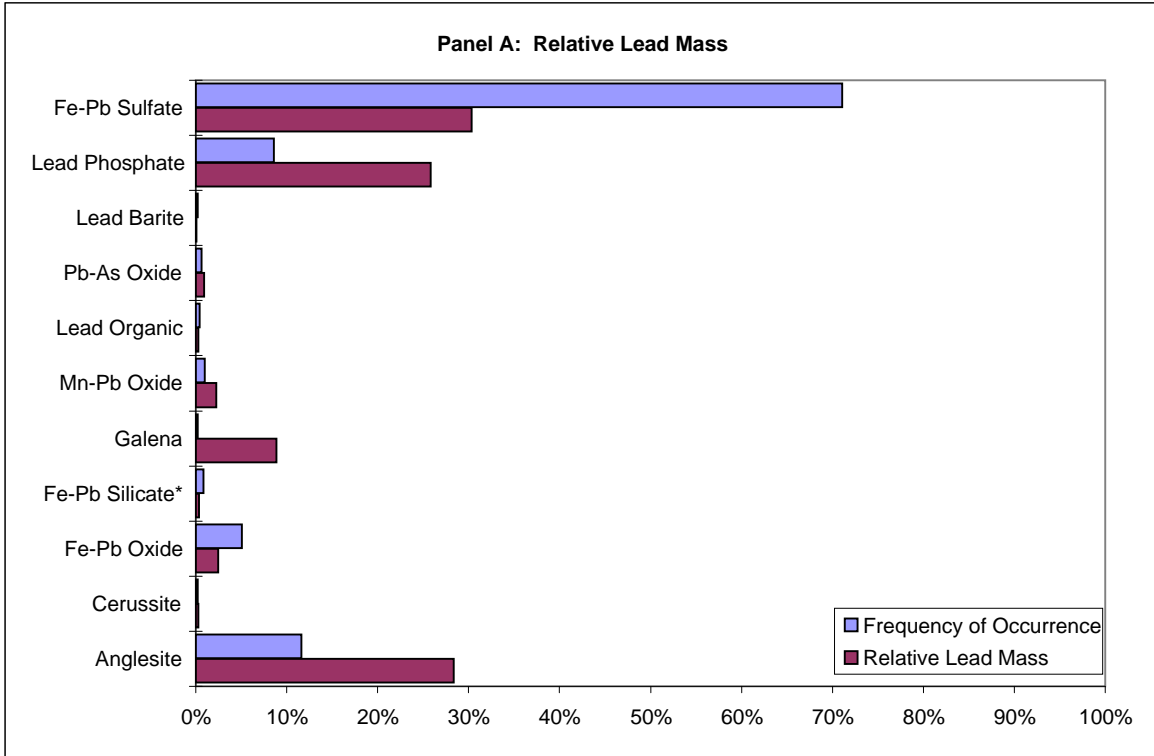
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	66.2%	66.0%	13.9%	13.8%
5-9	13.6%	13.6%	17.5%	17.5%
10-19	9.8%	9.8%	18.4%	18.4%
20-49	6.1%	6.1%	20.0%	20.0%
50-99	3.1%	3.1%	20.5%	20.5%
100-149	1.2%	1.2%	9.6%	9.6%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	100%	100%	100%

EXPERIMENT 2 - BINGHAM CREEK CHANNEL SOIL

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 3 - JASPER COUNTY HIGH LEAD SMELTER

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	1	1	12	12	12	0.25%	0.25%	0.11%	0.11%	6.3	0.684	0.9%	0.9%
Calcite	2	2	48	35	60	0.50%	0.50%	0.87%	0.87%	2.8	0.050	0.2%	0.2%
Cerussite	12	11	31	8	90	3.0%	2.8%	3.39%	3.26%	6.6	0.776	32.1%	30.7%
Clay	2	2	35	10	60	0.50%	0.50%	0.64%	0.64%	3.1	0.005	0.02%	0.02%
Fe-Pb Oxide	24	24	45	10	150	6.0%	6.0%	10.04%	10.04%	4.0	0.037	2.7%	2.7%
Fe-Pb Silicate*	22	22	83	4	175	5.5%	5.5%	16.80%	16.80%	3.7	0.100	11.5%	11.5%
Mn-Pb Oxide	5	5	47	12	100	1.3%	1.3%	2.18%	2.18%	5.1	0.112	2.3%	2.3%
Native Lead	56	0	2	1	9	14.0%	0.0%	1.07%	0.00%	11.3	1.000	22.2%	0.0%
Lead Oxide	6	1	6	1	10	1.5%	0.3%	0.31%	0.02%	4.0	0.037	0.09%	0.01%
Lead Phosphate	117	117	7	1	90	29.3%	29.3%	7.25%	7.25%	5.1	0.310	21.1%	21.1%
Slag	62	62	94	15	300	15.5%	15.5%	53.58%	53.58%	3.7	0.012	4.3%	4.3%
Fe-Pb Sulfate	90	75	5	1	10	22.6%	18.8%	3.75%	3.20%	3.7	0.100	2.6%	2.2%
TOTAL	399	322	27			100.0%	80.7%	100.00%	97.95%			100.0%	76.0%

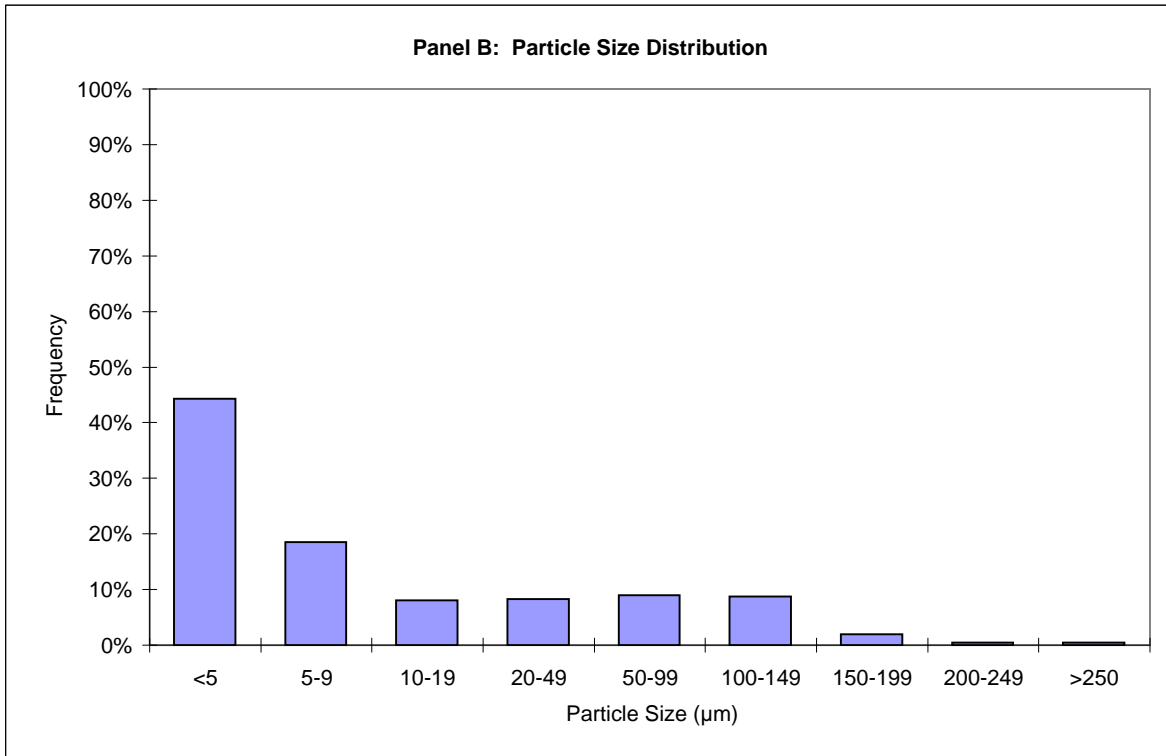
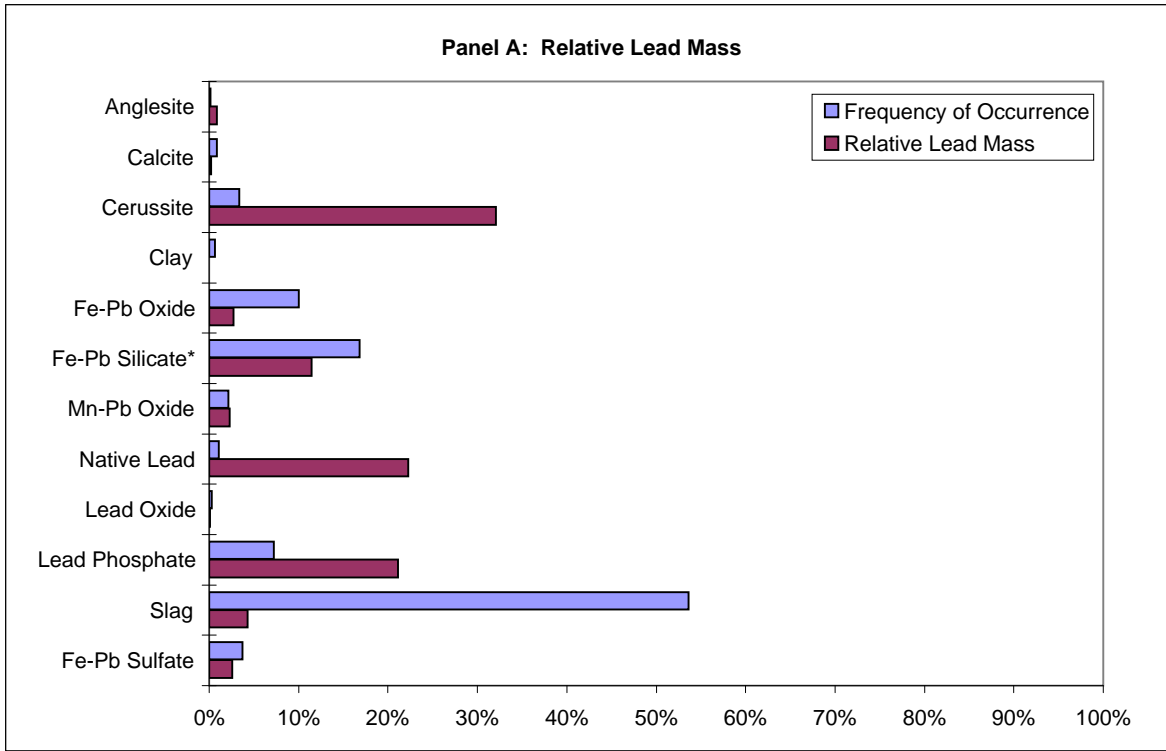
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	44.4%	28.1%	17.2%	3.8%
5-9	18.5%	16.0%	15.0%	5.7%
10-19	8.0%	7.5%	7.8%	6.4%
20-49	8.3%	8.3%	14.0%	14.0%
50-99	9.0%	9.0%	31.9%	31.9%
100-149	8.8%	8.8%	9.6%	9.6%
150-199	2.0%	2.0%	3.8%	3.8%
200-249	0.5%	0.5%	0.3%	0.3%
≥250	0.5%	0.5%	0.4%	0.4%
TOTAL	100%	81%	100%	76%

EXPERIMENT 3 - JASPER COUNTY HIGH LEAD SMELTER

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 3 - JASPER COUNTY LOW LEAD YARD

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	3	3	3	2	6	1.6%	1.6%	0.31%	0.31%	6.3	0.684	0.48%	0.48%
Cerussite	95	95	15	1	130	52.2%	52.2%	43.37%	43.37%	6.6	0.776	81.1%	81.1%
Clay	1	1	15	15	15	0.5%	0.5%	0.46%	0.46%	3.1	0.005	0.003%	0.003%
Fe-Pb Oxide	18	18	36	8	100	9.9%	9.9%	19.53%	19.53%	4	0.037	1.1%	1.1%
Fe-Pb Silicate*	9	9	33	5	100	4.9%	4.9%	9.11%	9.11%	3.7	0.1	1.2%	1.2%
Galena	2	1	53	25	80	1.1%	0.5%	3.21%	0.76%	7.5	0.866	7.6%	1.8%
Mn-Pb Oxide	10	10	25	8	55	5.5%	5.5%	7.73%	7.73%	5.1	0.112	1.6%	1.6%
Pb-As Oxide	1	1	8	8	8	0.5%	0.5%	0.24%	0.24%	7.1	0.243	0.15%	0.15%
Lead Silicate	2	2	2	1	2	1.1%	1.1%	0.09%	0.09%	8	0.167	0.04%	0.04%
Lead Phosphate	32	32	11	1	80	17.6%	17.6%	10.42%	10.42%	5.1	0.31	6.0%	6.0%
Fe-Pb Sulfate	9	9	20	1	100	4.9%	4.9%	5.53%	5.53%	3.7	0.1	0.75%	0.75%
TOTAL	182	181	18			100.0%	99.5%	100.00%	97.56%			100.0%	94.2%

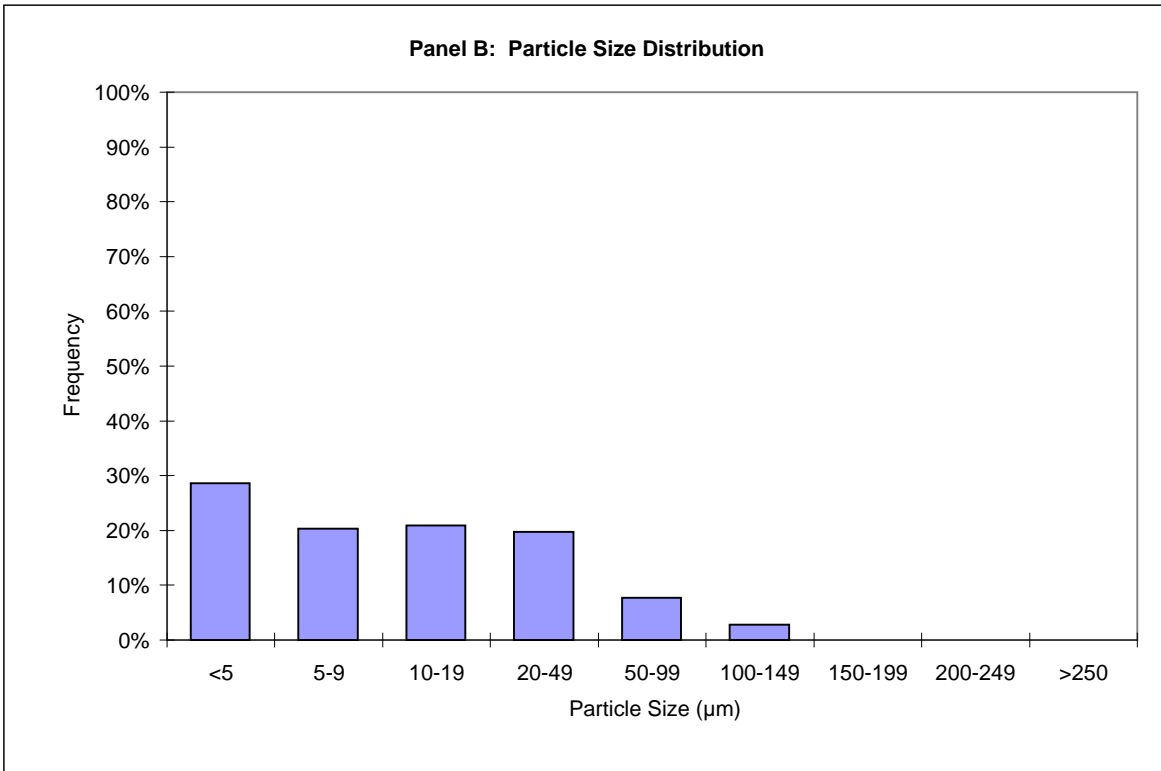
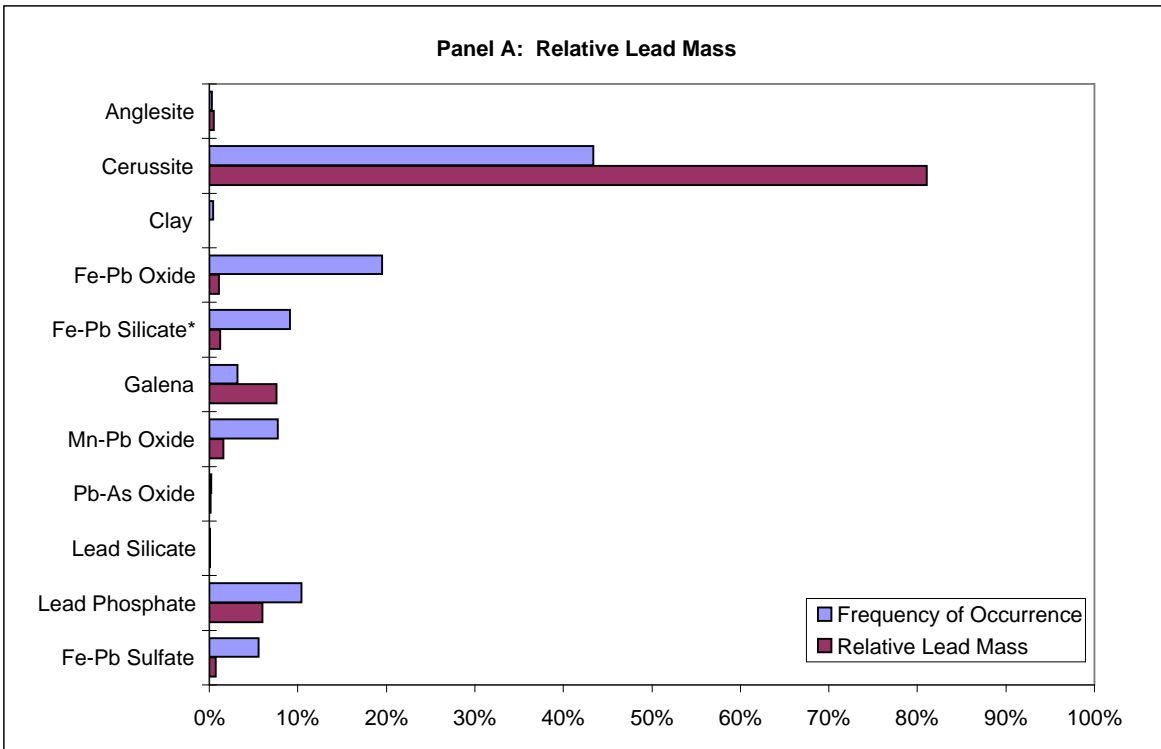
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	28.6%	28.6%	5.0%	5.0%
5-9	20.3%	20.3%	8.5%	8.5%
10-19	20.9%	20.9%	17.1%	17.1%
20-49	19.8%	19.8%	30.2%	30.2%
50-99	7.7%	7.1%	23.6%	17.8%
100-149	2.7%	2.7%	15.6%	15.6%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	99%	100%	94%

