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LEAD EXTRACTION PROCESS

by

R. Rayford, R. Evangelista, R. Unger
Enviresponse, Inc.
Livingston, NJ 07039

Contract No. 68-03-3255

Andre Zownir
Project Monitor
US Environmental Protection Agency
Emergency Response Branch
Edison, NJ 08837

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ABSTRACT

The disposal and processing of lead storage battery cases in a quarry in Woodville WI contaminated the soil with lead and lead compounds. PEI Associates, the Environmental Response Cleanup Service contractor, designed and installed a system to remove the lead using EDTA chelation and electrolysis to recover both the chelated lead (for sale) and EDTA for reuse. Due to a number of problems, the system was never fully operational. Enviresponse, Inc., the Emergency Environmental Response Unit contractor, was tasked with performing an engineering evaluation of the PEI system. Based on this evaluation, EI concluded that the PEI system was inadequate. EI was then assigned to develop a new transportable process system, which included laboratory feasibility investigations.

This report presents the engineering evaluation of the PEI Associates system, the new process system, the laboratory investigations, recommended follow-up testing, and estimated costs.

① also to see if system could be modified to operate effectively.

SECTION I

INTRODUCTION

STATEMENT OF WORK

Enviresponse, Inc. (EI), the Environmental Emergency Response Unit contractor, received an assignment to perform the following work:

1. to evaluate an existing system to remove lead from soil
2. to propose modifications to enable the system to perform adequately

BACKGROUND

The disposal and processing of spent lead storage battery cases in a quarry on the Lee Farm located near Woodville, WI contaminated the soil with lead and lead compounds. In 1984, the Environmental Protection Agency (EPA) Region V declared Lee Farm an immediate removal site. PEI Associates, the Environmental Response Cleanup Service contractor, was assigned to perform the removal action.

PEI Associates surveyed the site to determine the extent of contamination. Preliminary excavation and detailed surveying indicated that there were approximately 12,000 cu yd of contaminated material (this estimate was later revised to 15,000 cu yd). Transportation and disposal alone of 12,000 cu yd at Peoria Disposal, the closest hazardous waste landfill, was estimated at approximately $1.4 million.

In response to an EPA request to consider other disposal methods, PEI Associates evaluated a process in which lead salts are converted to a soluble form using a chelating agent such as nitriloacetic acid (NTA) or ethylenediaminetetraacetic acid (EDTA). After sufficient rinsing, the soil could be rendered nonhazardous, as defined in the Resource Conservation and Recovery Act Extraction Procedure Toxicity (EP Tox) Procedures (40 CFR, Part 261, Appendix A), i.e., the soil yields an extract containing less than 5 ppm of leachable lead (EP Tox of 5 ppm). The US Environmental Protection Agency (EPA) had demonstrated the feasibility of this technique in a similar cleaning of a test site in ① Leeds, AL in April 1984.

for only 1-5 cy of material

Bench-scale experiments performed by PEI Associates indicated that, although chelation and water washing would reduce the lead content, the EP Tox of 5 ppm was not consistently obtained. Furthermore, a pilot run using NTA did not reduce the soil lead content below the EP Tox of 5 ppm. The use of EDTA, however, proved to be worthy of further

Does first sentence refer to NTA or EDTA investigation. The results of PEI's experiments perhaps should have indicated that additional laboratory tests and engineering were required before initiating field work.

State whether they were performed.

A means to remove the lead from solution and to recycle the costly EDTA had to be devised. The addition of sodium sulfide to form the extremely insoluble lead sulfide was explored. The evolution of highly toxic hydrogen sulfide was a danger, but a monitoring system was devised ana the reaction was controlled in the pilot study.

Concurrently, an electrodialysis technique in which metallic lead is electroplated from the EDTA solution was developed utilizing technology from Purdue University. This method was selected because it is safer and the 95% pure lead obtained from this operation could be readily sold to a lead processor. After some bench-scale tests, PEI Associates reported that the lead could be successfully plated out of solution and that the estimated costs of both the sodium sulfide and electroplating techniques were comparable. A study performed by Roy F. Weston, Inc. for the US EPA indicated that the total cost of the EDTA/ Electrodialysis System would be comparable to that of removing the contaminated soil to a secure landfill.

[illegible] what?

Define the amount of bench-testing.

What does this refer to?

PEI Associates developed a process system that utilized this technique and assembled it at Lee Farm, using locally available equipment, during the late summer and fall of 1985. Initial activities included preparation of the site and consolidating the contaminated material into piles. Attempts to operate the process were hampered by equipment inappropriate for the intended use and by equipment that continually required repair. For example, a high-pressure rinse with water to clean the larger material was abandoned because the required water flow was considered to be too high.

Inclement weather and the need to move equipment into a building for shelter further delayed operations. After several on-site revisions to the process, the equipment was in place by late November and a few short tests were run.

How many?

A brief, continuous (2-3 hr) run was performed utilizing the EDTA reaction and rinsing system. Initially, the product met the EP Tox test for lead, indicating that the process is feasible. However, the results also indicated that the EP Tox test for lead could not be met in continuous operation with this equipment. In addition, one hand-made electrolytic cell was assembled on site and tested for a very short period. Lead was successfully plated from the chelate solution, but it plated out in a spongelike mass that would not be acceptable for continuous operation, indicating that additional engineering and testing were required. The process was never operated as a whole system.

define short period?

As a result of the difficulties in developing this process and operating with existing equipment, funding for the project was terminated.

After visiting the site to inspect the equipment and after examining the On-Scene Coordinator's (OSC) description of the site activities and the reports of PEI's laboratory tests and field work, EI concluded that additional laboratory experiments to determine the efficiency of the process were necessary.

The evaluation also showed the process system to be inadequate and in need of substantial modification. Based upon these conclusions, EI proceeded to develop a new transportable system. While designing the new system, EI was given the task of performing an engineering feasibility study of the process.

The findings of the existing equipment evaluation, EI's laboratory experiments, testing by vendors; the revised process flow; estimated cost of the revised system; conclusions drawn from the testing program; and recommended follow-up testing are discussed in this report.

SECTION II

DESCRIPTION OF EXISTING PROCESS

The process system installed by PEI Associates consisted of a feed sizing and handling system, a soils washing system, and an EDTA and lead recovery system. The process system concept was changed several times between the initial design and the final process. The system was estimated to be able to process 30 tons per hour.*

The feed sizing and handling system consisted of a vibrating screen and radial stacker to remove boulders, boards, and other debris; a crusher to reduce the size of the remaining material to 2 in or less; and conveyors to move the material. The screen was often clogged with rags and debris and broken by large rocks.

or 28% (?)

The sized feed entered the washing compartment of a 30-in washing-dewatering screw where the soil was contacted with a 30% EDTA solution. Agitation was provided by the screw's rotation. Attempts to increase the agitation by circulating the chelating solution were not successful due to insufficient pump head. A portion of the chelating solution overflowed a weir at the back of the washing compartment, carrying fines. Bits of plastic were also carried over in this operation and were skimmed off. The solution containing the fines was transferred to holding tanks for treatment.

The dewatering screw carried the remaining material up an inclined trough, where the material was dewatered and discharged from the upper end of the trough. A portion of the chelating solution could be pumped from the wash compartment to the upper end of the trough to wash the soil back into the wash compartment, thus preventing its discharge. The use of the circulating EDTA solution made it possible to provide sufficient reaction time in the device, but prevented the addition of soil. When the EDTA circulation was stopped and the soil finally discharged from the dewatering trough, fresh soil could be added to the washing compartment. However, unless the EDTA circulation was resumed, insufficient reaction time and mixing were encountered.

The removal of fines by floating them over the weir at the back of the washing compartment was inefficient, causing some of this material to be carried forward with the heavy material. The fine material contains a higher concentration of lead than the heavy material, is more difficult to treat, and very difficult to dewater. As the concentration of this light material increases in the product, the chances that the product will fail the EP Tox test for lead increase.

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*Quantities of soil have been variously quoted in cubic yards and in short tons per hour. The terms are interchangeable if the bulk density is approximately 74 pounds per cubic foot (sp.gr. = 1.19).

The material discharged from the dewatering screw fell into a polish rinse solution of 2% EDTA, which was not agitated. A small (6 in) grain auger transferred the soil from the polish tank to a rinse tank containing water. Again, no agitation was provided. To prevent the transfer of excessive amounts of EDTA solution from the polish rinse to the wash tank and water from the wash tank to product storage, holes were cut in the walls of the grain augers and screens were installed to drain off the liquid. This system provided insufficient agitation in the stages, and the grain augers were not adequate for the duty. The process design envisioned one or two more rinsing stages, which were not installed.

Centrifuges for dewatering and water rinsing were intended to treat the slurry of fines, silt, and clay that overflowed the weir at the back of the wash section of the washer-dewatering screw. This system was not installed or tested on site.

Chelated lead is soluble and is not permitted to be discharged, while EDTA in large concentrations is hazardous. This, along with the high cost of EDTA, requires that the spent chelating solution be treated to remove the lead and to recover the EDTA for reuse. The method selected to accomplish the EDTA recovery was electrolysis in electrolytic cells equipped with membranes. PEI Associates contracted to have electrolytic cells constructed, by hand, to their specifications by a subcontractor.

After removal of the lead in the electrolytic cell, the EDTA solution was to be recycled to the washer-dewaterer. A portion of the recovered EDTA solution would be sent to a wastewater treatment system consisting of two separate tanks with facilities for pH adjustment of the EDTA solution before each tank.

Before entering the first tank, the pH would be lowered to around 2 with sulfuric acid, which would cause the EDTA to precipitate out as the insoluble acid form and the lead to precipitate out as lead sulfate.

The pH of the solution would then be raised to an acceptable level (probably 6.5-8.5) with caustic soda and the wastewater sent to a municipal sewage treatment plant. If the lead content of the wastewater at this point were not acceptable, another treatment step using sodium sulfide to precipitate the remaining lead as lead sulfide was proposed.