EXPERIMENT 3 - JASPER COUNTY LOW LEAD YARD

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 4 - MURRAY SMELTER SLAG

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	3	0	12	10	15	0.2%	0.0%	0.04%	0.00%	6.3	0.684	1.0%	0.0%
Cerussite	4	3	8	3	15	0.3%	0.2%	0.04%	0.04%	6.6	0.776	1.1%	1.0%
Fe-Pb Oxide	3	3	18	8	35	0.2%	0.2%	0.07%	0.07%	4	0.031	0.04%	0.04%
Fe-As Oxide	3	3	17	4	35	0.2%	0.2%	0.06%	0.06%			0.0%	0.0%
Fe-Pb Silicate*	9	9	28	8	80	0.7%	0.7%	0.32%	0.32%	4	0.22	1.5%	1.5%
Galena	98	7	2	1	15	7.2%	0.5%	0.27%	0.08%	7.5	0.866	9.2%	2.6%
Mn-Pb Oxide	7	7	31	8	110	0.5%	0.5%	0.28%	0.28%	5.1	0.112	0.8%	0.8%
Native Lead	3	2	3	2	4	0.2%	0.1%	0.01%	0.01%	11.3	1	0.7%	0.5%
Pb-As Oxide	39	31	6	1	60	2.9%	2.3%	0.30%	0.27%	7.1	0.5	5.7%	5.1%
Pb(M)O	8	3	18	2	110	0.6%	0.2%	0.19%	0.16%	8	0.5	3.9%	3.3%
Lead Oxide	143	79	8	1	100	10.5%	5.8%	1.48%	1.18%	9.5	0.93	68.7%	54.6%
Slag	1037	1037	73	5	310	76.1%	76.1%	96.71%	96.71%	3.65	0.0038	7.0%	7.0%
Fe-Pb Sulfate	2	2	55	10	100	0.1%	0.1%	0.14%	0.14%	3.7	0.1	0.3%	0.3%
Zn-Pb Silicate	4	3	16	10	30	0.3%	0.2%	0.08%	0.07%	5.1	0.014	0.03%	0.03%
TOTAL	1363	1189	58			100.0%	87.2%	100.00%	99.38%			100.0%	76.8%

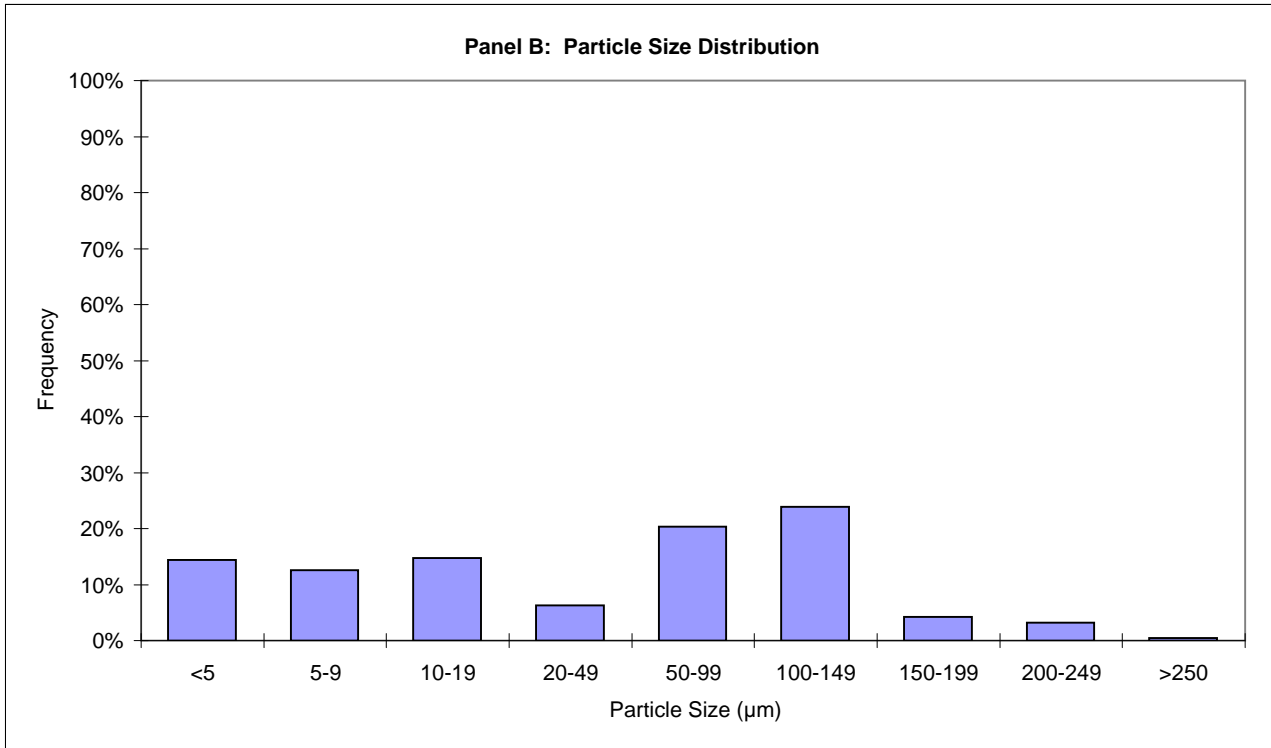
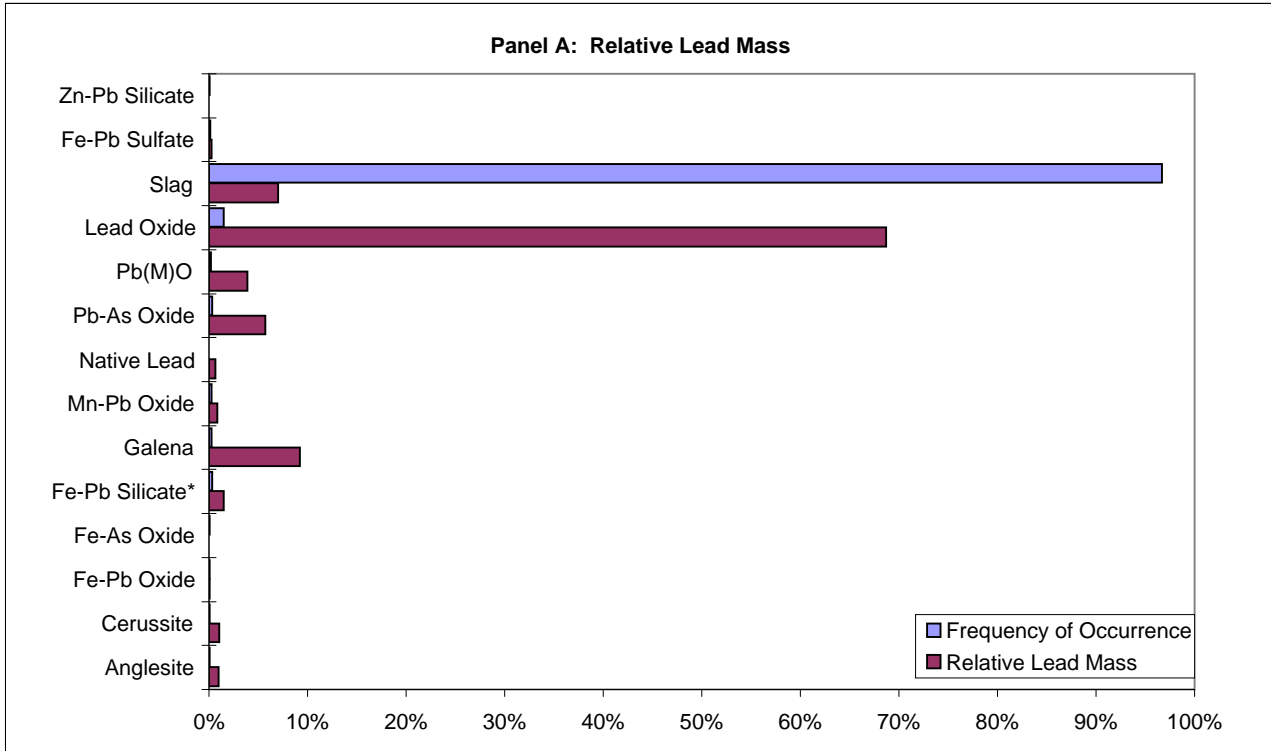
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	14.5%	4.1%	15.6%	5.4%
5-9	12.6%	11.2%	13.7%	7.9%
10-19	14.7%	13.9%	22.9%	17.3%
20-49	6.2%	6.2%	17.1%	15.3%
50-99	20.3%	20.3%	16.2%	16.2%
100-149	23.8%	23.8%	12.8%	12.8%
150-199	4.2%	4.2%	0.8%	0.8%
200-249	3.2%	3.2%	0.8%	0.8%
≥250	0.4%	0.4%	0.1%	0.1%
TOTAL	100%	87%	100%	77%

EXPERIMENT 4 - MURRAY SMELTER SLAG

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 4 - JASPER COUNTY HIGH LEAD MILL

Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	1	1	25	25	25	0.36%	0.36%	0.36%	0.36%	6.3	0.684	1.6%	1.6%
Lead Barite	1	1	3	3	3	0.36%	0.36%	0.04%	0.04%	4.5	0.045	0.01%	0.01%
Calcite	1	1	25	25	25	0.36%	0.36%	0.36%	0.36%	2.8	0.05	0.1%	0.1%
Cerussite	90	90	8	1	70	32.0%	32.0%	10.74%	10.74%	6.6	0.776	57.0%	57.0%
Clay	3	3	24	8	40	1.1%	1.1%	1.04%	1.04%	3.1	0.005	0.02%	0.02%
Fe-Pb Oxide	33	33	22	3	110	11.7%	11.7%	10.44%	10.44%	4	0.037	1.6%	1.6%
Fe-Pb Silicate*	41	41	36	1	210	14.6%	14.6%	21.16%	21.16%	3.7	0.1	8.1%	8.1%
Galena	6	0	6	1	30	2.1%	0.0%	0.51%	0.00%	7.5	0.866	3.4%	0.0%
Mn-Pb Oxide	39	39	27	3	125	13.9%	13.9%	14.77%	14.77%	5.1	0.112	8.7%	8.7%
Native Lead	3	0	4	1	10	1.1%	0.0%	0.18%	0.00%	11.3	1	2.2%	0.0%
Lead Oxide	3	1	17	5	40	1.07%	0.36%	0.71%	0.57%	9.5	0.93	6.5%	5.2%
Lead Silicate	1	1	10	10	10	0.36%	0.36%	0.14%	0.14%	8	0.45	0.53%	0.53%
Lead Phosphate	15	15	21	2	100	5.3%	5.3%	4.53%	4.53%	5.1	0.31	7.4%	7.4%
Slag	24	24	92	15	210	8.5%	8.5%	31.45%	31.45%	3.65	0.012	1.4%	1.4%
Fe-Pb Sulfate	20	20	13	3	60	7.1%	7.1%	3.58%	3.58%	3.7	0.1	1.4%	1.4%
TOTAL	281	270	25			100.0%	96.1%	100.00%	99.16%			100.0%	93.1%

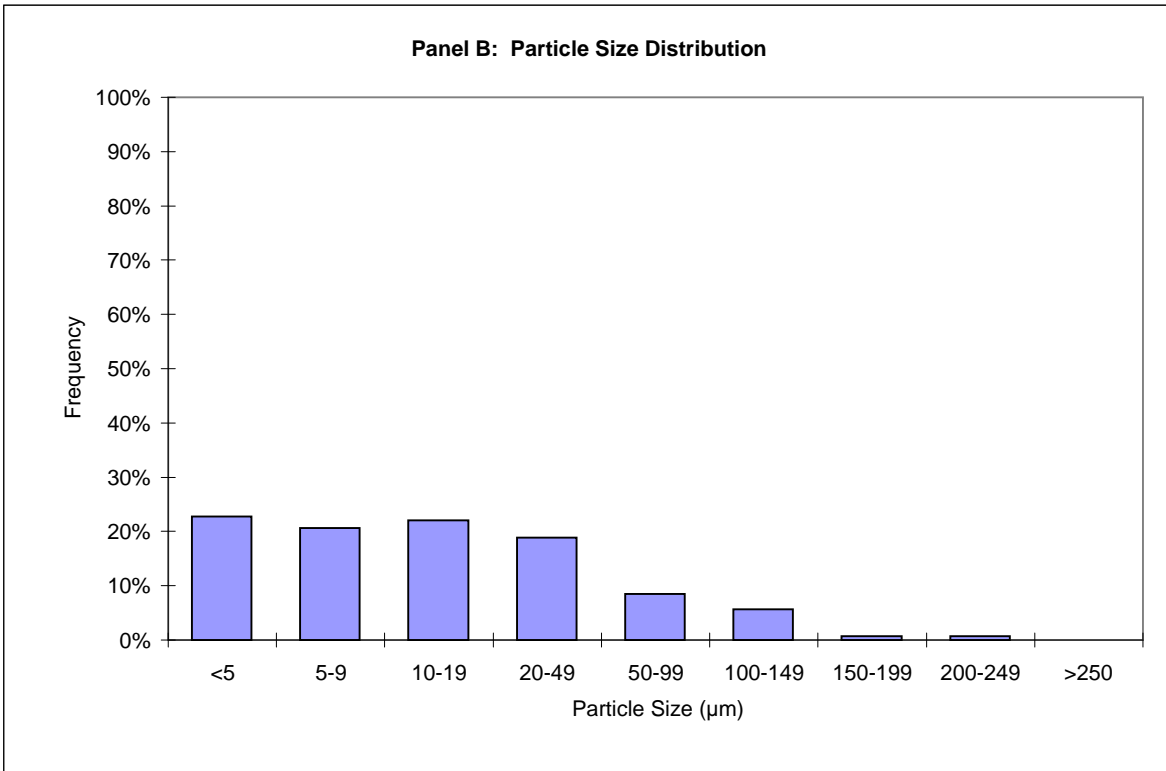
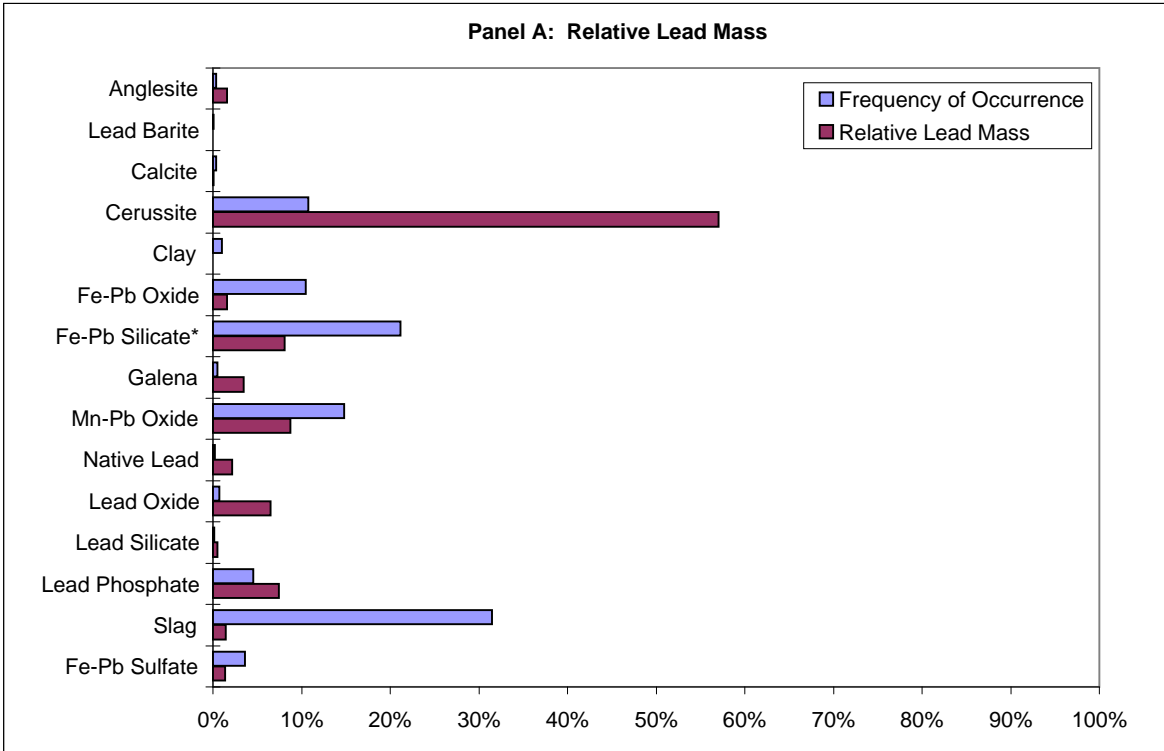
*This mineral is now considered to be equivalent to Fe-Pb Oxide.