The precipitated solids were to be moved to the second tank where sufficient caustic would be added to raise the pH to about 10 to return the EDTA and lead to solution. This concentrated solution would then be returned to the electrolysis system for additional lead removal and EDTA recovery.

This wastewater treatment system was never installed, and no equipment intended for use in this system was obtained. It exists only as a part of a conceptual drawing attached to a memo. There are no details or descriptions of how the solids removal and other operations were to be carried out. Furthermore, there is no assurance that the system would have operated successfully, and that it would have produced a wastewater of satisfactory quality for discharge to a sewage treatment plant. If

- short statement saying why there is no assurance.

Something is missing. This is disjointed

treatment with sodium sulfide were required, disposal of the resulting lead sulfide would be necessary.

The total system was based on the use of the 30-in washer-dewatering screw to contact the soil with the EDTA solution. Since the grain augers installed for transferring the material from tank to tank were inadequate for the duty, it is most likely that capacity of the washer-dewatering screw determines the charge rate to the system.

According to the manufacturer, a 36-in screw normally revolves at 21 rpm and treats 100 short tons per hour, and a 30-in screw generally revolves at 26 rpm and treats 75 short tons per hour. At the normal rates, both screws provide a 1-minute residence time in the washing compartment.

The manufacturer stated that the screw speed can be reduced to 10% of normal without seriously affecting its efficiency. Although one would expect that reducing the rotating speed of the 36-in screw to 2.1 rpm would reduce throughput to 10 tons per hour and give a residence time of 10 minutes, the manufacturer stated that the 36-in screw rotating at this speed could process 20 tons per hour and provide a residence time of approximately 8 minutes.

one ¶

Therefore, reducing the rotating speed of a 30-in screw to 2.6 rpm would be expected to reduce the throughput to 7.5 tons per hour with a residence time of 10 minutes, but, by comparison, would process 15 tons per hour and provide a residence time of 8 minutes. Increasing the throughput rate would reduce the residence time.

Based on the results of laboratory tests by EI, the design residence time for the heavier material should be 15 to 20 minutes. Using the lower design residence time of 15 minutes produces a design charge rate of 8 yd/hr of heavy material. Allowing for removal and separate treatment of fines, silt, and clay, the total charge rate would be in the range of 8.5 to 10.5 yd/hr depending on the percentage of fines in the soil. Laboratory tests by PEI Associates indicated that, if the fines, silt, and clay are not separated from the remaining material, a residence time of 30-35 minutes is required. This would reduce the total charge rate to 4 yd/hr.

The unit was operated on site by adding a yard of total soil to the EDTA solution in the screw and retaining it there by pumping a stream of EDTA solution to the top end of the trough. Allowing for a design holding time of 15 minutes and 1 minute to remove the soil from the unit after the EDTA pumping stopped, a design rate of 1 yd/hr in 16 minutes, or less than 4 yd/hr will result.

By this reasoning, a design charge rate ranging from less than 4 to 10-11 yd/hr is expected. In actual operation, rates 50%-60% greater might be achieved. Therefore, the actual charge rate could be in a range of 5.6 yd/hr to as much as 17 yd/hr.

A 36-in washing/dewatering screw for processing a charge of 20 yd/hr was considered in the design of the revised system. This was rejected because the achievable retention time was considered inadequate.

SECTION III

PROCESS EVALUATION

Good! and understandable

It is very important to appreciate that the system evaluation had to be, in a large part, qualitative. Much of the system was never assembled, and the portion that was assembled was operated for such a short period of time that no operating data could be obtained. There are no field operating data such as flow rates, holding times, temperature, chemical and utility consumption. Furthermore, there are no field data on compositions or yields. The soils washing system was operated for such a short period (2 to 3 hours) that operating conditions never reached equilibrium. In fact, no recycling of any kind was achieved.

The overall system was evaluated by means of a site visit, a study of available reports describing the site activities and at the US EPA ERB site in Alabama, examination of the laboratory results reported by PEI Associates, the results of experiments performed by EI, a study of literature obtained from vendors, and discussions with equipment vendors. Each section of the unit was evaluated in terms of whether it could be expected to perform adequately. The evaluation procedure varied from system to system, but generally began with data from the laboratory and reports to determine what would be required of the system and then determining from observation, reports on the operation of the system, and vendor data whether the system could be expected to meet those requirements.

OVERALL SYSTEM

In general, the evaluation of the overall system design and installation demonstrated that the engineering was inadequate. Attempts to assemble an operating unit for a complicated processing operation using locally available equipment are often not successful.

FEED SIZING AND HANDLING

From a process standpoint, this system would perform adequately if it can produce sufficiently fine material. The results of laboratory tests performed by EI indicated that the major concentrations of lead are associated with the fines, silt, and clay. Laboratory results obtained by PEI Associates showed that the lead is more difficult to remove from the fines, silt, and clay than from the heavier material. If, as proposed in the revised process, the fines, silts, and clay are removed from the heavier material and treated separately, the heavier material must be thoroughly washed to remove any remaining fines, silt, and clay before treatment.

Due to the nooks and corners, the larger pieces of battery case fragments will be difficult to wash thoroughly if the soil is sized to 2 in or less. A soil size of 0.5 in to approximately 250 mesh is recommended for a two-train treatment system. Note that a size of 250 mesh for separating the heavier material from the fines, silt, and clay is approximate, and may change as a result of additional laboratory tests. A finer-sized material will be required for a possible one-train treatment process. The alternate treatment processes are discussed later. If it is necessary to separate the fines, silt, and clay from the heavier materials before processing, facilities to accomplish this will have to be added.

With substantial modification, the system would perform adequately. However, as discussed in the following section, parts of it may be mechanically inadequate.

SOILS WASHING

This is the heart of the process and is one part of the system where the engineering was inadequate. In all of the areas listed below, the system was evaluated to be inadequate (refer to Appendix A and Section II for details).

1. EDTA reaction and soil dewatering
   - Insufficient retention time
   - Insufficient agitation
   - Inadequate separation of fines, silt, and clay
   - No facilities for control of EDTA concentration
   - No facilities for controlling EDTA make-up
   - No facilities for recycling EDTA solution

2. Polish Rinse
   - Unnecessary
   - No agitation

3. Water Rinse
   - Only one rinse was provided. Two additional rinses were planned.
   - No agitation
   - No facilities for transferring rinse water
   - Square tanks with cone bottoms would not provide for adequate mixing

FINES, SILT, AND CLAY TREATING

This system was never installed. Centrifuges intended for use in this process were brought on site. The centrifuges were either only marginally adequate for the duty or not suitable for the service.

SECTION IV

EQUIPMENT EVALUATION

Based on PEI Associates' operating experience, vendor equipment specifications and expertise, the equipment for PEI Associates' process was evaluated for function, capacity, quality, power consumption, and operation. Plant operating data were not available because the equipment was never operated as a system. The equipment was further evaluated for its ability to perform in the revised process system, which is designed for a throughput of 20 tons per hour.

The major equipment items include:

1. Portable conveyor with feed hopper
2. Vibrating screen
3. Impact crusher
4. Transfer conveyor
5. Washer-dewatering screw
6. Polish tank system
7. Rinse tank system
8. Electrolysis system (EMR's)
9. Bird centrifuges
10. C-M-I fine coal centrifuge

Certain equipment items, primarily in the feed sizing and handling system, appeared to be adequate for the intended service. Modifications and significant additions would be required if these equipment items were to be included in the revised process system. However, most of the equipment was inadequate for the required service. The deficiencies included insufficient capacity, inadequate phase separation capability, metallurgical deficiencies, and hazardous operating conditions. For a detailed evaluation of each equipment item, refer to Appendix A.

PORTABLE CONVEYOR WITH FEED HOPPER

This item was deemed adequate for the intended service, as it met all of the evaluating criteria. It was also considered suitable for use as a conveyor in the revised process system. This item is part of the integrated Finlay Portable Hydroscreen System evaluated below.

LEAD AND EDTA RECOVERY

This system was only partially installed when work on site was stopped. Consequently, there were no support facilities such as pumps, tanks, instruments, etc. The electrolytic cells were only partially completed. The evaluation of the system as installed is as follows:

> Hand-made electrolytic cells appeared fragile. Frames were made of wooden slats.
>
> Hand-made bus bar constructed of copper plates separated by wooden spaces was uninsulated and had no protective cover.
>
> The one short trial run with one cell produced a spongelike lead mass which would have been difficult to handle. An electrolytic cell manufacturer said that this was probably due to too high a current density.
>
> To remove the lead required unhooking the electric leads, which were connected to the cells to clamps, lifting the cell from the tank, and scraping off the lead mass - all by hand.
>
> The whole system was believed to be dangerous.

WASTEWATER TREATMENT

There were no wastewater treatment facilities. The draft copy of a report by the OSC presented a plan for a wastewater treatment unit. Discussions with firms which produce wastewater treatment facilities for heavy metals indicated that the planned facilities would probably have to be modified to produce a treated wastewater that could be sent to a municipal sewage treatment plant. The design of a system to treat the wastewater adequately will require furtner experiments and engineering.

VIBRATING SCREEN (FINLAY MODEL 40/30)

This item was evaluated as marginally adequate for the intended service, but required modification and additions to the system. When fitted with a plate-type screen, blinding was experienced. When the plate-type screen was replaced with a piano-wire screen, it broke due to impingement of heavy rocks and pieces of metal. Modifications for use in the intended service would have to include a new type of screen, such as a bar or wedge-wire screen, with water sprays, and the installation of a magnetic separator upstream of the screen.