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	22.8%	20.3%	8.3%	7.2%
5-9	20.6%	19.9%	12.9%	11.6%
10-19	22.1%	21.7%	24.3%	22.7%
20-49	18.9%	18.5%	33.7%	30.9%
50-99	8.5%	8.5%	12.8%	12.8%
100-149	5.7%	5.7%	6.5%	6.5%
150-199	0.7%	0.7%	0.2%	0.2%
200-249	0.7%	0.7%	1.3%	1.3%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	96%	100%	93%

EXPERIMENT 4 - JASPER COUNTY HIGH LEAD MILL

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 5 - ASPEN BERM

Lead Speciation Summary Statistics

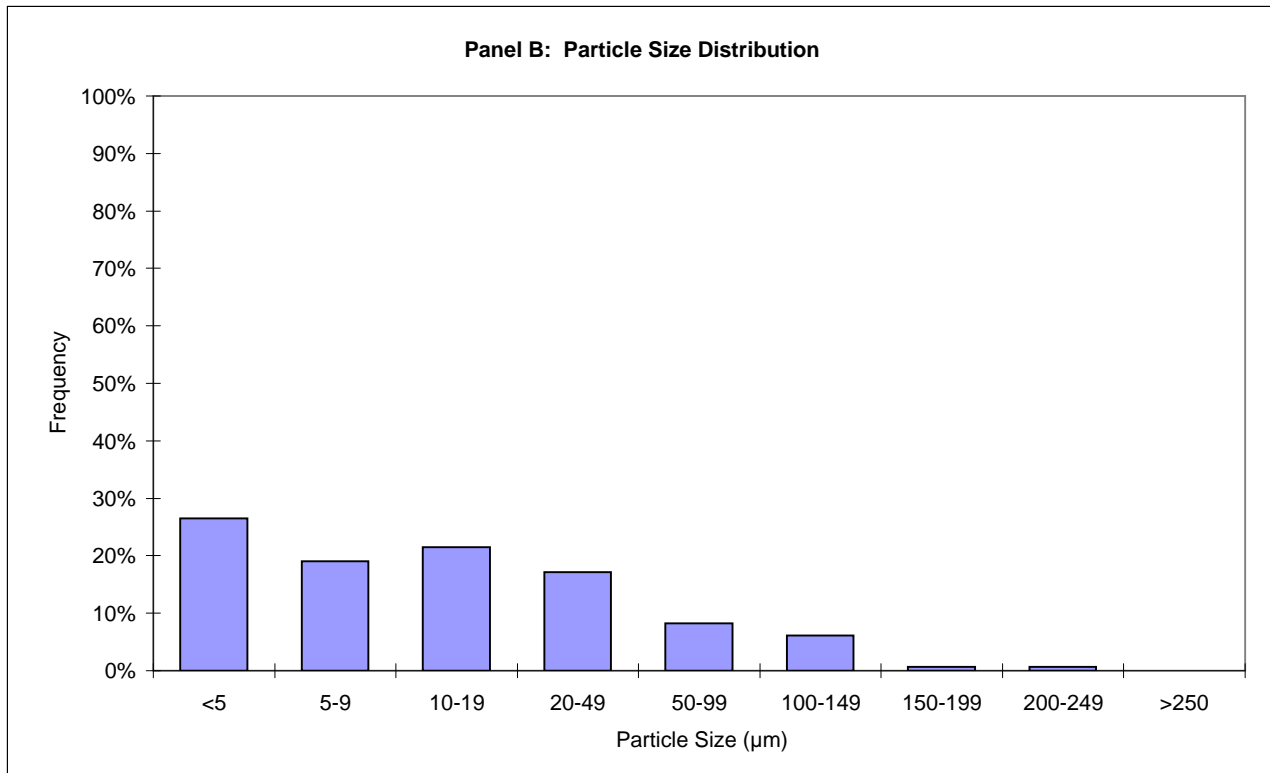
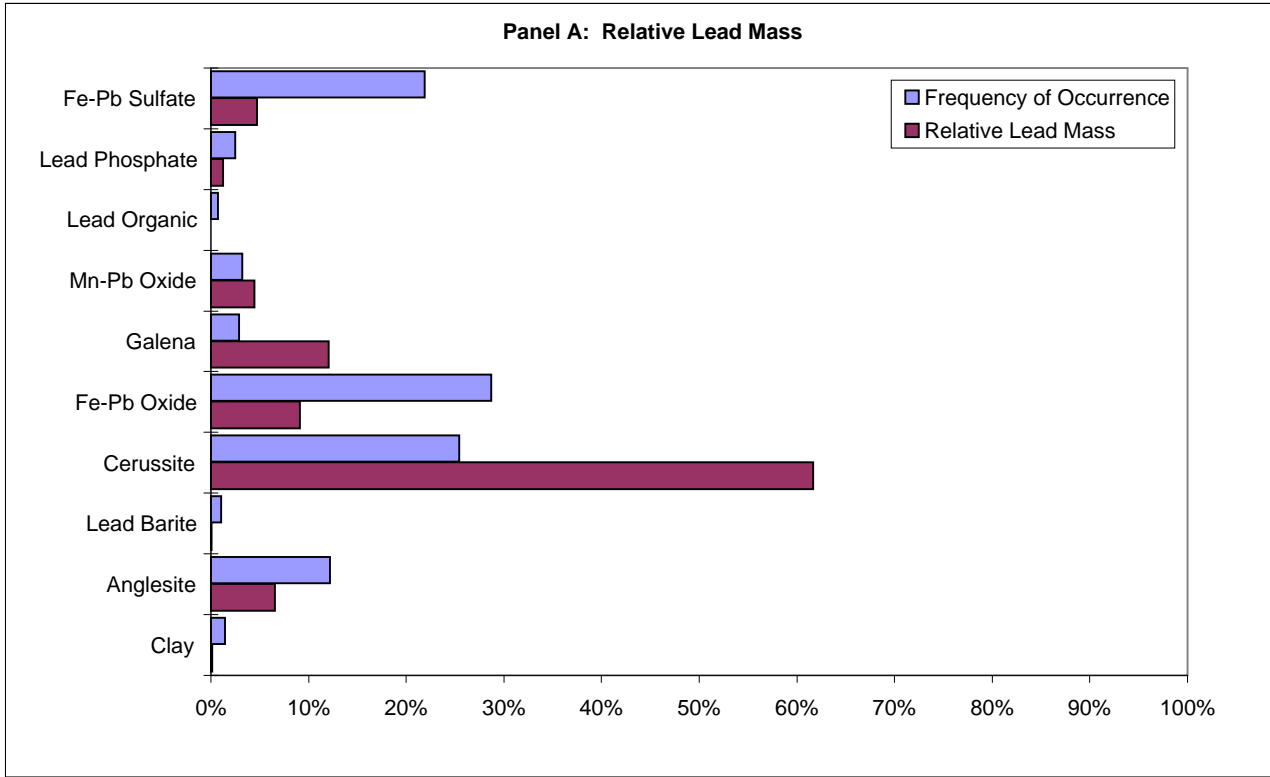
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Clay	4	4	55	10	120	1.4%	1.4%	3.30%	3.30%	2.6	0.02	0.1%	0.1%
Anglesite	34	34	5	1	90	12.2%	12.2%	2.63%	2.63%	6.3	0.684	6.6%	6.6%
Lead Barite	3	3	10	2	25	1.1%	1.1%	0.45%	0.45%	4.5	0.05	0.1%	0.1%
Cerussite	71	68	20	1	110	25.4%	24.4%	20.80%	20.11%	6.6	0.776	61.7%	59.6%
Fe-Pb Oxide	80	69	35	2	210	28.7%	24.7%	41.43%	36.09%	4	0.095	9.1%	7.9%
Galena	8	6	27	10	50	2.9%	2.2%	3.23%	2.70%	7.5	0.86	12.0%	10.1%
Mn-Pb Oxide	9	9	56	10	150	3.2%	3.2%	7.58%	7.58%	5.1	0.2	4.5%	4.5%
Lead Organic	2	2	70	40	100	0.7%	0.7%	2.10%	2.10%	1.3	0.018	0.0%	0.0%
Lead Phosphate	7	7	45	10	110	2.5%	2.5%	4.73%	4.73%	5.1	0.09	1.3%	1.3%
Fe-Pb Sulfate	61	39	15	4	90	21.9%	14.0%	13.75%	6.87%	3.7	0.16	4.7%	2.4%
TOTAL	279	241	24			100.0%	86.4%	100.00%	86.57%			100.0%	92.5%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	26.5%	25.4%	2.5%	2.3%
5-9	19.0%	15.8%	5.9%	5.6%
10-19	21.5%	17.6%	14.4%	12.6%
20-49	17.2%	14.3%	29.7%	26.3%
50-99	8.2%	5.7%	25.3%	23.4%
100-149	6.1%	6.1%	19.0%	19.0%
150-199	0.7%	0.7%	1.8%	1.8%
200-249	0.7%	0.7%	1.4%	1.4%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	86%	100%	92%

EXPERIMENT 5 - ASPEN BERM

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 5 - ASPEN RESIDENTIAL

Lead Speciation Summary Statistics

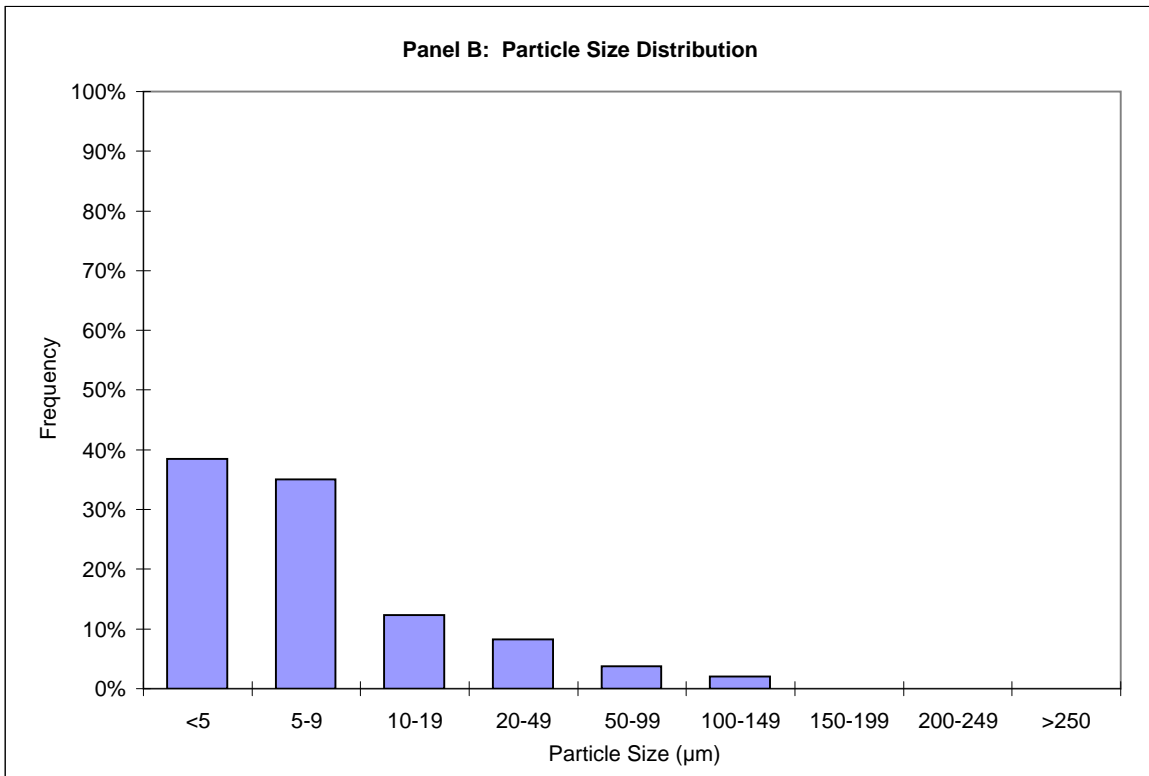
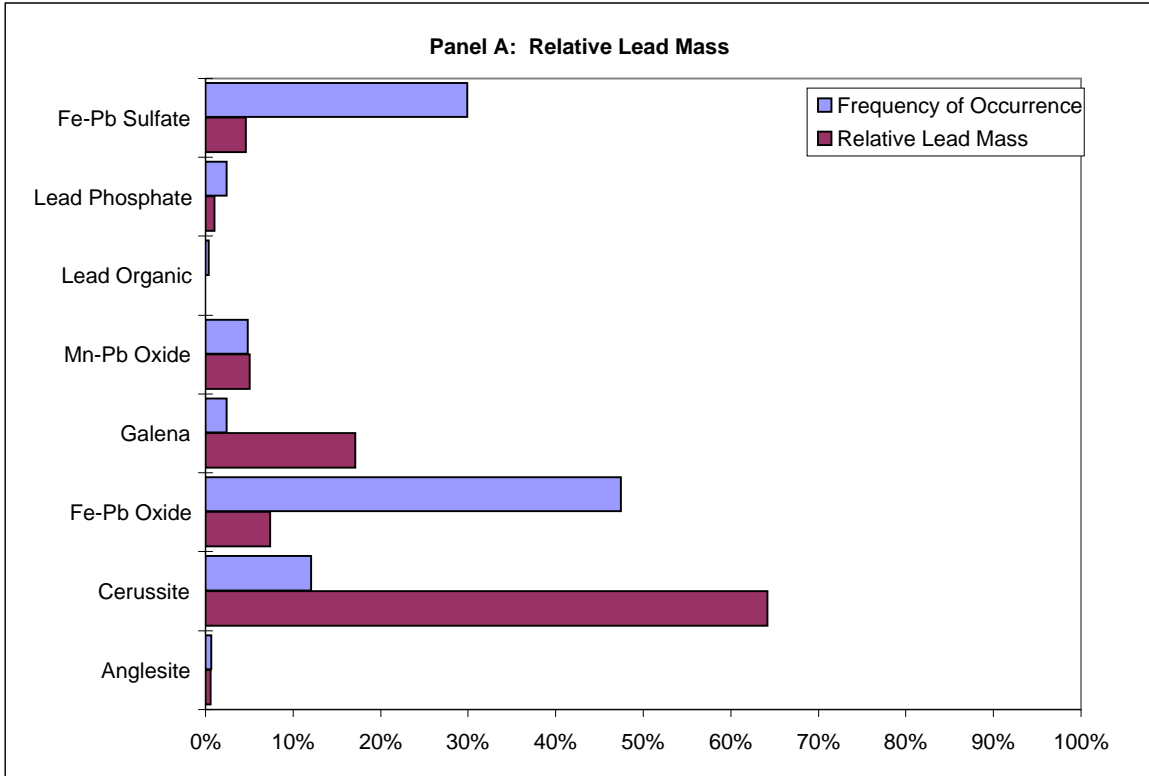
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	2	2	5	4	5	0.7%	0.7%	0.27%	0.27%	6.3	0.684	0.6%	0.6%
Cerussite	35	35	23	2	125	12.0%	12.0%	24.57%	24.57%	6.6	0.776	64.2%	64.2%
Fe-Pb Oxide	138	138	9	1	100	47.4%	47.4%	38.18%	38.18%	4	0.095	7.4%	7.4%
Galena	7	1	25	5	110	2.4%	0.3%	5.21%	3.31%	7.5	0.86	17.1%	10.9%
Mn-Pb Oxide	14	14	23	5	80	4.8%	4.8%	9.73%	9.73%	5.1	0.2	5.1%	5.1%
Lead Organic	1	1	80	80	80	0.3%	0.3%	2.41%	2.41%	1.3	0.018	0.0%	0.0%
Lead Phosphate	7	7	21	3	60	2.4%	2.4%	4.49%	4.49%	5.1	0.09	1.1%	1.1%
Fe-Pb Sulfate	87	87	6	1	60	29.9%	29.9%	15.15%	15.15%	3.7	0.16	4.6%	4.6%
TOTAL	291	285	11			100.0%	97.9%	100.00%	98.10%			100.0%	93.8%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	38.5%	38.5%	4.5%	4.5%
5-9	35.1%	34.0%	9.3%	7.5%
10-19	12.4%	11.7%	9.2%	7.2%
20-49	8.2%	7.9%	22.7%	20.2%
50-99	3.8%	3.8%	8.6%	8.6%
100-149	2.1%	2.1%	45.7%	45.7%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	98%	100%	94%