The revised two-treating train process system specifies use of a wet trommel to provide a wash step as well as screening. Therefore, the Finlay vibrating screen is unnecessary for the revised two-train treatment process. Since this screen is part of an integrated Finlay Portable Hydroscreen System that includes the portable conveyor with feed hopper, and since that unit would be used only as a conveyor, it would be preferable to obtain equipment expressly selected for the service.

A one-train treating system, which will be tested, would not require a washing step. With modification and additions, the Finlay Portable Hydroscreen System could be adapted for use in such a system.

HAZEMAG MODEL APK-30 IMPACT CRUSHER

This unit was evaluated as adequate for the intended service, except that fouling required frequent cleaning, reducing the capacity. The addition of water sprays would reduce the fouling problem, and the unit would have adequate capacity. This unit was operated by PEI Associates to produce material smaller than 2 in. As discussed elsewhere, this is not sufficiently fine. Material smaller than 0.5 in is suggested for a two-train treatment system. If viable, a one-train treatment system will require even finer material. With modifications to ensure production of finer material, the unit is evaluated as adequate for the revised process system.

TRANSFER CONVEYOR

This item was evaluated as adequate for the intended service and adequate for use in the revised process system.

WASHER-DEWATERING SCREW

This 30-inch diameter, 25-foot long dewatering screw equipped with a washing compartment at its lower end is designed to provide a 1-minute holding time at normal operating rotating speed. By reducing the rpm of the screw to the point of efficiency loss and inadequate capacity, the retention time can be increased to approximately 8 minutes. The separation of fines, silt, and clay from the heavier material was to be accomplished by overflowing a portion of the EDTA solution over a weir at the back of the washing compartment. This unit was evaluated as inadequate due to insufficient retention time and agitation, inefficient separation of fines, silt, and clay, and insufficient capacity at the maximum retention time.

POLISH TANK SYSTEM

This system consists of a 6-in auger and a square, pyramid bottom, carbon steel grain tank coated with a resin to retard corrosion. There was no agitation provided. The system was evaluated as inadequate for the intended purpose because the tank construction does not permit adequate agitation and none was provided, the materials of construction were incorrect, and the specifications for the grain auger was proven to be unsuitable for dewatering soils. Laboratory experiments indicate that a polish rinse is not necessary and may be detrimental.

For these reasons, this system has been evaluated as being unsuitable in the revised process.

RINSE TANK SYSTEM

The rinse system consisted of a grain tank and auger identical to the polish tank system. Two additional tanks and augers were planned. For the same reasons that the polish tank system was evaluated to be inadequate for the intended service and of no use in the revised process system, the wash tank system is considered unsuitable for the intended service and of no use in the revised system.

ELECTROLYSIS SYSTEM

This system was intended to remove the chelated lead from solution by electrolysis in lead plate cells with membranes and wooden slats. The system, which was not completed, consists of hand-made electrolytic cells immersed in the EDTA-chelated lead solution contained in rectangular carbon steel tanks. The cells were connected by clamps and electric cables to a bus bar made from layers of copper plate separated by wooden spacers. The bus bars were uninsulated and not protected by a cover. Upon field inspection, EI judged this hand-made system as fragile, dangerous, and poorly designed. The operation of one portion of this system for a very brief test was discussed previously. There were no associated facilities such as pumps, piping, instruments, etc., perhaps because the system was not completed.

The system was evaluated to be inadequate for the intended service and inadequate for use in the revised system. With safety modification, the bus bar could be used at the Woodville site. However, the manner of its construction and assembly prevents it from being transportable.

BIRD CENTRIFUGES

Two small Bird solid bowl continuous centrifuges were provided for dewatering fines, silts, and clays. Their combined capacity of 60 gpm is probably adequate for one dewatering stage in the revised system. If this centrifuge capacity were provided, treatment of the fines would have to be a batch operation, which would require additional tank capacity. The centrifuges are the correct type for the service, but the selected model does not provide sufficient separation, and the solids concentraion of the bottoms would probably be too low. The centrifuges were evaluated as being marginally adequate for the intended service, and as inadequate for use in the revised process.

C-M-I CENTRIFUGE

This basket-type, coal-fines centrifuge was never delivered to the site. This centrifuge would serve no discernible purpose in either the original or in the revised process flow. The unit was evaluated as inadequate for both processes.

SUMMARY

With the possible exception of the impact crusher and the transfer conveyor, none of the equipment used or intended for use in the original flow scheme was correct for the revised system without modification. With modifications, certain items, such as the portable conveyor with feed hopper and the vibrating screen, could be adapted for use, but would unnecessary in the revised plant. The bus bar could be modified for use on the Lee Farm site only. The majority of the equipment items were judged to be inadequate.

PART B

PROPOSED PROCESS MODIFICATIONS

SECTION V

DESCRIPTION OF MODIFIED PROCESS

SOIL PREPARATION

The Feed Processing Section (Figure 1) is designed to: 1) receive the contaminated soil from the site; 2) remove oversized, ferric, and other waste material; 3) crush the remaining material to a size suitable for processing; 4) separate the fines from the heavier material; and 5) provide the necessary size classification. The fines require different processing than the heavier material due to the large concentration of lead in this fraction and to the difficulty of dewatering it.

Soil excavated from the site is fed by a front end loader into the Soil Feed Hopper TK-101 fitted with a 4 in x 4 in grizzly to prevent oversized material (boulders, logs, etc.) from entering the system. After thorough washing, the oversized material will be disposed of in an environmentally acceptable manner, possibly by simply burying it.

The unscreened soil is discharged from TK-101 by Soil Feeder FD-101, which meters the soil at a design rate of 20 cubic meters per hour, onto Screen Feed Conveyor CR-101 which discharges the soil into Soil Screen S-101. A Magnetic Separator S-115 removes tramp iron from the soil, and a Soil Feed Scale WS-101 weighs the soil as it is transferred by CR-101.

The inlet to S-101, a trommel-type screen, is at a lower elevation than the discharge to provide a zone for washing the finer soil from larger stones, pieces of bakelite, and hard rubber. Internal lifting flights further agitate the material and transport it through the trommel. Water sprays are provided to wash the soil and to prevent blinding of the screen deck. The material that passes through the screen is pumped as a slurry by the Screen Unders Pump P-101 A/B to Soil Classifier S-102. The oversized material is transferred by the Crusher Feed Conveyor CR-110 to the Screen Overs Crusher SR-101 designed to receive wet oversize material and reduce it to the designed size. Recycle Conveyor CR-102 transfers the crushed soil from SR-101 to S-101 for reclassification.

Soil classifier S-102 is a rectangular water scalping classifying tank. Slurry from P-101 A/B and water from Recycle Water Pumps P-103 are introduced into S-102 at the feed end. As the slurry flows through the tank, solids settle to the bottom, with the larger and denser material settling near the feed end of the tank. The material becomes progressively finer and lighter as the distance from the feed end of the tank increases. The heavier, settled materials are discharged into collecting flumes and flow to Dewatering Screws S-103 A/B. Metallic lead, the densest material, is dewatered and transferred by S-103 B to storage for sale. The remaining heavier soil material is dewatered and transferred by S-103 A to Soil Extraction and Rinsing via the Reactor Feed Conveyor CR-103.

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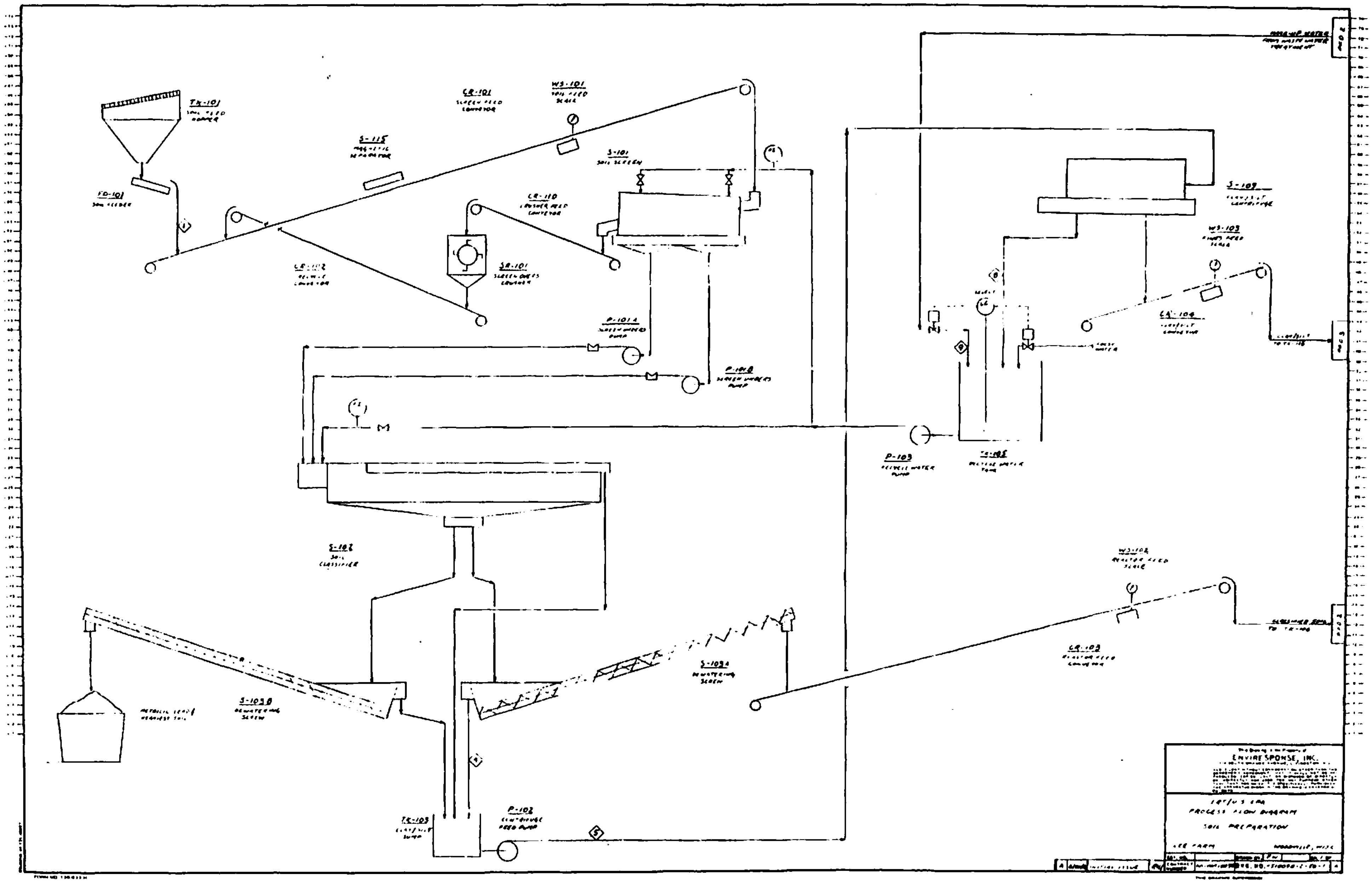


Figure 1. Soil Preparation Process Flow Diagram

Fines, which do not settle, overflow a peripheral weir to the Clay/Silt Sump TK-103 from where they are pumped to the Clay/Silt Centrifuge S-109. After dewatering in S-109, the fines are transferred to Fines Extraction and Rinsing via the Clay/Silt Conveyor CR-104.

The Reactor Feed Scale WS-102 and the Fines Feed Scale WS-103 weigh the heavier material and the fines as they are transferred from feed processing to their respective treatment sections.

Water overflow from S-109 flows into Recycle Water Tank TK-105 for reuse in S-101 and S-102. Any required make-up water will be taken from treated wastewater only if it is substantially free of EDTA.

SOIL EXTRACTION AND RINSING

The Soil Extraction and Rinsing Section (Figure 2) is designed to remove lead from the heavier material received from the Soil Preparation Section. The soil is reacted with a 15-20% solution of EDTA in water to extract the lead and put it in solution by chelation. The soil is then rinsed with a series of water rinses to remove enough chelated lead so it can be landfilled.

Soil from the Feed Processing System is fed into EDTA Reaction Tank TK-106 by CR-103. In TK-106, the Reaction Tank Mixer M-102 mixes the soil with a 15-20% solution of EDTA in water. Sufficient reaction time is provided to allow chelation of virtually all of the lead compounds in the soil. The slurry, consisting of soil, chelated lead, and unreacted EDTA in water, is transferred from TK-106 to the Reactor Dewaterer S-104 by Reaction Tank Pump P-105. Additional reaction time is provided in the wash tank compartment of S-104. The soil is dewatered in the inclined auger and delivered to the First Rinse S-105 where it is rinsed in the wash tank compartment, dewatered in the inclined auger, and delivered to the Second Rinse S-106. The process is repeated through successive rinses as necessary to ensure that the EP Tox requirement of 5 ppm lead will be achieved. A total of four rinses is shown; more may be required.

The EDTA solution removed from the soil by S-104 is returned by the Reactor Dewaterer Pump P-106 to TK-106 for reuse. On level control, a portion of the EDTA is withdrawn and sent to the EDTA Recovery/Lead Removal System where a series of electrolytic cells and resin adsorbers remove the lead as metallic lead and regenerate the EDTA for reuse. The wastewater remaining after removal of the lead and EDTA is sent to the Wastewater Treatment System.

EDTA solution make-up to replace losses to the treated product and to wastewater is transferred from the EDTA Surge Tank TK-112 to TK-106 by the EDTA Reaction Metering Pump P-114. The make-up rate is controlled by the concentration of unreacted EDTA in TK-106.

Fresh EDTA make-up is prepared by dissolving solid EDTA in water in EDTA Make-Up Tank TK-113. The fresh EDTA solution is added as required to the systems by EDTA Make-Up Pumps P-116 and P-112.

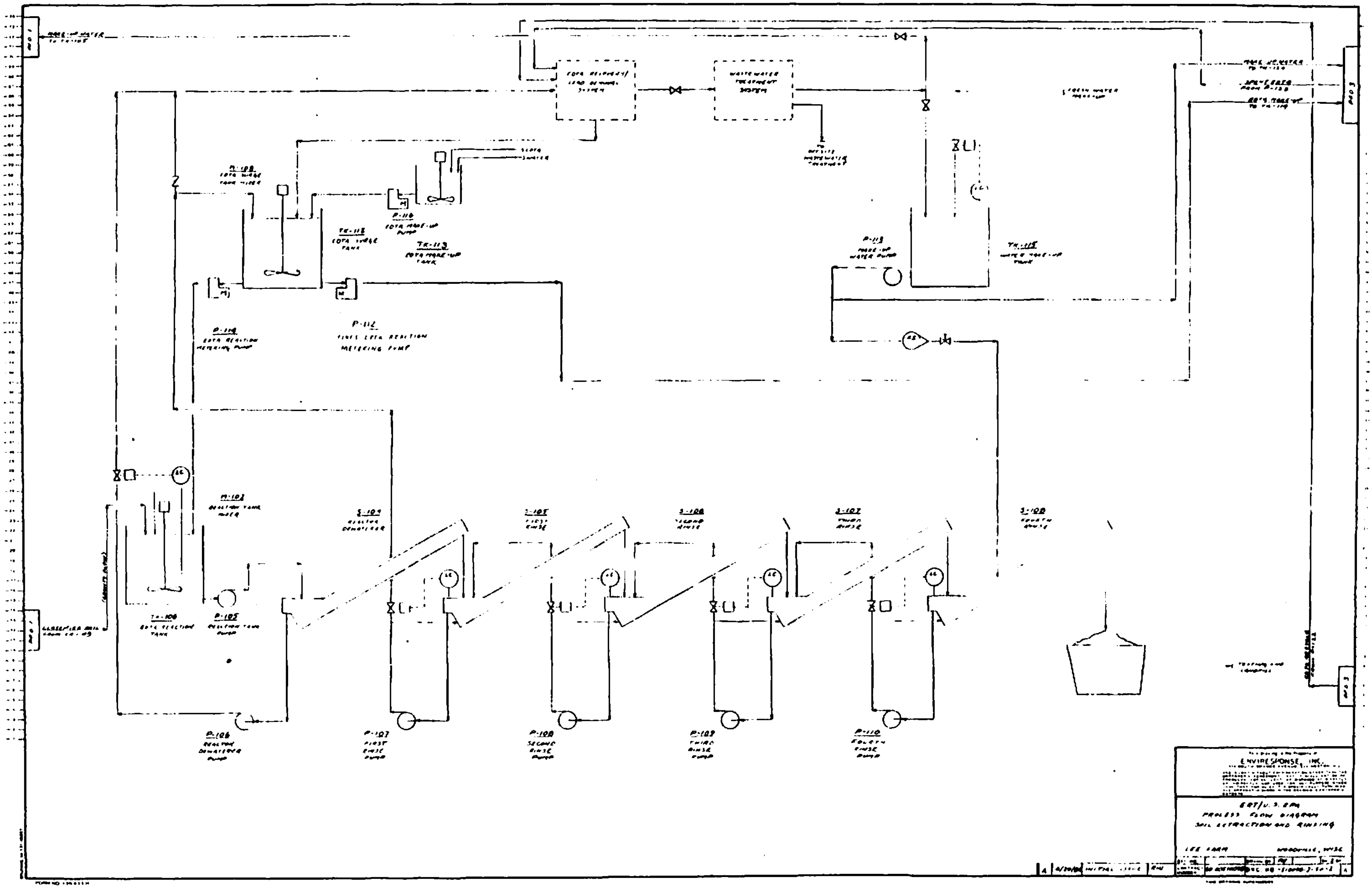


Figure 2. Soil Extraction and Rinsing Process Flow Diagram

Fresh rinse water is added to the final rinse stage. The required amount of fresh water will depend upon the degree of chelated lead removal required, the number of rinse stages provided, the rinsing efficiency at each stage, and, most importantly, the degree of dewatering achieved between stages. On level control, the rinse water is moved progressively from the last rinsing stage to the first rinsing stage. The overflow from the first rinsing stage (which is expected to contain 2-3% unreacted EDTA) is transferred by the First Rinse Pump P-107 to TK-112 for blending with fresh EDTA for reuse in TK-106.

Excess rinse water flows to the EDTA Recovery/Lead Removal System and to the Wastewater Treatment System for final treatment. If the EDTA concentration in the treated wastewater is within acceptable limits (to be determined in the field), the treated wastewater will be recycled to TK-105 and to the final rinsing stage. Treated wastewater will be drawn off as necessary to control the TDS and other substances.

Although the processes planned for the EDTA Recovery/Lead Removal and the Wastewater Treatment Systems are known, the detailed design of these systems will require additional experimentation and testing. The processing steps will consist of electrolysis for lead and EDTA recovery, adsorption for concentration of lead, and pH adjustment for final EDTA recovery. Additional treatment processes may include clarification and filtration. Arrangements have been made to have these tests and designs carried out.

FINES EXTRACTION AND RINSING

The Fines Extraction and Rinsing Section (Figure 3) is designed to remove the lead from the fines material from the Soil Preparation Section. The fines are reacted with a 15-20% solution of EDTA in water to extract the lead from the fines and put it in solution by chelation. The fines are serially rinsed with water to remove enough chelated lead to allow them to be landfilled.

Fines from the Soil Preparation System are fed into the Fines Reactor TK-116 by CR-104 where the Fines Reactor Mixer M-103 mixes them with the EDTA solution. Sufficient reaction time is provided to allow chelation of virtually all of the lead compounds associated with the fines. The slurry of fines, chelated lead, and unreacted EDTA in water is transferred from TK-116 to the Fines Reactor Centrifuge S-110 by the Fines Reactor Pump P-117 where the EDTA solution is separated from the fines and recycled to TK-116 via the Fines EDTA Recyle Tank TK-117 and the Fines EDTA Recycle Pump P-122.