EXPERIMENT 5 - ASPEN RESIDENTIAL

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 6 - MIDVALE SLAG

Lead Speciation Summary Statistics

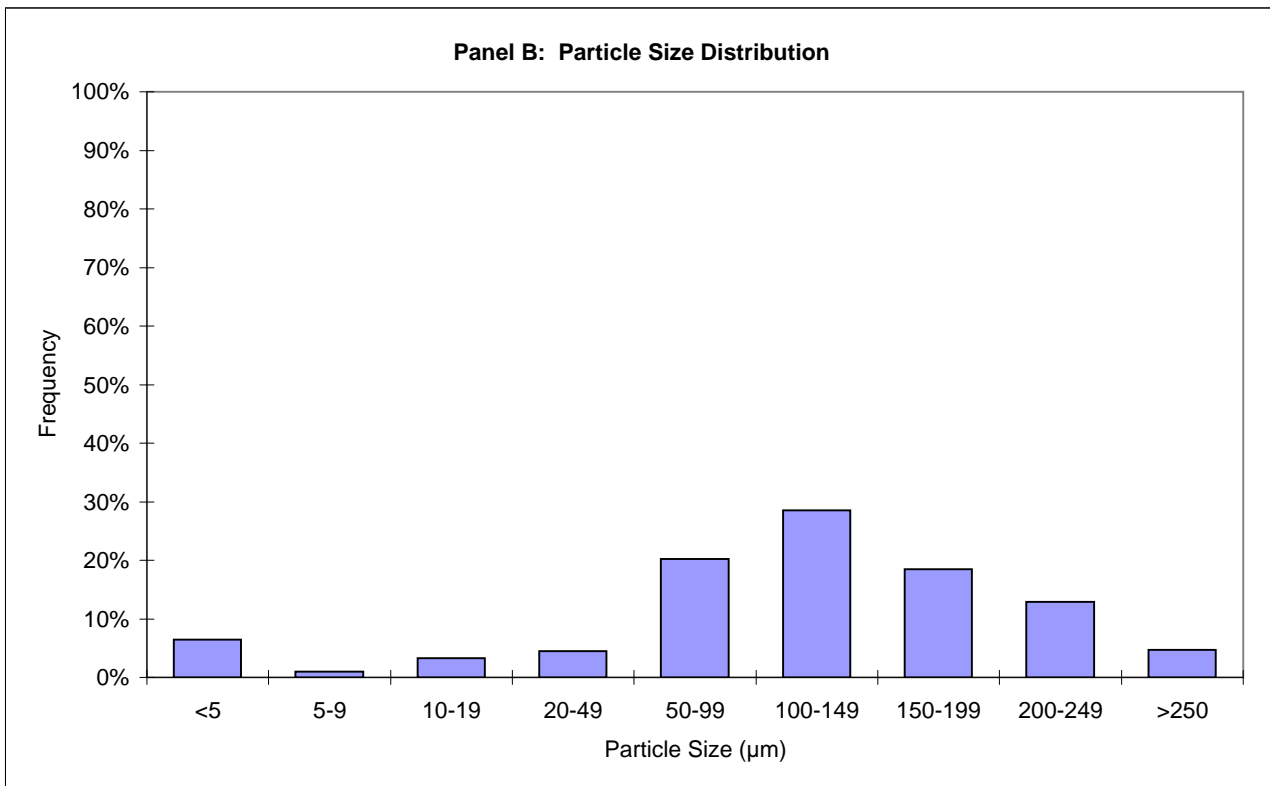
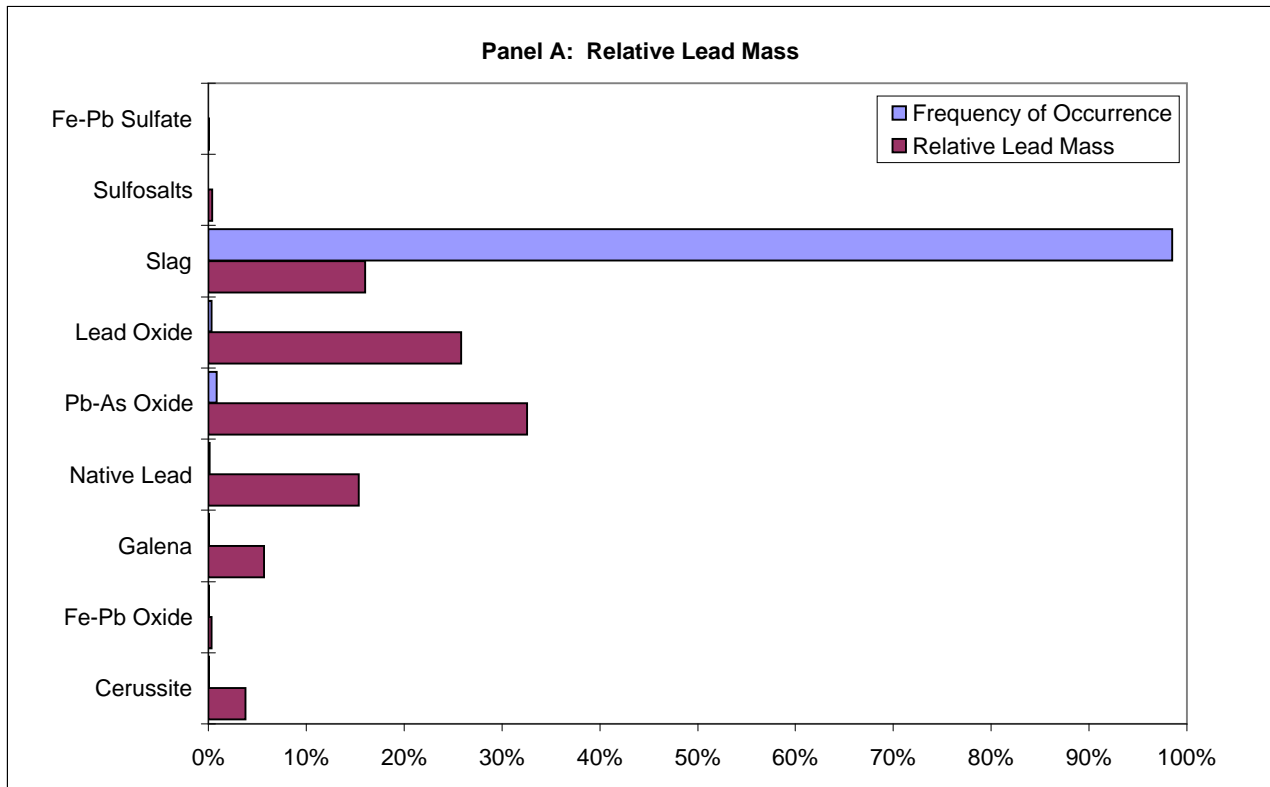
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Cerussite	7	7	22	10	45	0.4%	0.4%	0.07%	0.07%	6.6	0.776	3.8%	3.8%
Fe-Pb Oxide	4	4	26	12	45	0.2%	0.2%	0.04%	0.04%	4	0.15	0.3%	0.3%
Galena	2	2	90	80	100	0.1%	0.1%	0.08%	0.08%	7.5	0.866	5.7%	5.7%
Native Lead	67	6	4	1	40	3.4%	0.3%	0.12%	0.04%	11.3	1	15.4%	5.0%
Pb-As Oxide	119	41	16	1	100	6.0%	2.1%	0.82%	0.61%	7.1	0.5	32.6%	24.2%
Lead Oxide	61	29	12	1	55	3.1%	1.5%	0.31%	0.26%	9	0.83	25.9%	21.6%
Slag	1721	1721	131	10	600	86.7%	86.7%	98.52%	98.52%	3.65	0.004	16.0%	16.0%
Sulfosalts	1	1	50	50	50	0.1%	0.1%	0.02%	0.02%	6	0.25	0.4%	0.4%
Fe-Pb Sulfate	2	2	15	15	15	0.1%	0.1%	0.01%	0.01%	3.7	0.14	0.1%	0.1%
TOTAL	1984	1813	115			100.0%	91.4%	100.00%	99.65%			100.0%	77.0%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	6.5%	0.1%	8.4%	0.2%
5-9	1.0%	0.5%	3.5%	2.2%
10-19	3.2%	1.8%	17.7%	8.7%
20-49	4.4%	4.1%	33.7%	29.2%
50-99	20.3%	20.3%	17.7%	17.7%
100-149	28.6%	28.6%	9.4%	9.4%
150-199	18.5%	18.5%	4.0%	4.0%
200-249	12.9%	12.9%	3.8%	3.8%
≥250	4.7%	4.7%	1.8%	1.8%
TOTAL	100%	91%	100%	77%

EXPERIMENT 6 - MIDVALE SLAG

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 6 - BUTTE SOIL

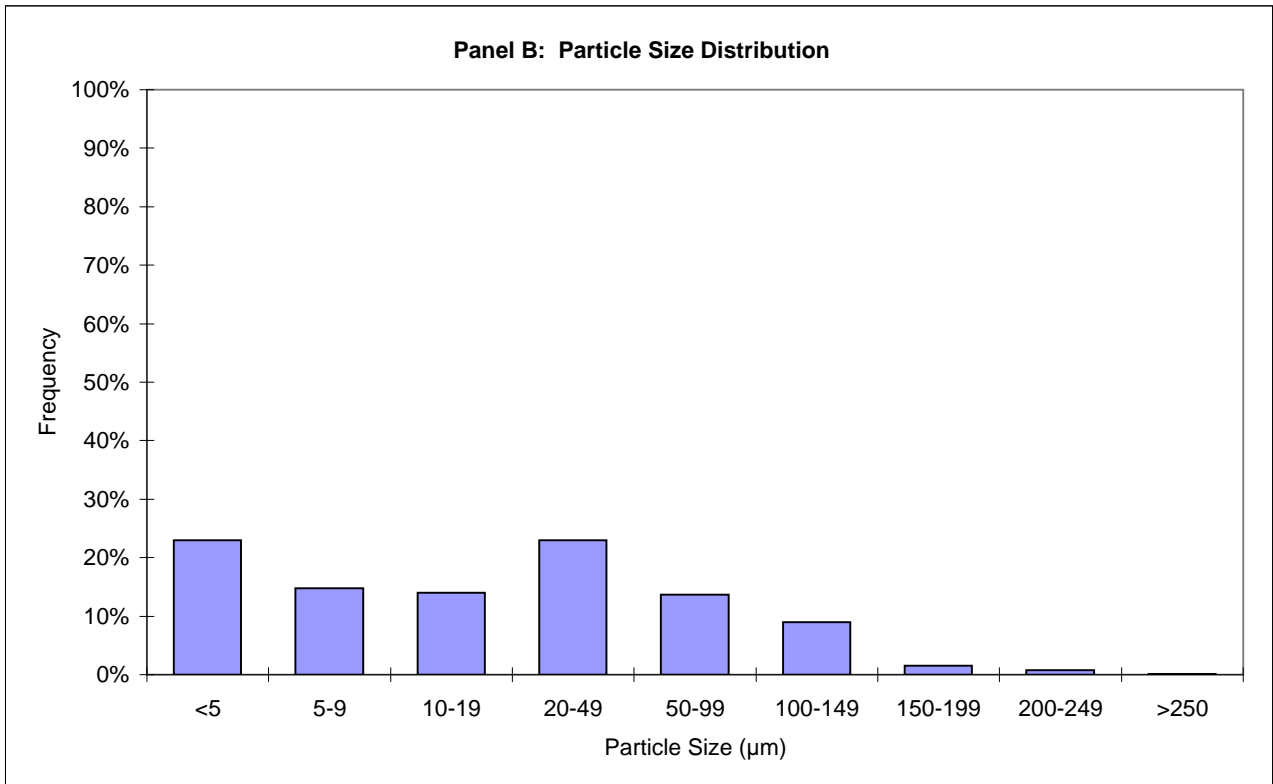
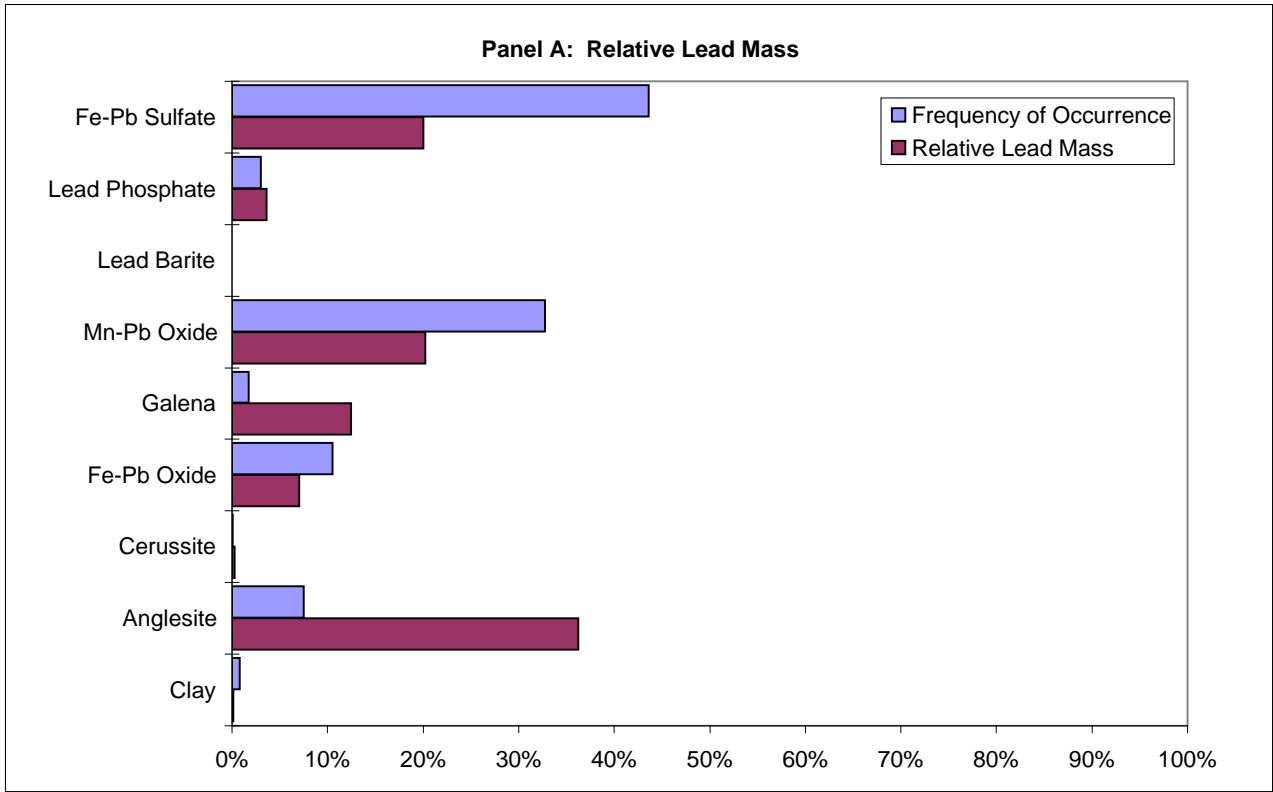
Lead Speciation Summary Statistics

Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Clay	3	3	58	30	100	0.5%	0.5%	0.82%	0.82%	3.2	0.039	0.1%	0.1%
Anglesite	138	134	12	1	100	21.7%	21.1%	7.51%	7.37%	6.3	0.684	36.2%	35.6%
Cerussite	1	1	10	10	10	0.2%	0.2%	0.05%	0.05%	6.6	0.776	0.3%	0.3%
Fe-Pb Oxide	37	27	61	4	180	5.8%	4.3%	10.48%	8.28%	4	0.15	7.0%	5.6%
Galena	37	35	10	1	55	5.8%	5.5%	1.72%	1.70%	7.5	0.866	12.5%	12.4%
Mn-Pb Oxide	161	150	44	3	200	25.4%	23.6%	32.77%	29.29%	5.1	0.108	20.2%	18.1%
Lead Barite	1	1	5	5	5	0.2%	0.2%	0.02%	0.02%	4.5	0.058	0.0%	0.0%
Lead Phosphate	12	1	54	5	200	1.9%	0.2%	3.03%	0.06%	5.1	0.208	3.6%	0.1%
Fe-Pb Sulfate	245	226	38	2	250	38.6%	35.6%	43.61%	40.55%	3.7	0.111	20.1%	18.6%
TOTAL	635	578	34			100.0%	91.0%	100.00%	88.13%			100.0%	90.7%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	23.0%	22.2%	3.4%	3.3%
5-9	14.8%	13.2%	9.8%	9.5%
10-19	14.0%	12.4%	11.4%	10.7%
20-49	23.0%	21.7%	26.5%	25.8%
50-99	13.7%	11.3%	25.0%	22.1%
100-149	9.0%	8.0%	17.0%	15.1%
150-199	1.6%	1.4%	2.9%	2.9%
200-249	0.8%	0.5%	3.3%	1.5%
≥250	0.2%	0.2%	0.6%	0.6%
TOTAL	100%	91%	100%	91%

EXPERIMENT 6 - BUTTE SOIL
Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 7 - CALIFORNIA GULCH PHASE I RESIDENTIAL SOIL

Lead Speciation Summary Statistics

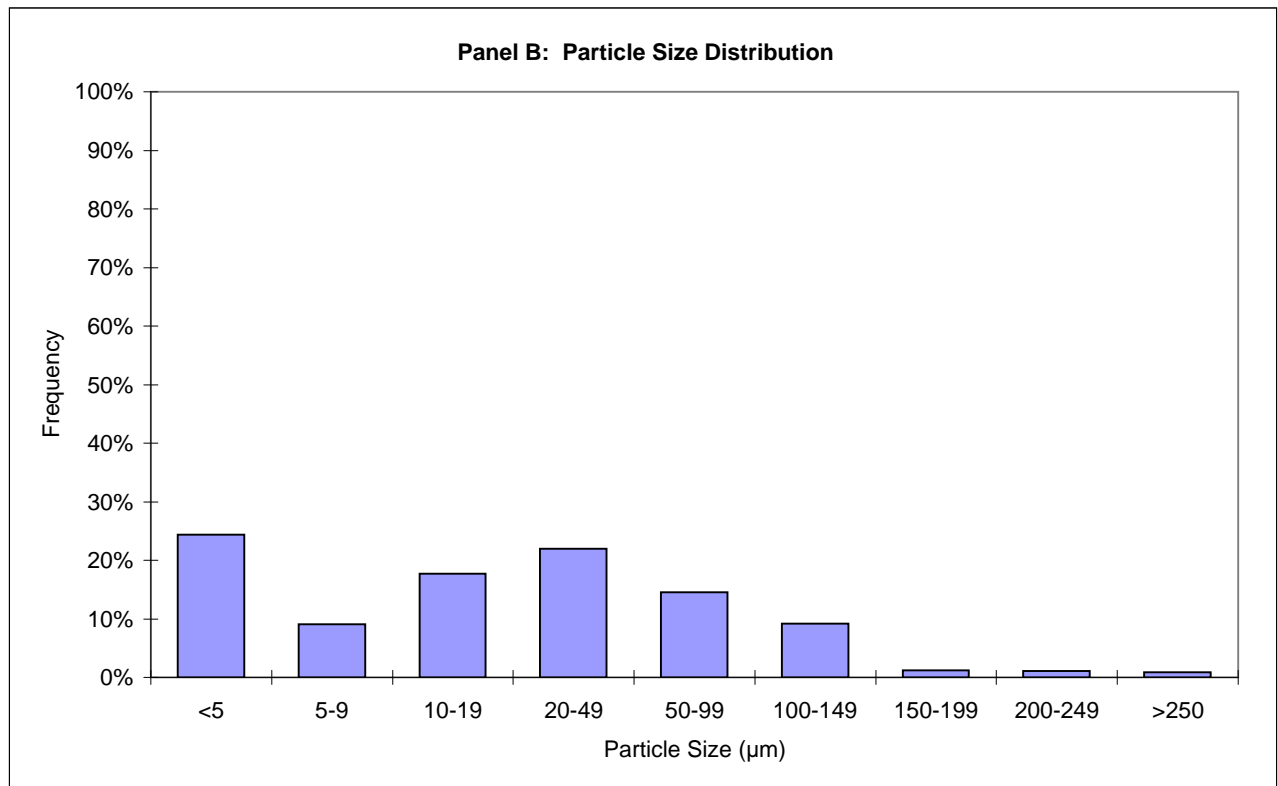
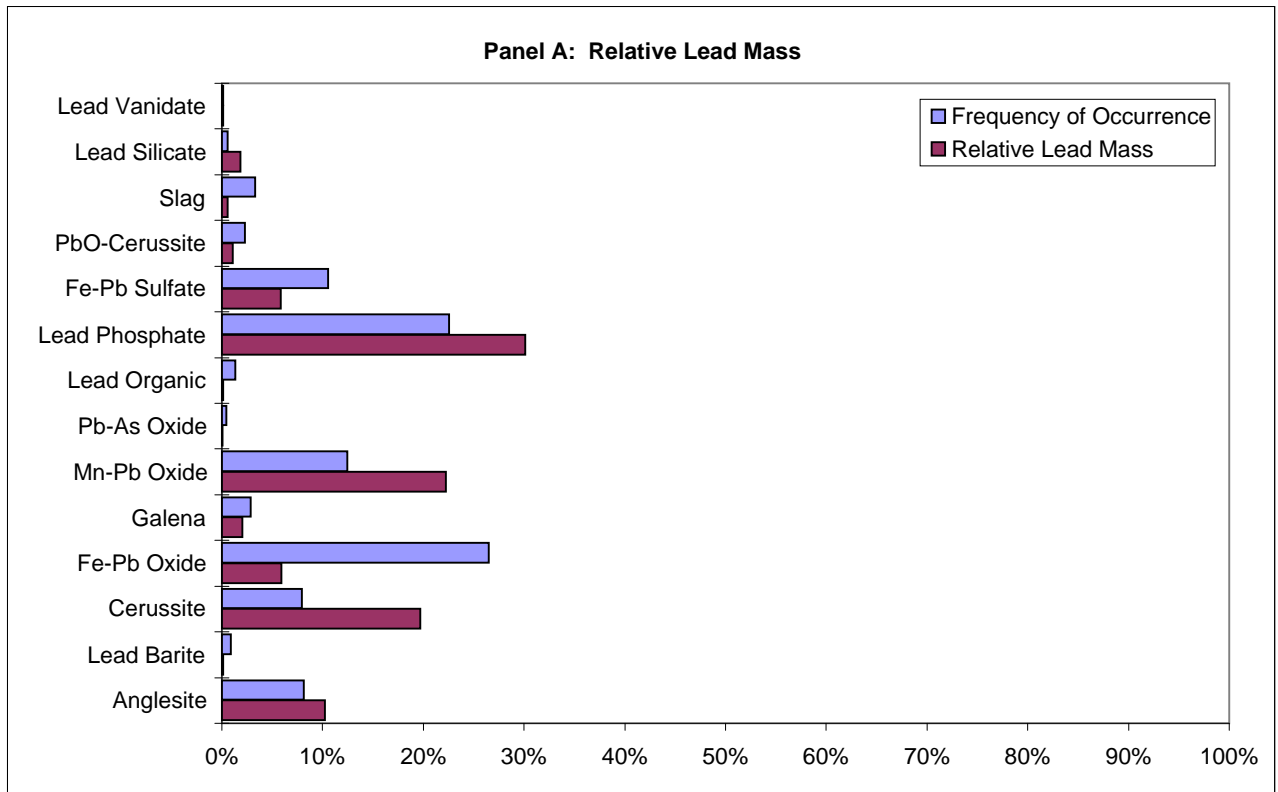
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	54	28	9	1	45	8.1%	4.2%	2.02%	1.58%	6.3	0.684	10.2%	8.0%
Cerussite	53	33	14	1	125	8.0%	5.0%	3.28%	3.11%	6.6	0.776	19.7%	18.7%
Fe-Pb Sulfate	70	65	31	1	120	10.5%	9.8%	9.59%	9.56%	3.7	0.14	5.8%	5.8%
Mn-Pb Oxide	83	83	43	1	250	12.5%	12.5%	15.77%	15.77%	5	0.24	22.2%	22.2%
Lead Phosphate	150	115	19	1	150	22.6%	17.3%	12.57%	11.96%	5.1	0.4	30.1%	28.6%
Pb-As Oxide	3	0	3	1	5	0.5%	0.0%	0.04%	0.00%	7.1	0.24	0.1%	0.0%
Lead Barite	6	1	18	2	100	0.9%	0.2%	0.48%	0.44%	4.5	0.058	0.1%	0.1%
Fe-Pb Oxide	176	166	52	1	300	26.5%	25.0%	40.45%	40.40%	4	0.031	5.9%	5.9%
PbO-Cerussite	15	0	3	1	10	2.3%	0.0%	0.18%	0.00%	6.6	0.776	1.1%	0.0%
Lead Organic	9	9	78	20	110	1.4%	1.4%	3.08%	3.08%	1.3	0.023	0.1%	0.1%
Galena	19	0	3	1	10	2.9%	0.0%	0.27%	0.00%	7.5	0.866	2.0%	0.0%
Lead Silicate	4	4	30	10	50	0.6%	0.6%	0.53%	0.53%	6	0.5	1.9%	1.9%
Lead Vanidate	1	1	10	10	10	0.2%	0.2%	0.04%	0.04%	6.4	0.32	0.1%	0.1%
Slag	22	22	121	25	250	3.3%	3.3%	11.71%	11.71%	3.65	0.012	0.6%	0.6%
TOTAL	665	527	34			100.0%	79.2%	100.00%	98.18%			100.0%	92.0%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	24.4%	8.3%	5.1%	1.7%
5-9	9.0%	5.0%	5.3%	2.0%
10-19	17.7%	17.3%	11.9%	11.2%
20-49	22.0%	22.0%	22.3%	22.3%
50-99	14.6%	14.4%	22.4%	21.7%
100-149	9.2%	9.2%	27.4%	27.4%
150-199	1.2%	1.2%	3.0%	3.0%
200-249	1.1%	1.1%	0.6%	0.6%
≥250	0.9%	0.9%	2.1%	2.1%
TOTAL	100%	79%	100%	92%

EXPERIMENT 7 - CALIFORNIA GULCH PHASE I RESIDENTIAL SOIL

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 7 - CALIFORNIA GULCH Fe/Mn PbO

Lead Speciation Summary Statistics

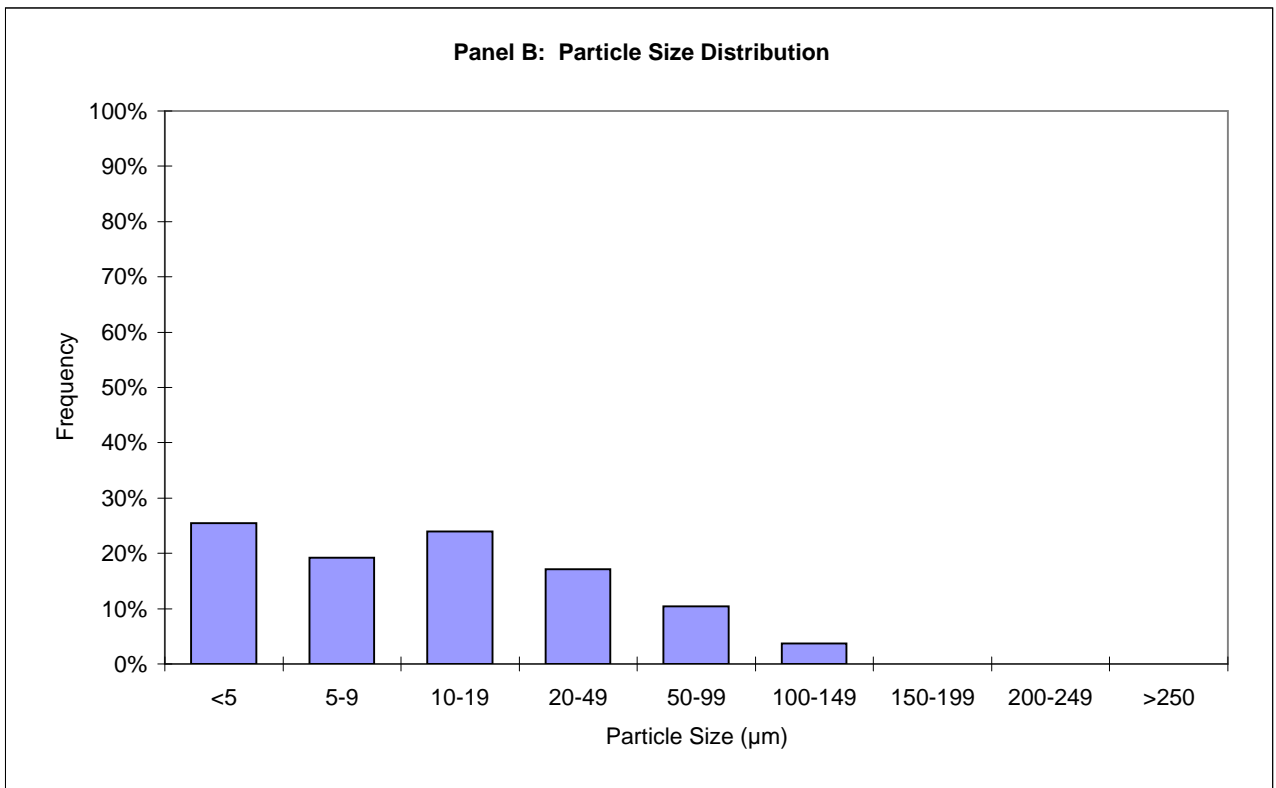
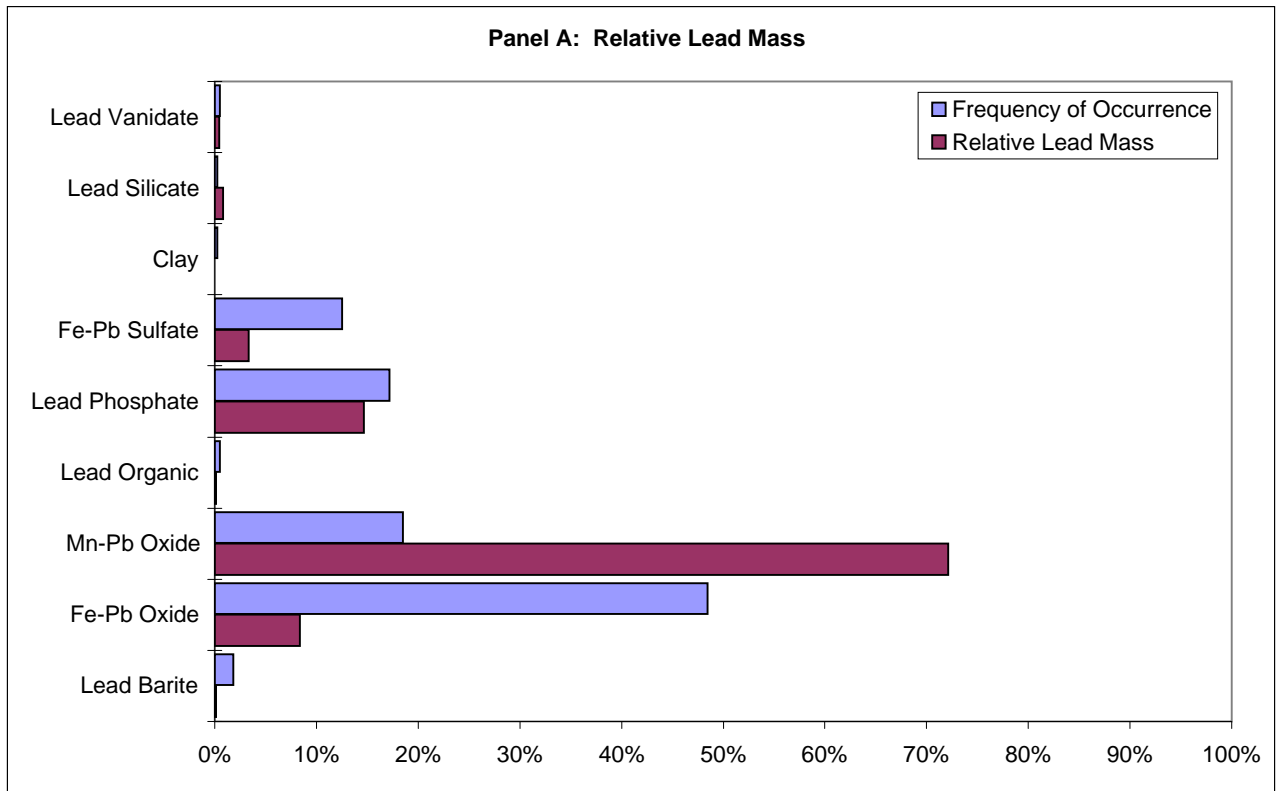
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Lead Barite	7	1	5	2	10	1.8%	0.3%	0.40%	0.10%	4.5	0.05	0.1%	0.0%
Clay	1	1	50	50	50	0.3%	0.3%	0.61%	0.61%	3.1	0.005	0.0%	0.0%
Fe-Pb Oxide	186	186	20	0	130	48.4%	48.4%	44.85%	44.85%	4	0.031	8.4%	8.4%
Mn-Pb Oxide	71	71	45	2	125	18.5%	18.5%	39.14%	39.14%	5.1	0.24	72.1%	72.1%
Lead Organic	2	2	103	80	125	0.5%	0.5%	2.49%	2.49%	1.3	0.0232	0.1%	0.1%
Lead Silicate	1	1	15	15	15	0.3%	0.3%	0.18%	0.18%	6	0.5	0.8%	0.8%
Lead Vanadate	2	2	6	3	8	0.5%	0.5%	0.13%	0.13%	6.4	0.32	0.4%	0.4%
Lead Phosphate	66	64	8	1	60	17.2%	16.7%	6.16%	6.09%	5.1	0.31	14.7%	14.5%
Fe-Pb Sulfate	48	48	10	3	100	12.5%	12.5%	6.03%	6.03%	3.7	0.1	3.4%	3.4%
TOTAL	384	376	21			100.0%	97.9%	100.00%	99.62%			100.0%	99.7%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	25.5%	24.0%	4.0%	3.8%
5-9	19.3%	19.0%	4.8%	4.7%
10-19	24.0%	23.7%	10.9%	10.8%
20-49	17.2%	17.2%	23.4%	23.4%
50-99	10.4%	10.4%	41.7%	41.7%
100-149	3.6%	3.6%	15.3%	15.3%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	98%	100%	99.7%

EXPERIMENT 7 - CALIFORNIA GULCH Fe/Mn PbO

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 8 - CALIFORNIA GULCH AV SLAG