The dewatered fines are transferred to the First Rinse Tank TK-119 by the Fines Reactor Discharge Conveyor CR-105, where they are mixed with rinse water by the First Fines Rinse Mixer M-104, and transferred to the First Rinse Centrifuge S-111 by the First Fine Rinse Pump P-118. The dewatered fines are transferred to the Second Fines Rinse Tank TK-120 by the First Fines Discharge Conveyor CR-106 where they undergo a second rinsing. The process is repeated through successive rinses as necessary to ensure that the EP Toxicity test requirements for lead will be achieved. A total of four rinses is shown; more may be required.

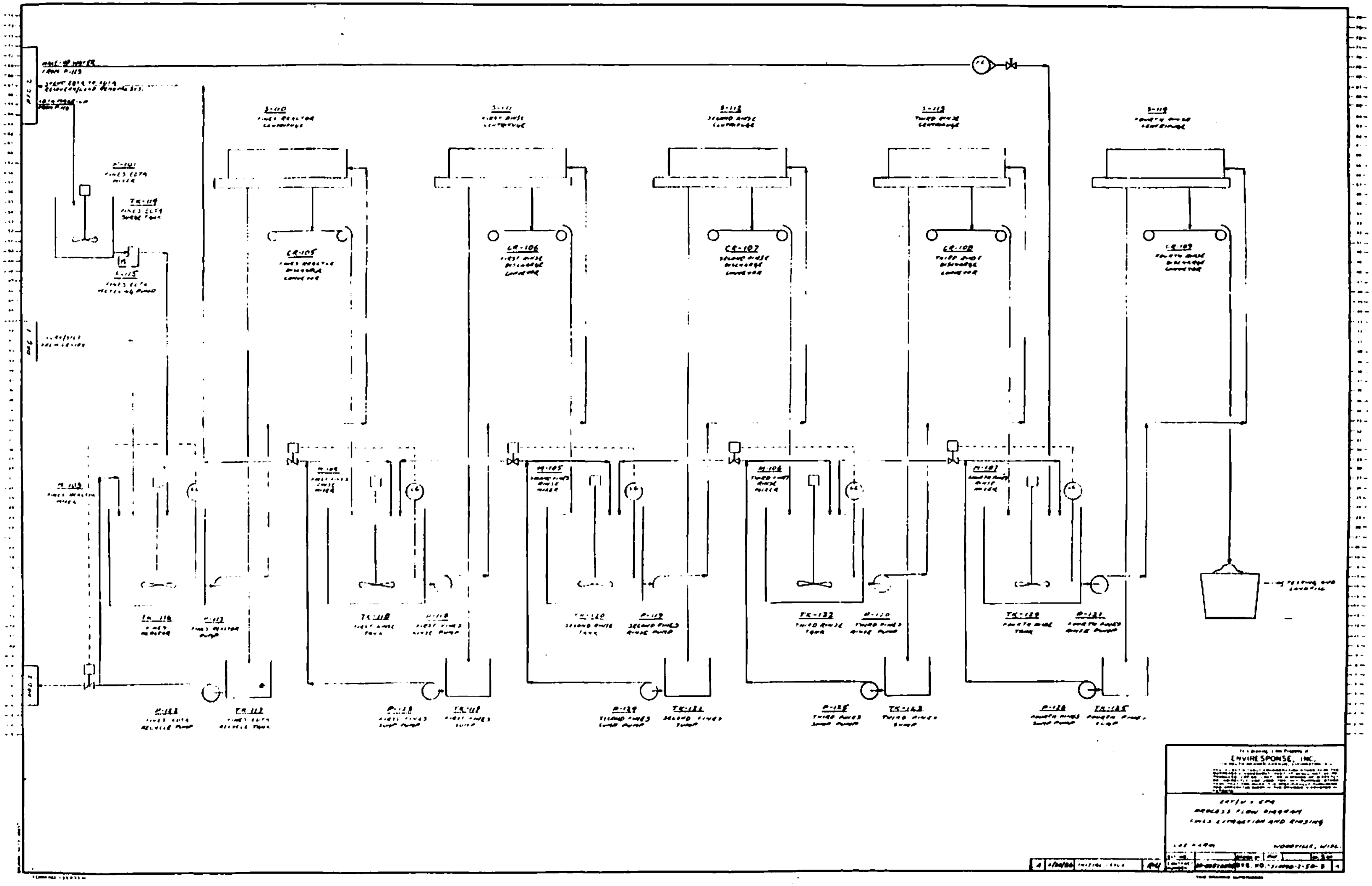


Figure 3. Fines Extraction and Rinsing Process Flow Diagram

A portion of the EDTA solution recycled to TK-116 is removed on level control to the EDTA Recovery/Lead Removal System. EDTA solution make-up to TK-114 by the Fines EDTA Metering Pump P-115 is controlled by the concentration of unreacted EDTA in TK-116.

Fresh rinse water is added to the final rinse tank. The water separated from the fines in the rinse centrifuge flows to the fines pump from where it is returned to the fines rinse mixer. The amount of fresh make-up water required to obtain adequate rinsing will depend upon the number of rinse stages provided (four are shown), the degree of lead removal required, the efficiency of the rinsing in each stage, and the degree of dewatering obtained between stages. The rinse water moves progressively from the last rinse stage to the first rinse stage on level control. The rinse water containing EDTA and chelated lead leaving the first rinse stage is sent to the EDTA Recovery/Lead Removal System for treatment.

SECTION VI

LABORATORY INVESTIGATION

BACKGROUND

Lead extraction from contaminated soil has encountered considerable process, soil handling, and mechanical difficulties during previous remediation efforts at Lee Farm and Leeds, AL (Table 1). The process and soil handling difficulties prompted an EI site evaluation per EPA request. EI concluded the Lee Farm process could not effectively decontaminate soil or operate easily without major revisions to the existing process (see Section III, Process Evaluation). A laboratory effort was established to assist in the process revision. The objectives of the lab effort were:

1. bench scale process development of soil decontamination and lead recovery (including soil classification, EDTA chelation, and spray rinsing oversized materials);
2. acquisition of data for design and scale-up;
3. testing pilot scale equipment (including centrifugation and screw dewatering).

Soil classification, the first phase of the process development program, was carried out to facilitate soil handling and to provide a more homogeneous feed for chelation. Classification is designed to eliminate or reduce previous pump and dewatering problems, and to separate the oversized soil fraction that can be decontaminated without chelation. In addition, classification allows for greater treatment feasibility and process flexibility since component soil fractions can be subjected to different treatment schemes. Lee Farm soil was classified into three fractions (oversized, sand, and silt) in this bench scale effort.

Chelation experiments were performed to determine the efficiency of EDTA lead removal from Lee Farm soil and to explore the effects of process environmental variables on soil chelation. Chelation must reduce lead levels in treated soil to the EP Tox requirement of 5 ppm leachable lead (maximum). Soil that meets this criterion is defined as nonhazardous.

It was unclear from PEI Associates' laboratory data that EP Tox requirements could be met consistently since much of this information was not reported (5). Field tests on site showed processed bakelite could meet EP Tox but whole soil could not. EDTA was the extractant of choice in bench scale experiments because of its previous use at Lee Farm and its reported success at reducing lead content of soil. Conmick reported buffered EDTA solution removing 63% of the soil's lead content (6). More favorable results were stated by

Table 1. PROCESS AND SOILS HANDLING PROBLEMS DURING LEAD EXTRACTION

TYPE	PROBLEM	LOCATION	REFERENCE
Process	During pilot studies, chelation agents, EDTA and NTA, "proved unsuccessful in reducing soils below EP Tox 5 (ppm of lead) when run at pH 10."	Lee Farm	1
Process	Insufficient mixing from high soil:liquid ratio	Leeds, AL	3
Process	"EDTA usage is unknown."	Lee Farm	2
Process	After EDTA chelation, "silts (fraction of soil) were not cleaned."	Lee Farm	2
Process	Hydrogen sulfide gas evolution from sodium sulfide lead recovery.	Leeds, AL Lee Farm	3 2
Process	"Unknown volumes of wastewater were created " and had to be treated.	Lee Farm	2
Process	Decontamination of bakelite and plastic pieces by high pressure water washers was "inadequate in reducing EP Toxicity of casings below 5 ppm (lead)."	Lee Farm	1
Soil handling	"Pumps plug," "small augers wear out," and "sands were difficult to handle."	Lee Farm	2
Soil handling	Plate and frame filters clogged and blinded during solid/liquid separation due to silts.	Lee Farm Leeds, AL	1 3
Soil handling	Auger carried over large quantities of chelant with soil into polish tank during solid/liquid separation.	Lee Farm	4

Ellis and Fogg, and Traver who reported 96% and 94-97% lead removal, respectively (3,7). The lab effort explores the feasibility of lead removal from soil by EDTA chelation, kinetic and equilibrium considerations, need for the polish rinse, and chelation process variables.

To reduce the amount of soil chelated, it was necessary to investigate alternative techniques to decontaminate oversize materials, soil, and broken battery casings greater than 0.25 in. This fraction comprises a significant amount of Lee Farm soil. Substantial savings can be achieved through an effective economical method resulting in material that can be delisted. The final section explains the approaches taken to achieve this goal.

Throughout this laboratory effort, data acquisition for design and scale-up was tantamount to process development. These data were used to determine reaction rates, material balances and chelant replacement (end recovery) rate. This information is at the core of the design of a soil treatment process.

SOIL CLASSIFICATION, SOIL PARTICLE SIZE DISTRIBUTION, AND LEAD ANALYSIS

Introduction

Past efforts to extract lead from soil have met with numerous difficulties. Problems in solid/liquid separation and pumping, and the failure to remediate the fines, silt, and clay in the soil may be eliminated through classification so that the soil is separated into several fractions before treatment. Treatment can then be individually tailored for each fraction with separate process conditions and appropriate process equipment.

Knowledge of the fraction's quantity helps determine whether treatment options, such as fixation and solidification of silts and spray wash to decontaminate oversized materials, are viable. Equipment size to treat each fraction is a function of several factors, including the amount of feed. Decisions on process design can be facilitated if the fraction's lead content is known and potential pitfalls, such as the previous failure to decontaminate the silts when whole soil was chelated, can be avoided.

The objective of the particle size distribution determinations was to determine the proportion of soil in each fraction (and subfraction). The purpose of the lead analyses was to ascertain if the concentration of metals varied wth particle size and, if so, which fraction contained the most lead salts and chelation-interfering metals.

Bench scale soil classification was included in the laboratory effort to explore the effectiveness and reproducibility of classifying Lee Farm soil necessary for effective large scale processing and to generate enough classified soil for experiments. Soil was classified into three fractions: 1) oversized, 2) sand, and 3) silt (Table 2).

TABLE 2. CLASSIFIED SOIL COMPONENTS

EI Nomenclature of Fraction	Particle Size Range (mm)	(in)	Mesh Size
Oversized	+ 6.35	+ 0.25	+ 1/4 in.
Sand	0.105-6.35	0.004-0.25	#140-1/4 in
Silt*	- 0.105	- 0.004	- #140

*Includes a colLoidal material larger than 140 mesh.

The selection of sand and silt fractions was based on equipment vendor testing of large-scale separations. Oversized material was separated from sand for processing by non-chemical methods. Several classification techniques were explored to devise a practical separation method that would yield reproducible classified soil. Lee Farm soil was categorized by particle size distribution and the lead content of each size.

Procedure

Classification--

Techniques explored were: mixing, settling and decanting; wet screening; and wet screening with flotation.

Mixing, settling and decanting--Approximately 3500 g of whole Lee Farm soil were placed into a hopper containing a 0.25-inch stainless steel screen. Deionized (DI) water (10.5 liters at approximately 25 psi) was sprayed onto soil while stirring with a large spoon so that all sides of rocks and broken battery casings in the soil were exposed to water spray.

The soil-water mixture that passed through the screen was collected in a 5-gal container under the hopper and allowed to settle for 5 minutes. After settling, the supernatant was decanted by siphoning. The sand fraction remaining in the 5-gal container was mixed with approximately 10.5 liters of clean DI water, settled for 5 minutes and the supernatant decanted. The soil in the supernatant was designated silt fraction and the soil remaining after the second settling was designated sand fraction.

Wet screening--Whole Lee Farm soil was wet-screened in the 0.25-inch screen as above. The soil-water mixture that passed through was screened again with a #140 mesh screen (105 micron). This mesh size was chosen based on vendor soil classification equipment tests. The soil (sand fraction) that did not pass through the screen was rinsed with DI water until it appeared to be clean and free of silt. The soil that passed through the screen was named silt fraction.

Wet screening with flotation--Soil was wet-screened (0.25 inch and #140 mesh screens) as above. The sand fraction remaining on the #140 mesh screen was hydroclassified by flotation. Flotation involved placing approximately 1300 g of the sand fraction into the bottom of a 4-liter beaker. DI water was pumped at 1 liter/min through a 0.25-inch perforated Tygon tubing ring placed in the bottom of beaker. Water overflowed the beaker, carrying residual silt fraction in the overflow. After flotation, water remaining in the beaker was poured through a #140 mesh screen. Soil remaining on the screen was returned to the beaker. Soil remaining in the beaker was named sand fraction.

Metal solubility in water during soil classification--Classification water after mixing and settling but before each decant of a triple mix/settle/decant soils classification (see Mixing, settling and decanting) was analyzed for total metals.

Characterization--Three types of soil were characterized for particle size distribution: 1) whole Lee Farm soil, 2) 0.25-inch dry-screened soil, and 3) wet screened with flotation sand fraction. Soils used for these tests arrived from the Lee Farm site in two lots and a sample from each lot was analyzed.

Whole soil samples for characterization were taken as is (whole) from shipping containers received from Lee Farm. Dry-screened soil was prepared by scraping (whole Lee Farm) soil over a 0.25-inch stainless steel screen inside a hopper to eliminate the rocks and large chunks of battery casings. The soil passing through was collected and characterized. The sand fraction was classified by wet screening with flotation. All soil samples were wet-screened on the following sieve sizes: 0.25 inch, #4, #8, #16, #30, #50, #100, #140, #200, #270, and #325. The soil passing #325 screen (44 micron) was characterized using a Coulter Counter, which detected particles as small as 0.6 micron.

After whole Lee Farm soil was separated into numerous fractions by wet screening, the nitric acid digestion-DC plasma technique was used for metals analysis of the various soil fractions.

Analytical procedures and QA/QC results are compiled in Appendix C.

Results

General--

Wet screening with flotation was the classification technique of choice to separate sand from silt fractions due to the effective and reproducible results. Hydroclassification does not significantly alter the metal content of the contaminated soil, and only trace quanitites can be found in classification water. Several classified sand fraction samples passed EP Tox lead analysis, even though the average total lead content was over 10,000 ppm. The oversized (greater than 0.25-inch) soil fraction comprised about 25% of the Lee Farm soil. Silt fraction (less than 0.105 mm) varied from approximately 25% in lot 1 soil to approximately 10% in lot 2 soil. The sand fraction comprises the difference. This large difference in fines indicates that process equipment selection and sizing must take into account a wide particle distribution range. Metals concentrations increased with decreasing soil particle size. A 230-fold increase in the average lead concentration was observed. The tendency for smaller soil particles to adsorb more metal salts is very pronounced for all four metals: iron, lead, calcium, and magnesium.

Classification--

There was difficulty obtaining reproducible classified soil for experiments by the mixing, settling and decanting technique due to the varying amount of a mud-like layer produced by this method. The sand fraction remaining after the second decantation contained a noticeable top layer of mud. The quantity of this mud layer (a "middle" fraction) varied among classifications because of experimenter differences in syphoning. The higher lead concentration in the mud layer compared with the sand (see Characterization) caused variability in the lead content of the sand fraction.

Wet screening classification was inadequate even though it generated reproducible sand fraction. There was still a small quantity of silt fraction remaining in the sand fraction. This material was noticeably less dense than the sand fraction, and settled out to form a fine layer on top of the heavier material. This silt fraction clogged the filter paper used for solid/liquid separation between chelation steps, thereby extending separation time.

Wet screening with flotation worked best due to increased fines removal and classification reproducibility. The addition of flotation to wet screening eliminated more silt fraction from the screened sand fraction. This resulted in a reduced solid/liquid time of approximately 66% compared with wet-screened (without flotation) classified soil.

EP Tox lead analysis on classified soil (wet screening with flotation) was done to determine if the sand fraction could pass the test without any chemical treatment. Five of seven samples passed the test (Table 3).

Table 3. EP TOX LEAD OF UNCHELATED CLASSIFIED SOIL

SAMPLE #	Pb (ppm)	EP TOX Pb (ppm)
252	11,600	0.3 13.0
292	14,600	0.2
296	9,250 6,700	0.1
297	8,240	23.6
298	8,200	0.1
303	14,900 12,500	2.5
AVERAGE	10,749	

Figure 4 and Table B-1 show that the lead concentration was not greater than 6.2 ppm in any of these water samples. Iron also had low solubilities in classification water. The calcium concentration was 40-56 ppm, while the magnesium concentration was lower.

Characterization--

For lot 1 Lee Farm soil, the three component fractions comprised the following proportions: oversized, 24.8%; sand, 55.5%; and silt, 25.5%.

Particle size distributions (Figure 5 and Appendix Table B-2) indicated a large difference between soil lots. In lot 1, 25.5% of the whole soil was the silt fraction (smaller than 0. 105 mm or 0.004 in), but only 10.2% of lot 2 was silt. This large differenece between lots demonstrates variability between soils from the same site. Approximately 50% of the silt fraction was smaller than 0.01 mm (0.0004 in) and some particles were as small as 0.001 mm (0.00004 in) (Table B-2). The quantity of these small particles may cause difficulties in solid/liquid separation.

The amount of oversized material (Table 4) is of special process interest. If this fraction can be effectively rinsed of entrapped soil, the resultant material may be delisted per EP Tox results without being exposed to chemical treatment. Since this fraction comprised nearly 25% of Lee Farm soil, any effort to treat materials without chelation is worthwhile.

Table 4. AMOUNT OF OVERSIZED MATERIAL IN WHOLE SOIL (lot 1)

Amount (%)*	Analyst
19.0	Eagle Iron Works
28.7	EI
23.3	EI
28.1	EI
24.7	Ei
24.8 AVERAGE	

There was a strong relationship between soil particle size and lead concentration: as particle size decreases, lead concentration increases (Figure 6). When comparing the lead concentration of the largest soil size distribution (4.76-6.75 mm) to the smallest size distribution (less than 0.044 mm), Eagle Iron Works and Foster Wheeler Development Corporation analyses (Table B-2) displayed lead increases of two and nearly three orders of magnitude, respectively. Particular attention must be given to silt remediation. In Figure 7, this trend does not hold for other metals. As particle size decreases, Fe, Mg, and Ca increased relatively little.