Lead Speciation Summary Statistics

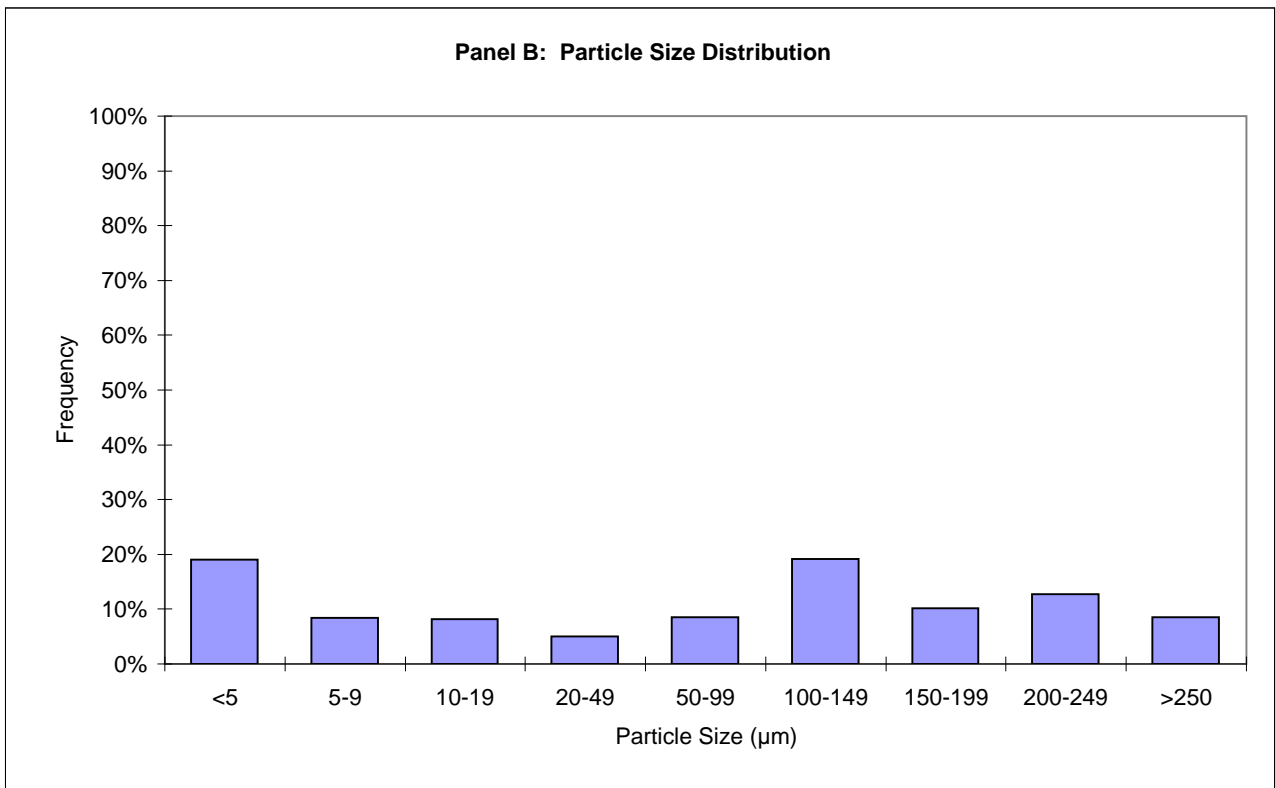
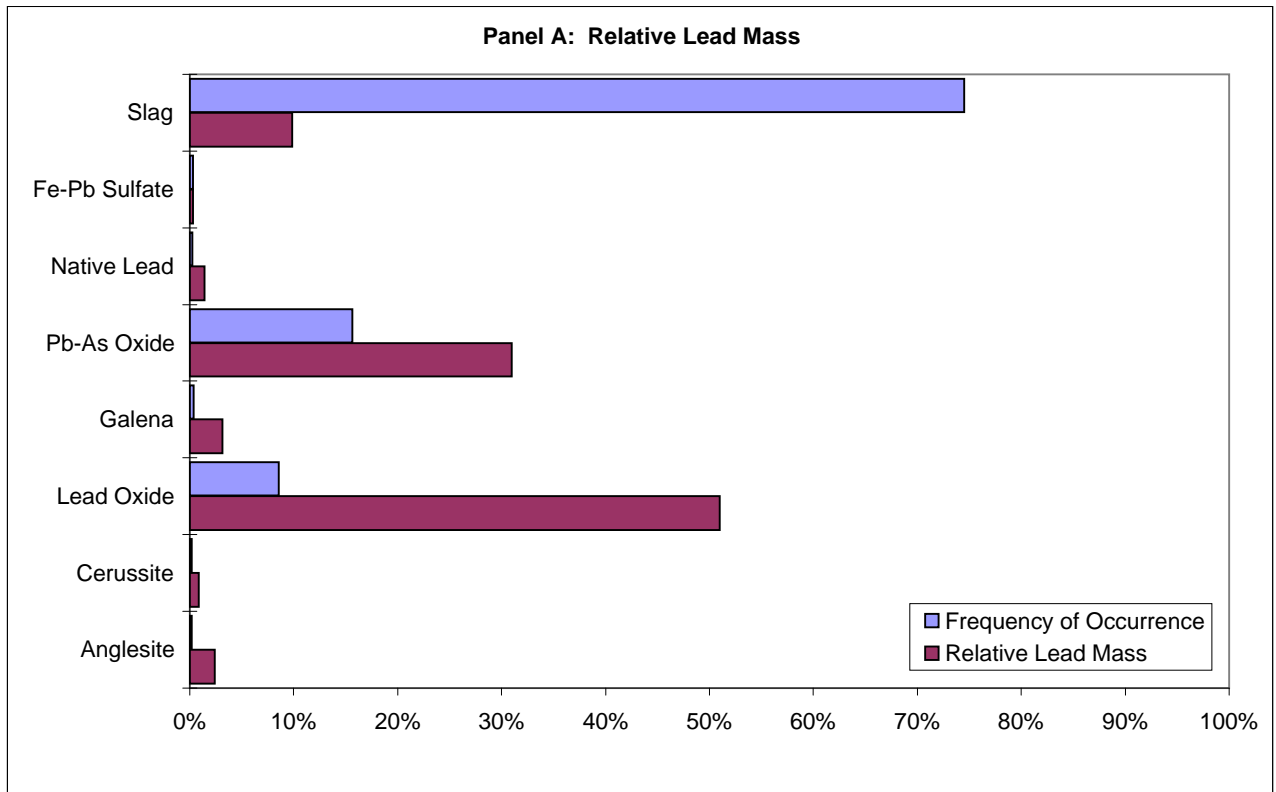
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	3	3	37	30	45	0.2%	0.2%	0.07%	0.07%	6.3	0.684	2.4%	2.4%
Cerussite	3	3	11	8	15	0.2%	0.2%	0.02%	0.02%	6.6	0.776	0.9%	0.9%
Galena	6	1	16	1	80	0.4%	0.1%	0.06%	0.05%	7.5	0.866	3.1%	2.7%
Native Lead	4	1	6	2	15	0.2%	0.1%	0.02%	0.01%	11.34	1	1.4%	0.9%
Pb-As Oxide	253	34	8	1	125	15.6%	2.1%	1.30%	0.90%	6	0.5	30.9%	21.4%
Lead Oxide	139	18	8	1	125	8.6%	1.1%	0.73%	0.59%	9.5	0.930	51.0%	41.5%
Slag	1206	1206	126	5	450	74.5%	74.5%	97.68%	97.68%	3.65	0.0035	9.9%	9.9%
Fe-Pb Sulfate	5	1	37	10	55	0.3%	0.1%	0.12%	0.04%	3.7	0.091	0.3%	0.1%
TOTAL	1619	1267	96			100.0%	78.3%	100.00%	99.36%			100.0%	79.6%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	19.1%	0.1%	11.3%	0.1%
5-9	8.5%	6.9%	4.7%	0.6%
10-19	8.2%	7.4%	6.8%	4.4%
20-49	5.0%	4.6%	23.5%	20.9%
50-99	8.6%	8.6%	24.2%	24.2%
100-149	19.2%	19.2%	22.4%	22.4%
150-199	10.1%	10.1%	1.7%	1.7%
200-249	12.8%	12.8%	2.7%	2.7%
≥250	8.6%	8.6%	2.7%	2.7%
TOTAL	100%	78%	100%	80%

EXPERIMENT 8 - CALIFORNIA GULCH AV SLAG

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 9 - PALMERTON LOCATION 2

Lead Speciation Summary Statistics

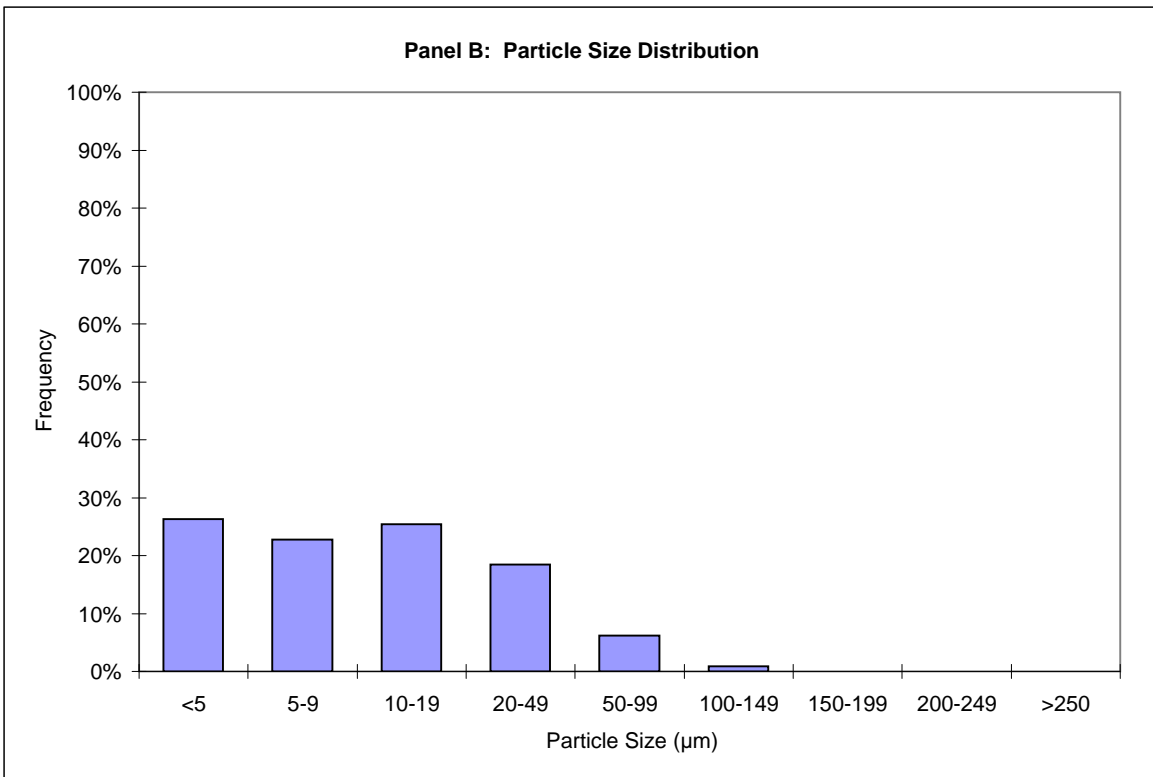
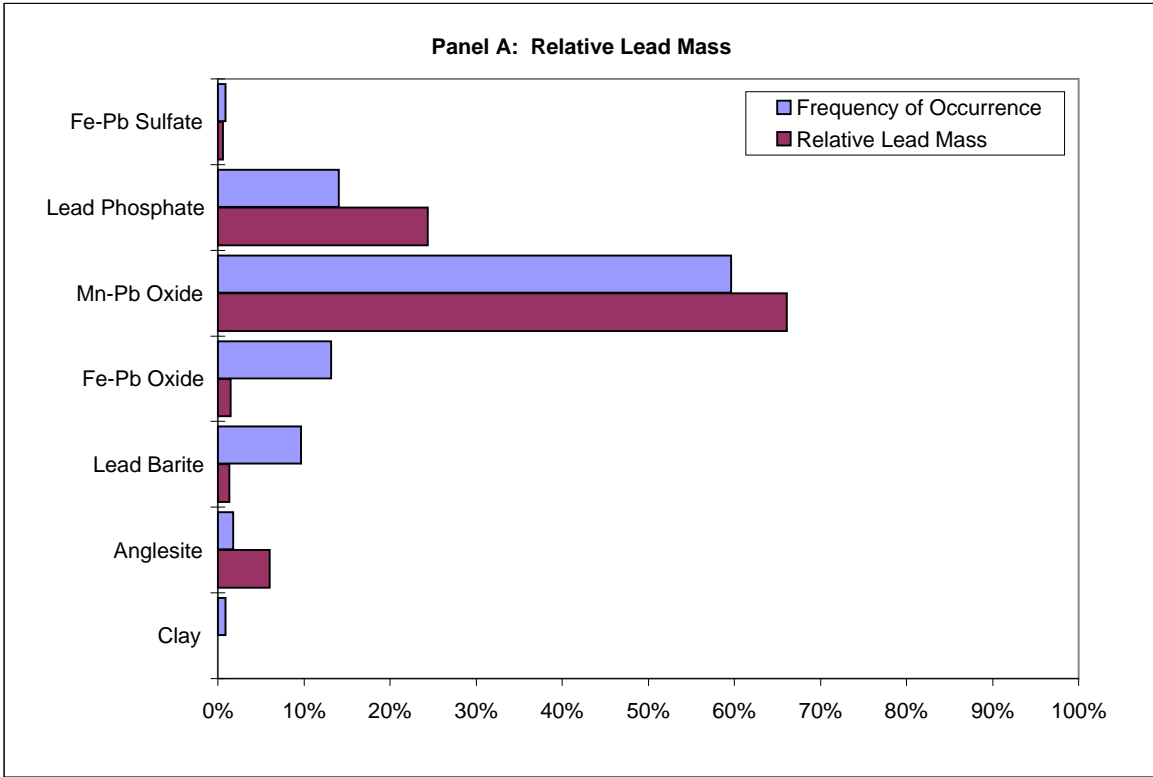
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Clay	1	1	10	10	10	0.9%	0.9%	0.6%	0.6%	3.1	0.005	0.0%	0.0%
Anglesite	2	2	4	3	4	1.8%	1.8%	0.4%	0.4%	6.3	0.684	6.0%	6.0%
Lead Barite	11	11	8	1	41	9.6%	9.6%	5.0%	5.0%	4.5	0.018	1.4%	1.4%
Fe-Pb oxide	15	15	8	3	20	13.2%	13.2%	7.4%	7.4%	4	0.015	1.5%	1.5%
Mn-Pb Oxide	68	68	17	2	100	59.6%	59.6%	68.8%	68.8%	5.1	0.055	66.1%	66.1%
Lead Phosphate	16	16	19	1	45	14.0%	14.0%	17.4%	17.4%	5.1	0.08	24.4%	24.4%
Fe-Pb Sulfate	1	1	8	8	8	0.9%	0.9%	0.5%	0.5%	3.7	0.1	0.6%	0.6%
TOTAL	114	114	11			100.0%	100.0%	100.0%	100.0%			100.0%	100.0%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	26.3%	26.3%	10.8%	10.8%
5-9	22.8%	22.8%	5.4%	5.4%
10-19	25.4%	25.4%	16.7%	16.7%
20-49	18.4%	18.4%	27.6%	27.6%
50-99	6.1%	6.1%	32.4%	32.4%
100-149	0.9%	0.9%	7.1%	7.1%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	100%	100%	100%