Figure 4
Metal solubility in classification water

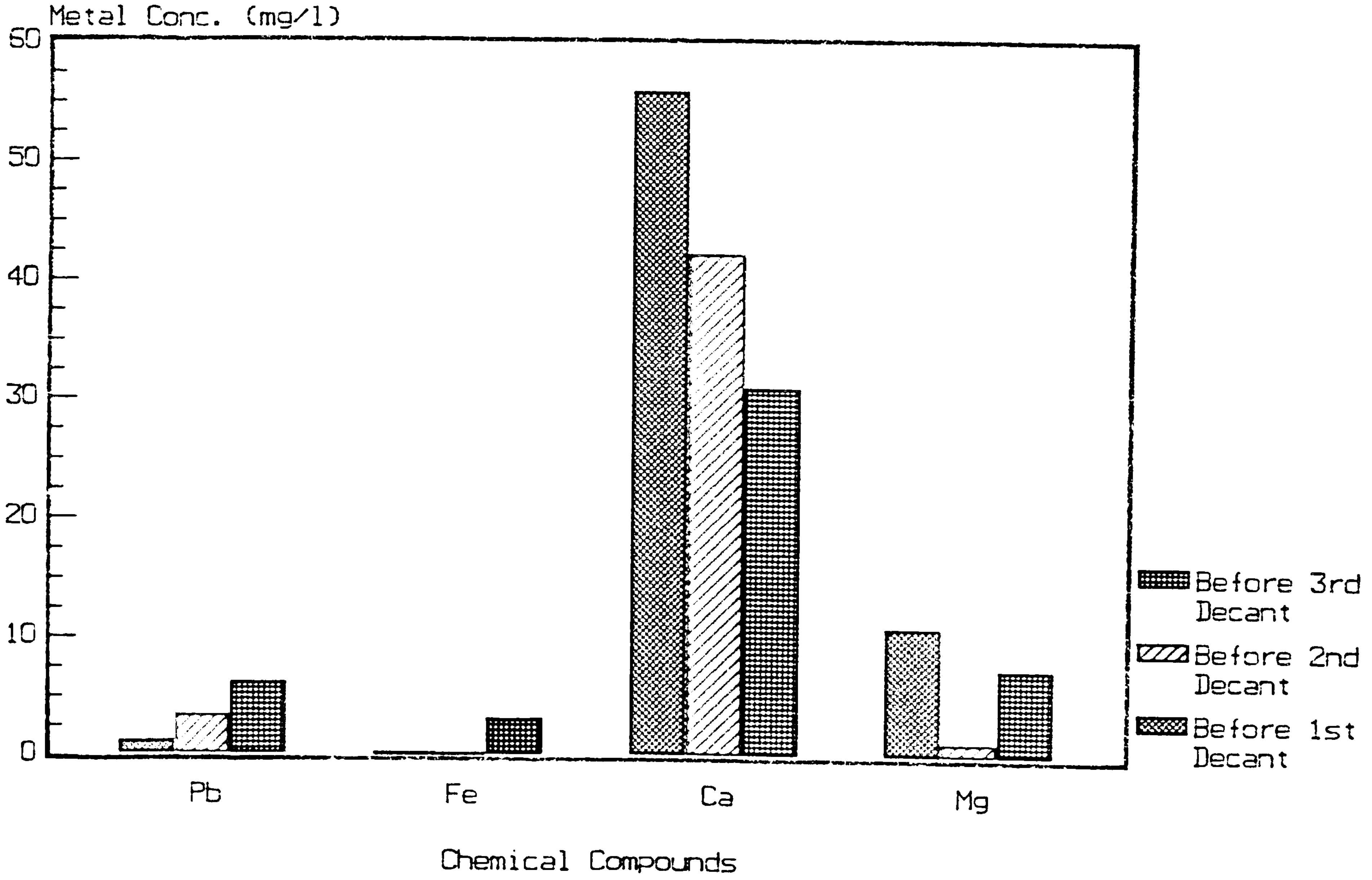


Figure 5
Amount of silt in Lee Farm soil

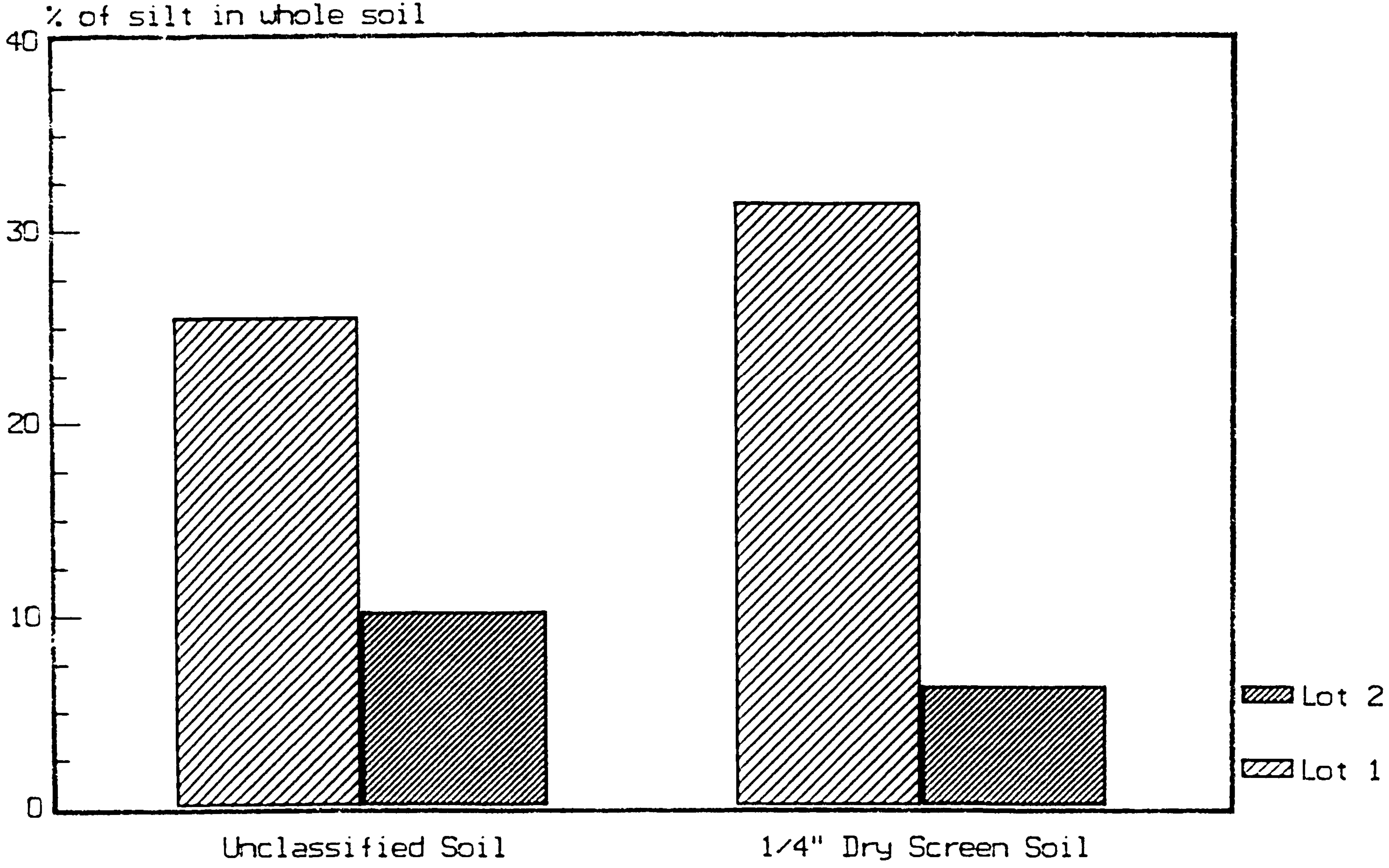


Figure 6
Relationship between particle size and lead concentration - Lot 1 soil

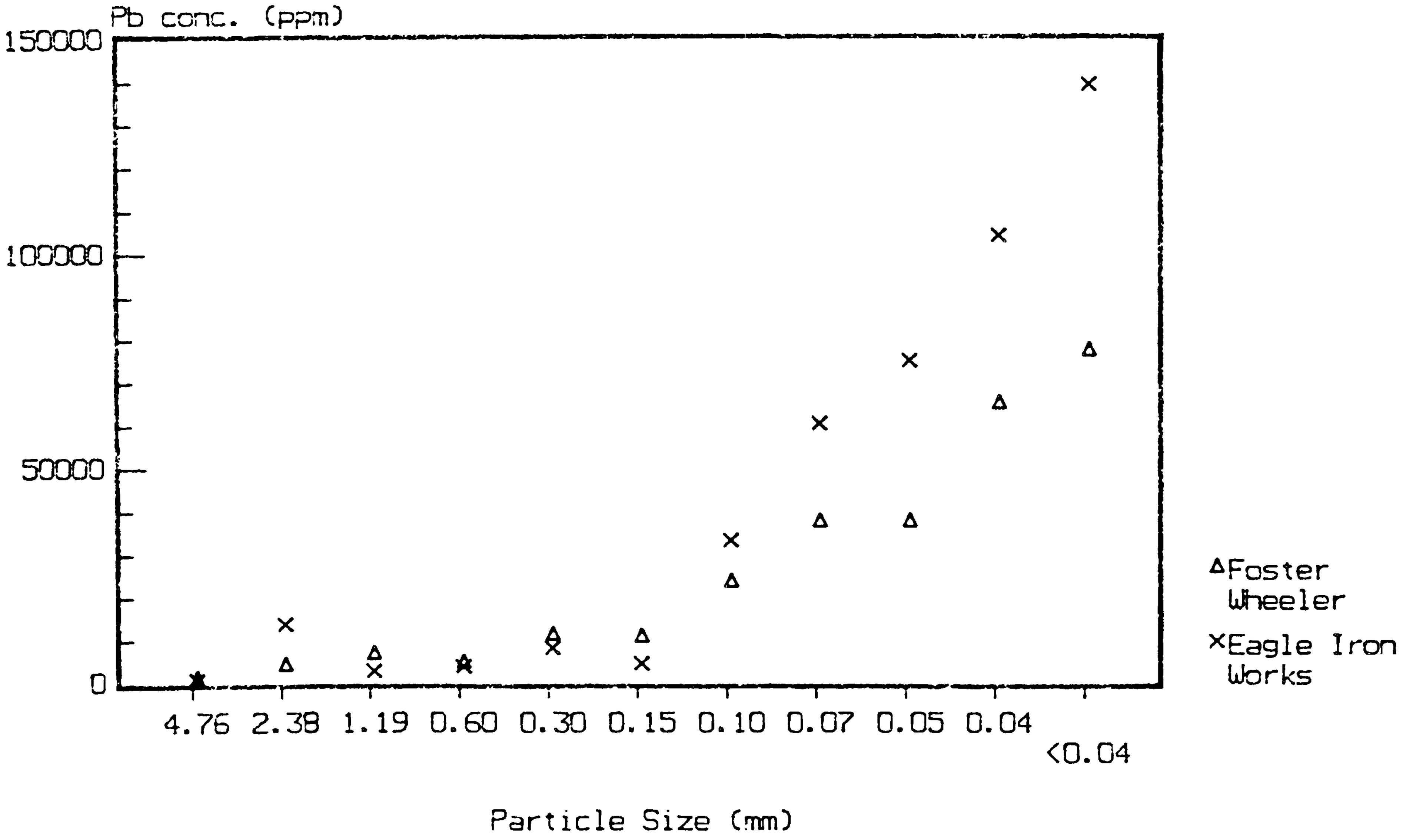
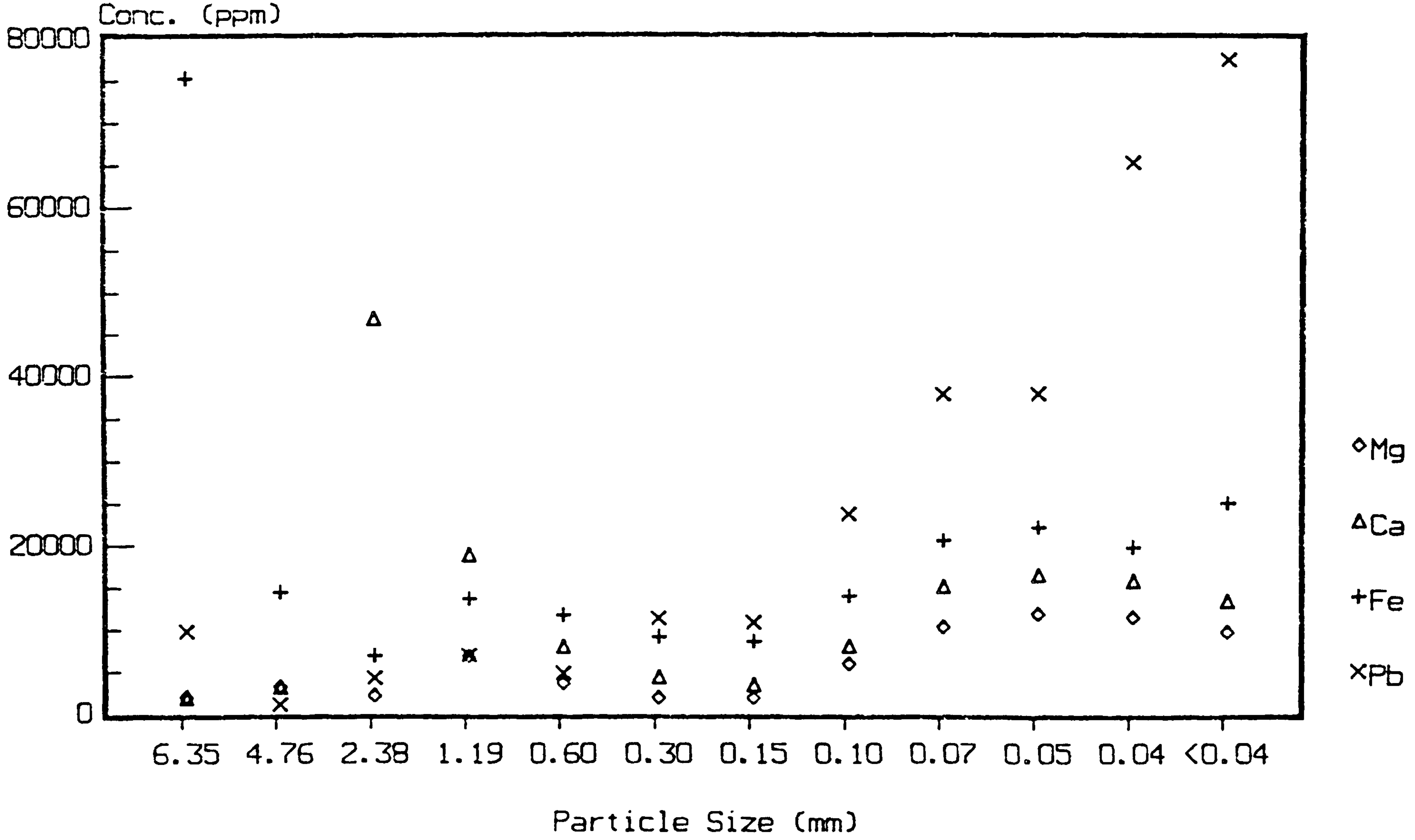


Figure 7
Relationship between particle size and
metals concentration - Lot 1 soil



SOIL CHELATION

Introduction

The purpose of chelation experiments was to determine the effectiveness of EDTA chelation in reducing contaminated soil lead to acceptable levels and lowering the EP Tox to required levels. In addition, kinetic and equilibrium information was needed for process design.

Determining EDTA effectiveness was performed by exploring some parameters that affect both residual lead and EDTA-lead complex levels remaining in the soil. These parameters were chelation duration, polish rinse EDTA concentration and soil loading. These parameters were varied to determine how they affect lead removal and yield favorable treatment results.

The speed of EDTA lead removal, or chelation kinetics, was needed for chelation vessel design, including the retention time necessary for effective lead reduction. This information would be most ideally obtained by extracting samples of soil at various time intervals from the reacting solution and analyzing these samples for total lead. An alternative approach was taken to simplify the experimental task. Liquid chelation solution samples were taken at designated time intervals from the chelation reactor. Since a decrease in soil lead concentration would yield a corresponding increase in chelation solution lead concentration, this method would give the necessary results.

The final set of experiments explored the chemical equilibrium considerations of the proposed process. The question under investigation was the following: At what point in the chelation do the active sites in EDTA become saturated so that the chelant is rendered ineffective? The answer would determine the rate of saturated chelant removal (to EDTA-lead recovery) and fresh chelant introduction into the treatment vessel. These chelations were performed in a semi-continuous manner: Fresh soil was introduced into the chelation vessel for a determined time, followed by soil/chelant separation, and the addition of fresh soil to the original chelation solution. Chelations were performed sequentially.

Procedure