EXPERIMENT 9 - PALMERTON LOCATION 2

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 9 - PALMERTON LOCATION 4

Lead Speciation Summary Statistics

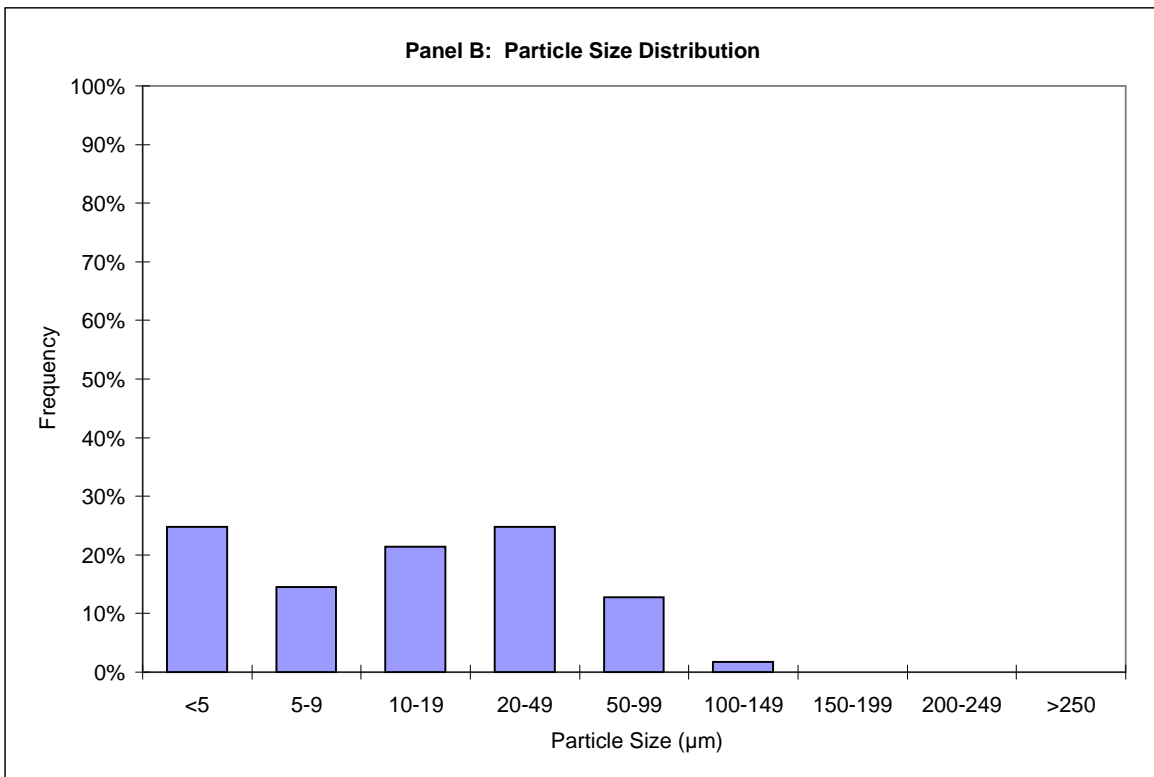
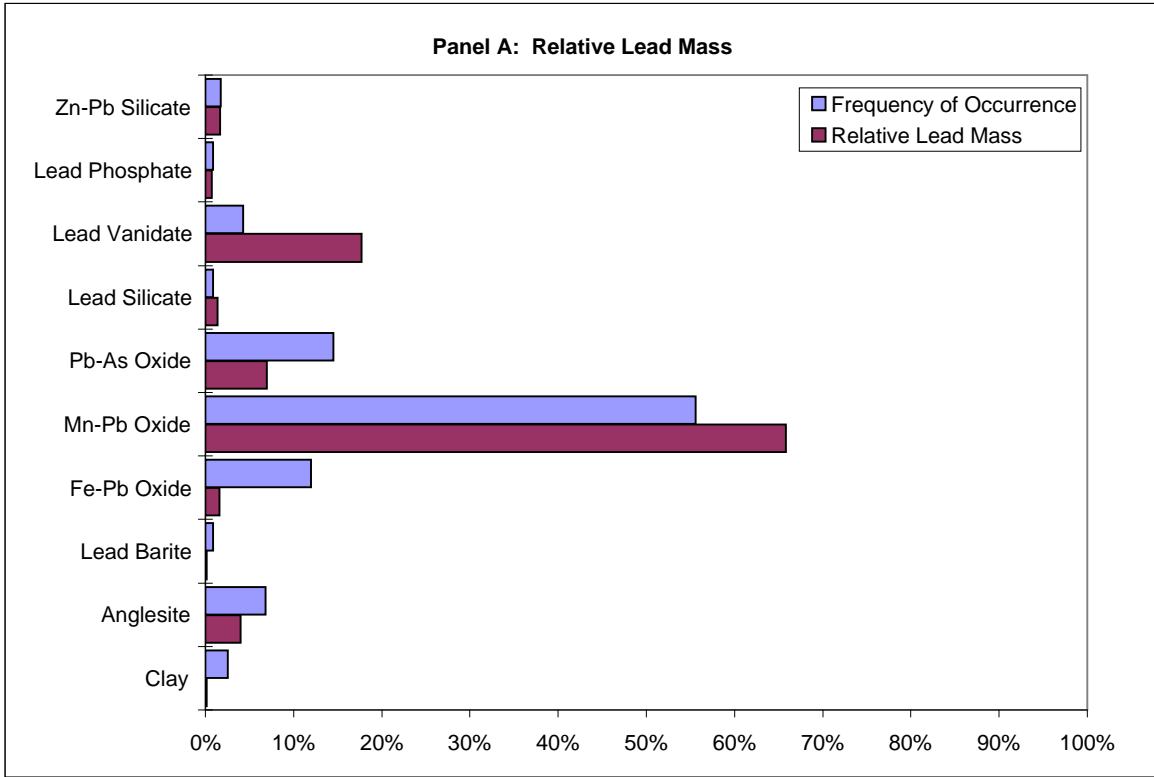
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Clay	3	3	24	8	45	2.6%	2.6%	2.90%	2.90%	3.1	0.005	0.1%	0.1%
Anglesite	8	0	1	1	1	6.8%	0.0%	0.32%	0.00%	6.3	0.684	4.0%	0.0%
Lead Barite	1	1	12	12	12	0.9%	0.9%	0.48%	0.48%	4.5	0.018	0.1%	0.1%
Fe-Pb Oxide	14	14	16	8	40	12.0%	12.0%	9.02%	9.02%	4	0.015	1.6%	1.6%
Mn-Pb Oxide	65	65	31	4	110	55.6%	55.6%	80.82%	80.82%	5.1	0.055	65.8%	65.8%
Pb-As Oxide	17	0	1	1	1	14.5%	0.0%	0.68%	0.00%	7.1	0.5	7.0%	0.0%
Lead Silicate	1	1	4	4	4	0.9%	0.9%	0.16%	0.16%	6	0.5	1.4%	1.4%
Lead Vanadate	5	5	15	5	35	4.3%	4.3%	2.98%	2.98%	6.4	0.32	17.7%	17.7%
Lead Phosphate	1	1	15	15	15	0.9%	0.9%	0.60%	0.60%	5.1	0.08	0.7%	0.7%
Zn-Pb Silicate	2	2	26	12	40	1.7%	1.7%	2.07%	2.07%	5.5	0.05	1.6%	1.6%
TOTAL	117	92	15			100.0%	78.6%	100.0%	99.0%			100.0%	89.1%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	24.8%	3.4%	12.7%	1.8%
5-9	14.5%	14.5%	5.0%	5.0%
10-19	21.4%	21.4%	8.8%	8.8%
20-49	24.8%	24.8%	34.4%	34.4%
50-99	12.8%	12.8%	32.3%	32.3%
100-149	1.7%	1.7%	6.8%	6.8%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	79%	100%	89%

EXPERIMENT 9 - PALMERTON LOCATION 4

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 11 - MURRAY SMELTER SOIL

Lead Speciation Summary Statistics

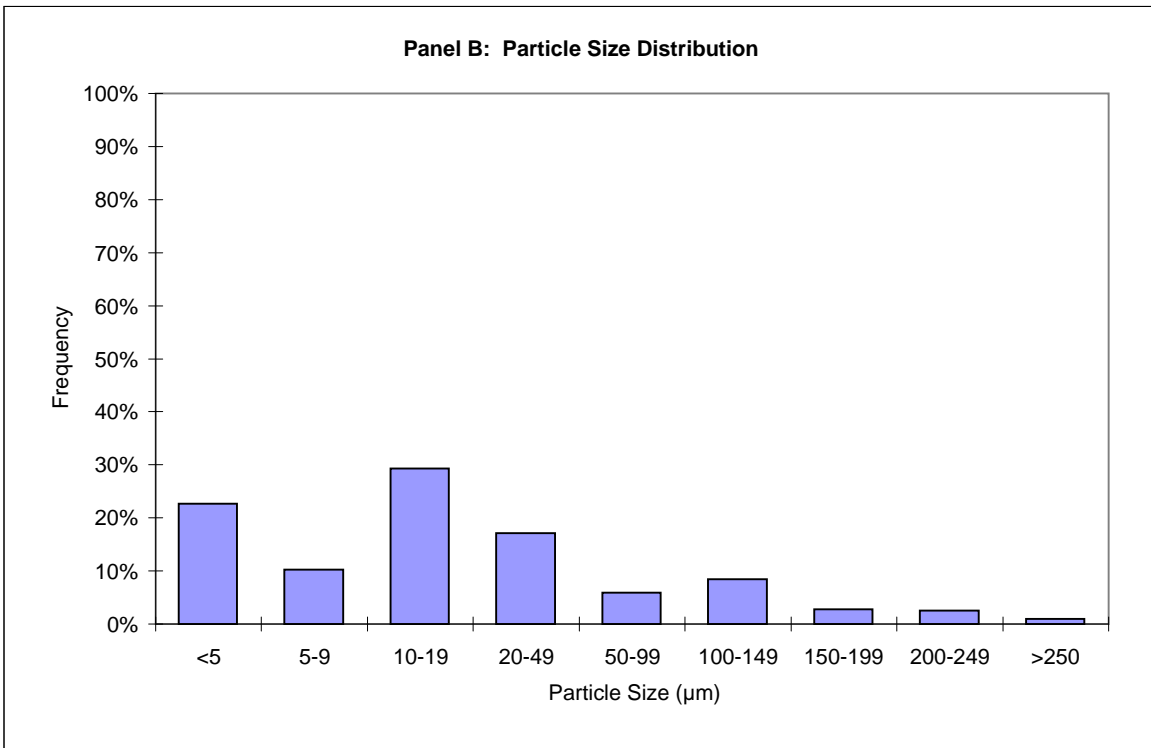
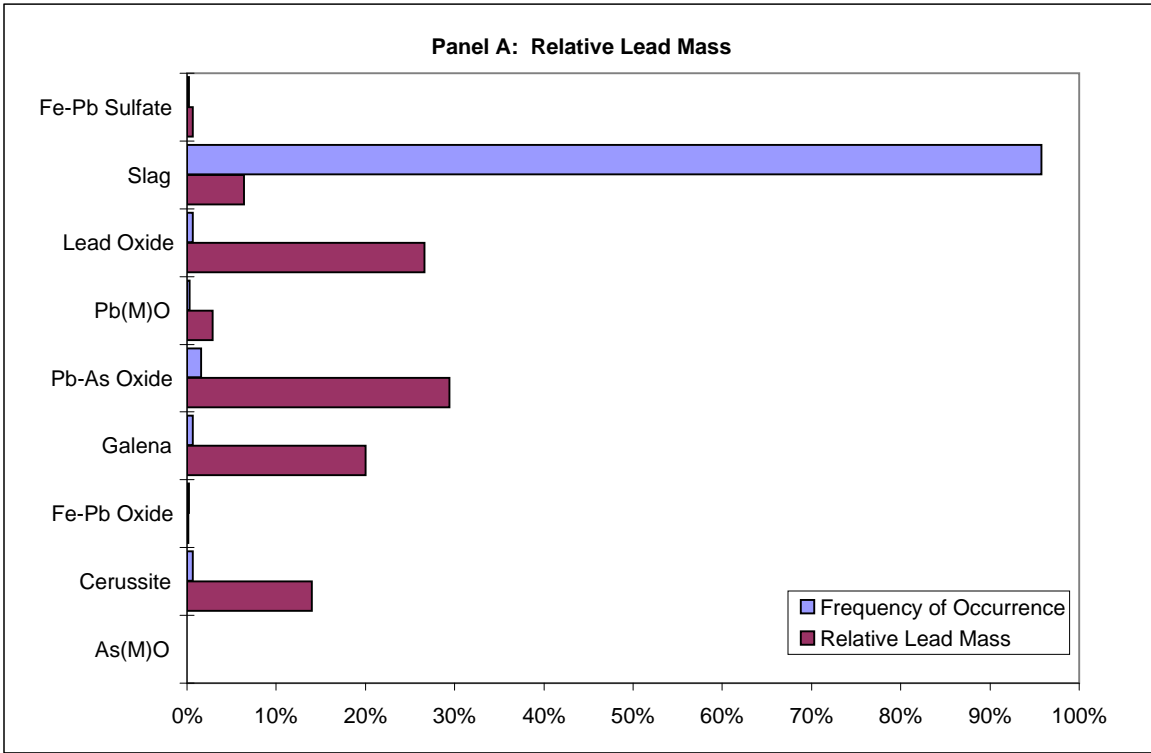
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
As(M)O	1	1	3	3	3	0.2%	0.2%	0.02%	0.02%	6.5	0.005	0.0%	0.0%
Cerussite	7	6	14	5	40	1.6%	1.4%	0.66%	0.38%	6.3	0.684	14.0%	8.2%
Fe-Pb Oxide	4	4	8	8	8	0.9%	0.9%	0.22%	0.22%	4	0.031	0.1%	0.1%
Galena	55	1	2	1	30	12.9%	0.2%	0.62%	0.21%	7.5	0.866	20.0%	6.6%
Pb-As Oxide	44	16	5	1	55	10.3%	3.7%	1.59%	1.22%	7.1	0.527	29.4%	22.4%
Pb(M)O	6	4	7	2	15	1.4%	0.9%	0.27%	0.18%	7	0.3	2.8%	1.8%
Lead Oxide	10	8	9	2	25	2.3%	1.9%	0.61%	0.56%	9.5	0.93	26.6%	24.2%
Slag	299	299	47	5	310	70.0%	70.0%	95.76%	95.76%	3.65	0.0037	6.4%	6.4%
Fe-Pb Sulfate	1	1	35	35	35	0.2%	0.2%	0.24%	0.24%	3.7	0.14	0.6%	0.6%
TOTAL	427	340	34			100.0%	79.6%	100.00%	98.78%			100.0%	70.4%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	22.7%	3.3%	26.5%	5.2%
5-9	10.3%	9.8%	10.6%	8.8%
10-19	29.3%	29.0%	17.6%	16.9%
20-49	17.1%	16.9%	33.4%	27.5%
50-99	5.9%	5.9%	7.8%	7.8%
100-149	8.4%	8.4%	1.8%	1.8%
150-199	2.8%	2.8%	0.8%	0.8%
200-249	2.6%	2.6%	1.0%	1.0%
≥250	0.9%	0.9%	0.5%	0.5%
TOTAL	100%	80%	100%	70%

EXPERIMENT 11 - MURRAY SMELTER SOIL

Speciation and Particle Size Data



*This mineral is now considered to be equivalent to Fe-Pb Oxid

APPENDIX F

EXPERIMENT 11 - NIST PAINT

Lead Speciation Summary Statistics

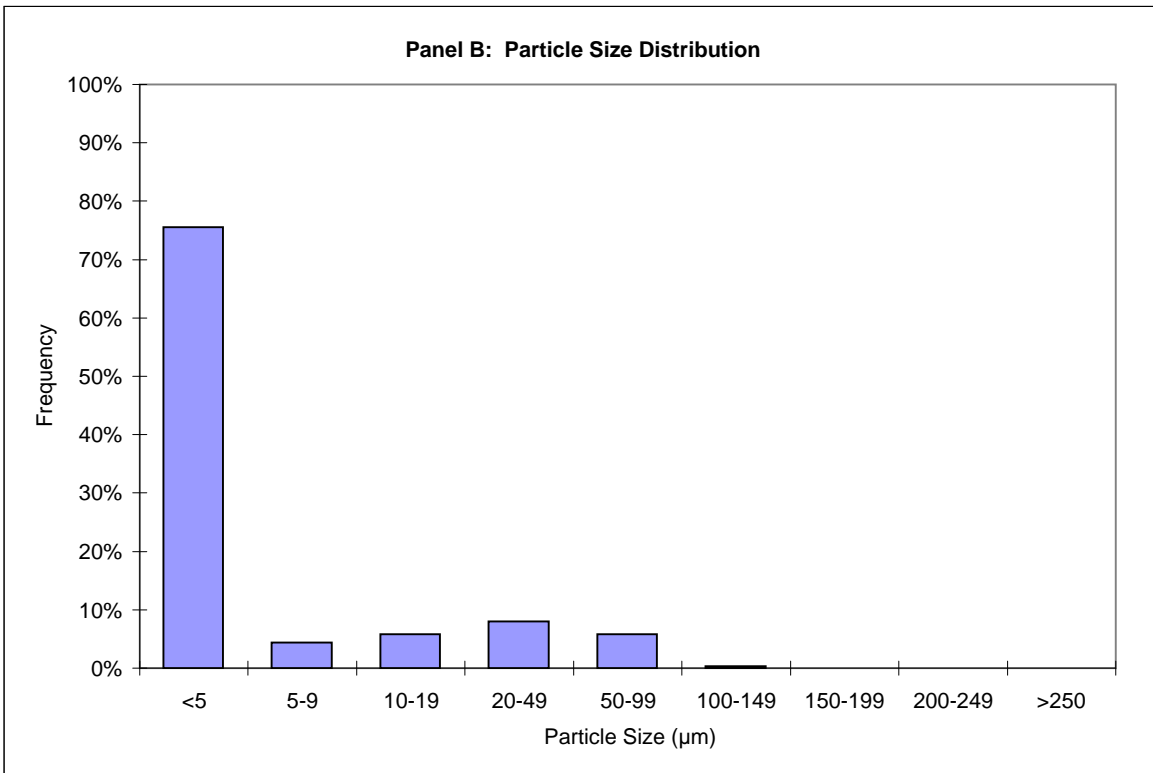
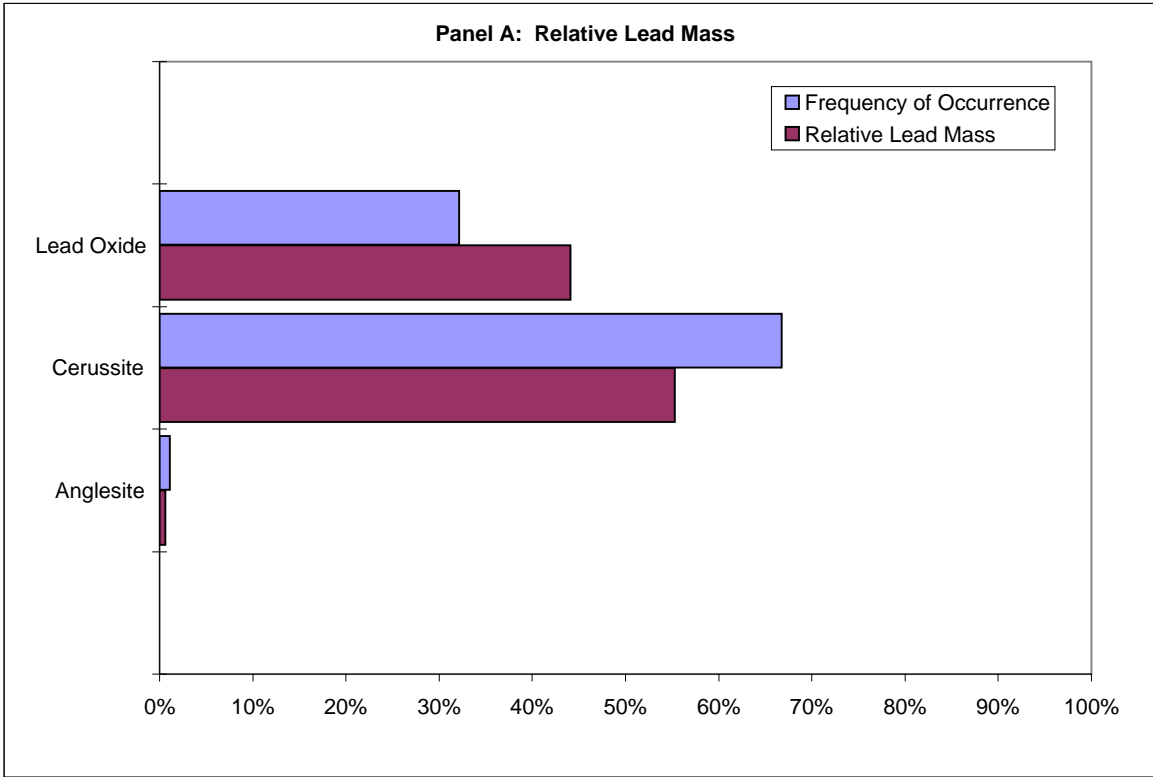
Mineral	Counts		Particle Size			Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib	Avg	Min	Max	Total	Lib	Total	Lib			Total	Lib
Anglesite	3	3	7	4	12	1.1%	1.1%	0.87%	0.87%	6.3	0.684	0.6%	0.6%
Cerussite	183	183	9	1	110	66.8%	66.8%	67.80%	67.80%	6.6	0.776	55.3%	55.3%
Lead Oxide	88	88	9	1	80	32.1%	32.1%	31.32%	31.32%	9.5	0.93	44.1%	44.1%
TOTAL	274	274	9			100.0%	100.0%	100.00%	100.00%			100.0%	100.0%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	75.5%	75.5%	15.0%	15.0%
5-9	4.4%	4.4%	3.1%	3.1%
10-19	5.8%	5.8%	6.4%	6.4%
20-49	8.0%	8.0%	27.8%	27.8%
50-99	5.8%	5.8%	43.9%	43.9%
100-149	0.4%	0.4%	3.7%	3.7%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	100%	100%	100%

EXPERIMENT 11 - NIST PAINT

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 12 - GALENA-ENRICHED SOIL

Lead Speciation Summary Statistics

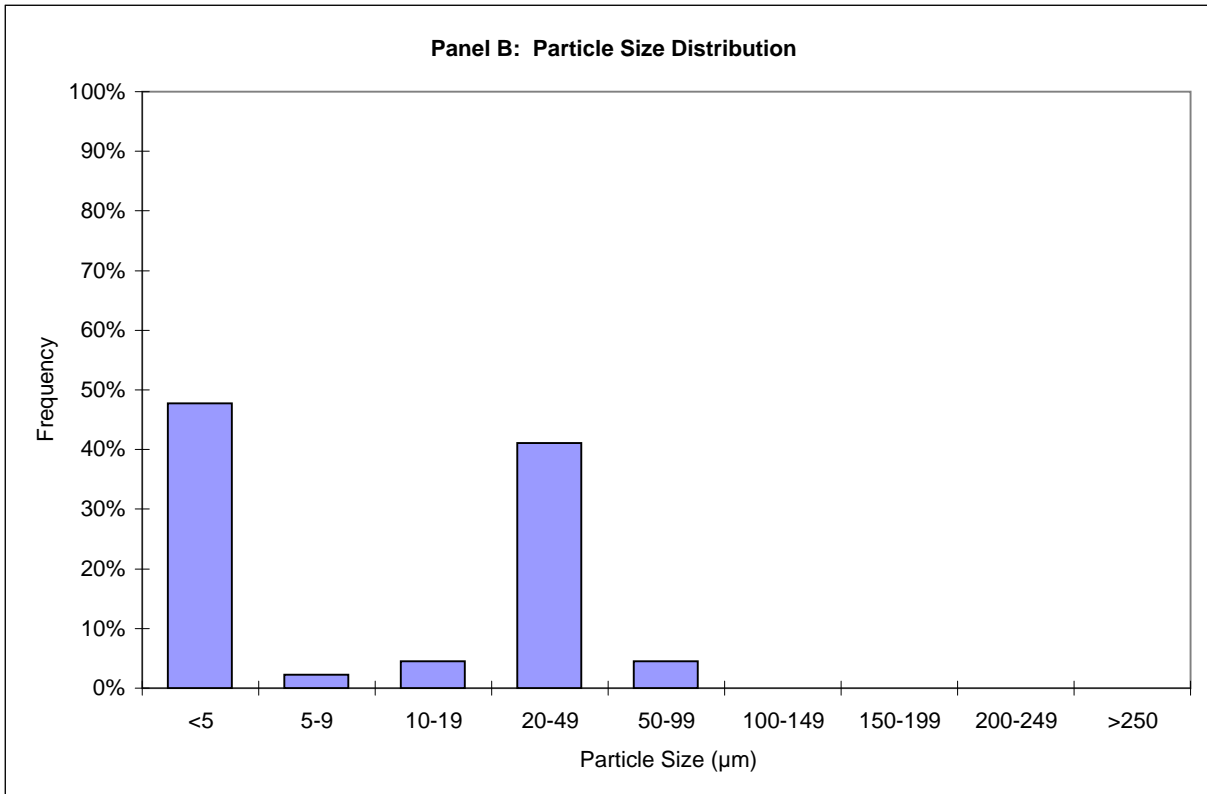
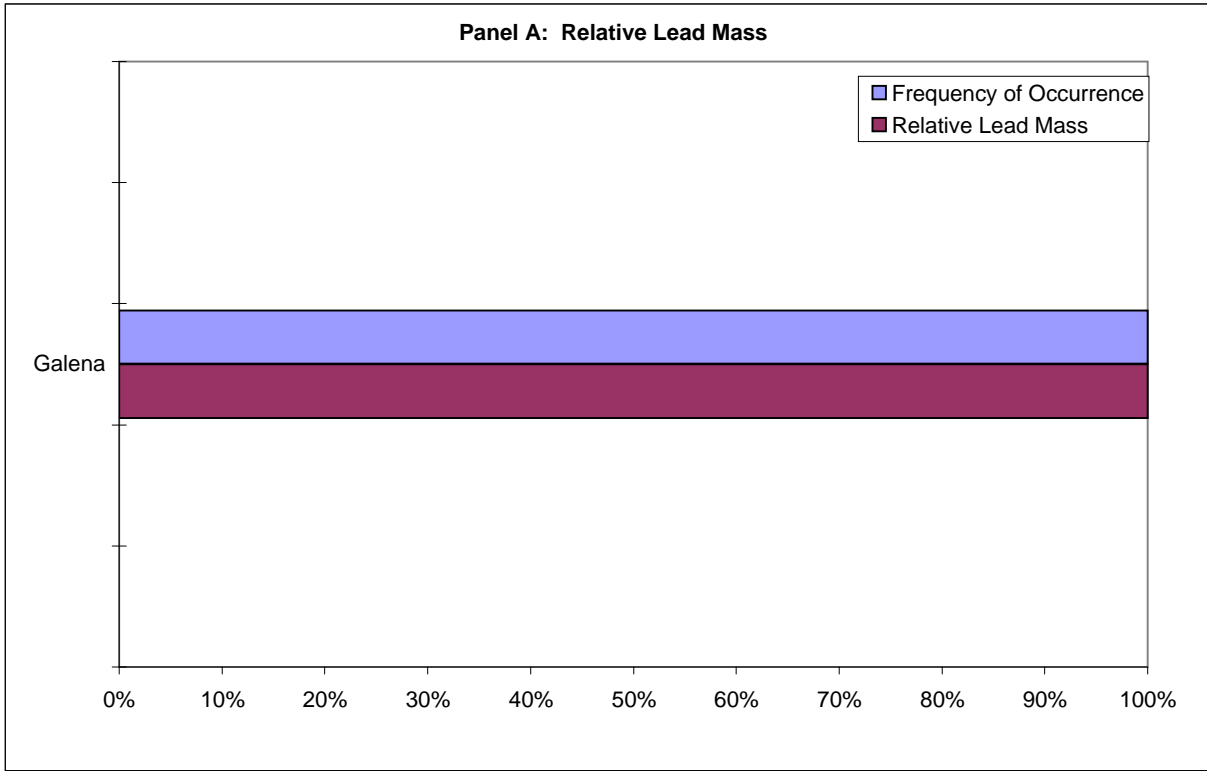
Mineral	Counts		Avg	Particle Size		Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib		Min	Max	Total	Lib	Total	Lib			Total	Lib
Galena	224	224	17	1	80	100.0%	100.0%	100.00%	100.00%	7.5	0.866	100.0%	100.0%
TOTAL	224	224	17			100.0%	100.0%	100.00%	100.00%			100.0%	100.0%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	47.8%	47.8%	4.9%	4.9%
5-9	2.2%	2.2%	0.7%	0.7%
10-19	4.5%	4.5%	3.3%	3.3%
20-49	41.1%	41.1%	75.9%	75.9%
50-99	4.5%	4.5%	15.3%	15.3%
100-149	0.0%	0.0%	0.0%	0.0%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	100%	100%	100%

EXPERIMENT 12 - GALENA-ENRICHED SOIL

Speciation and Particle Size Data



APPENDIX F

EXPERIMENT 12 - CALIFORNIA GULCH OREGON GULCH TAILINGS

Lead Speciation Summary Statistics

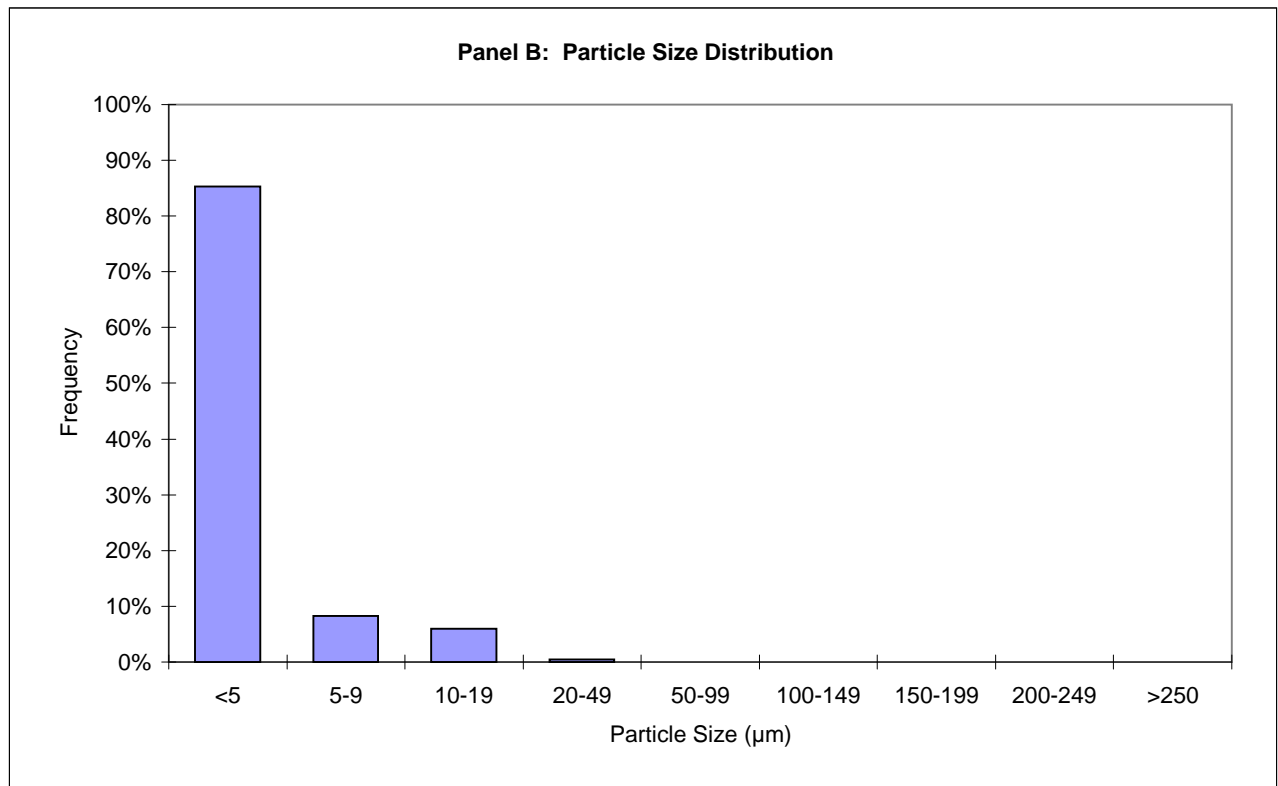
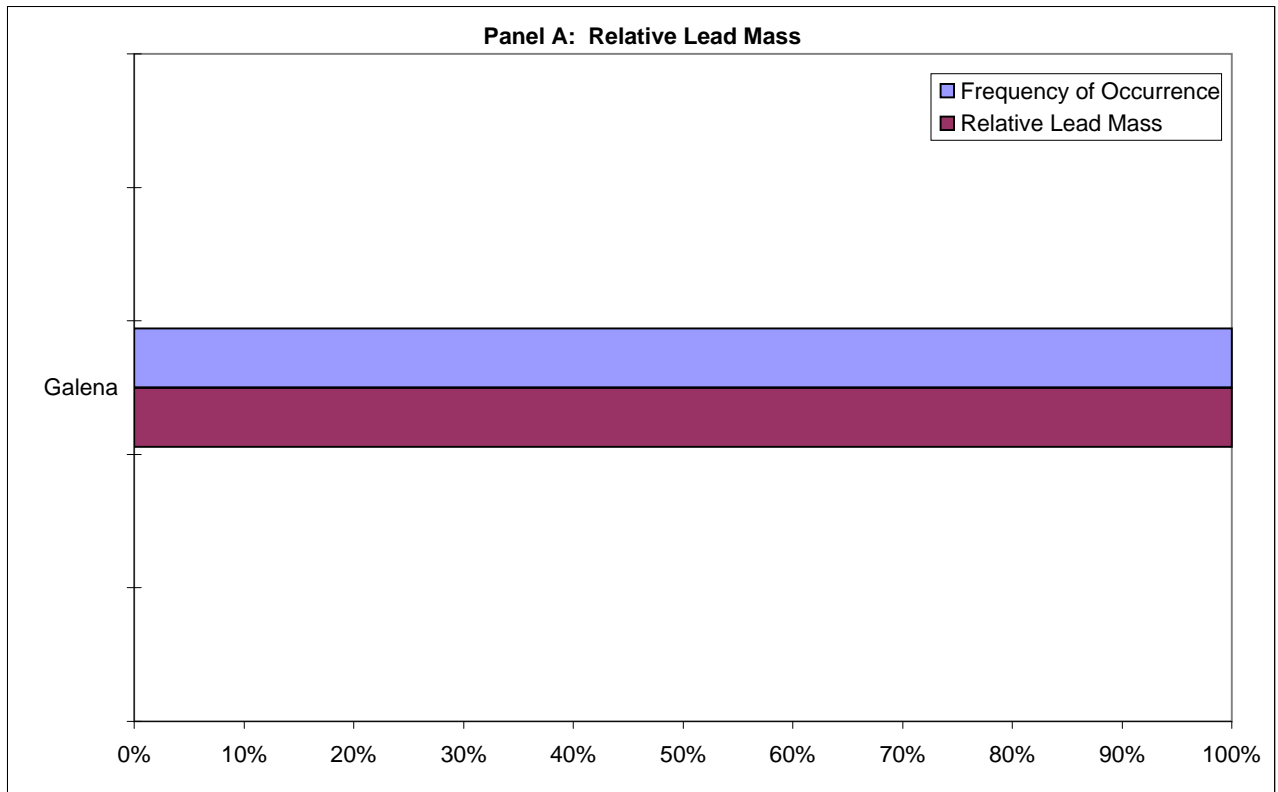
Mineral	Counts		Avg	Particle Size		Count Freq (%)		LW Freq (%)		Density	Lead Fraction	Relative Lead Mass (%)	
	Total	Lib		Min	Max	Total	Lib	Total	Lib			Total	Lib
Galena	217	4	2	1	25	100.0%	1.8%	100.00%	5.14%	7.5	0.866	100.0%	5.1%
TOTAL	217	4	2			100.0%	1.8%	100.00%	5.14%			100.0%	5.1%

Particle Size Distribution

Size	Total Freq	Lib Freq	Total RLM	Lib RLM
<5	85.3%	0.9%	46.8%	1.2%
5-9	8.3%	0.0%	21.5%	0.0%
10-19	6.0%	0.9%	26.7%	4.0%
20-49	0.5%	0.0%	4.9%	0.0%
50-99	0.0%	0.0%	0.0%	0.0%
100-149	0.0%	0.0%	0.0%	0.0%
150-199	0.0%	0.0%	0.0%	0.0%
200-249	0.0%	0.0%	0.0%	0.0%
≥250	0.0%	0.0%	0.0%	0.0%
TOTAL	100%	2%	100%	5%

EXPERIMENT 12 - CALIFORNIA GULCH OREGON GULCH TAILINGS

Speciation and Particle Size Data



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