Whole soil (0.25 inch screened, unclassified) and classified sand fraction (mix/settle/ decant method) samples were used in chelation experiments. In each experiment, soil was exposed to: An EDTA chelation reaction, an EDTA polish rinse and three DI water rinses. All chelation and polish solutions were adjusted to pH 7 with concentrated sulfuric acid before use. Chelation solutions contained slightly more than 20% EDTA before chelation to compensate for the moisture in the soil. Soil and chelation solution were combined to a designated mixture and agitated at 100 rpm. Samples (30-50 ml) were withdrawn during experiments from all solutions and filtered through #42 Whatman paper for later analysis. Solid/liquid separation was performed between each of the five processing steps with Buchner funnels, vacuum flasks, and filter papers.

Parameters for chelation experiments are listed in Table 5.

Table 5. CHELATION EXPERIMENTAL PARAMETERS

SOIL TYPE	SOIL IN MIXTURE (%)	EDTA IN CHELATION (%)	EDTA IN POLISH (%)
Whole[a]	25	20	---
Whole	25	20	2
Sand[b]	25	20	0
Sand	25	20	2
Sand	25	20	5
Sand	45	0[c]	0
Sand	45	20	0
Sand	45	20	2
Sand	45	20	5

[a] whole soil, unclassified

[b] sand fraction classified soil

[c] control experiment

In chelation equilibrium experiments, the EDTA solution was saved after reaction with sand fraction (wet screened with flotation classified). The partially spent EDTA solution was reacted with another fresh sample of soil. Chelated soils were subjected to fresh polish and water rinses. After each chelation, EDTA solutions were analyzed for free EDTA and total lead and rinsed soil was analyzed for total lead and EP Tox lead. Sequential chelations were carried out in this manner. Any losses in the EDTA chelation solution due to sampling, spilling, and filtering was not made up with fresh 20% EDTA solution. The amount of soils added to the reduced volume chelation solution were adjusted to a 25% soil mixture. All rinse volumes were reduced accordingly so that a 25% soil mixture was achieved.

Results

Chelation experiments with unclassified Lee Farm soil were unsuccessful due to problems in separating soil from chelant solution. Classified soil chelations reduced lead concentration to as low as 700 ppm (a 95% reduction) and reduced EP Tox lead below the 5 ppm requirement. Similar results were obtained by the US Bureau of Mines in Rolla, Missouri. Higher soil loading (45% w/w) resulted in higher mean residual lead levels, approximately 1,400 ppm. The EDTA polish rinse adversely affects treatment by increasing EP Tox lead in treated soil and failing to reduce residual total lead concentration.

Hydrometer readings of chelated solution were affected more by soil moisture dilution than by lead concentration, and were hence not usable for chelation process control. Finally, results were generally inconclusive for kinetic and equilibrium considerations. Additional experimentation is required.

When sufficient data points allowed, graphs were plotted with one standard deviation error bars. All data are plotted except for those points failing to meet the Dixon Test for Outliers 95% confidence level.

Whole, unclassified Lee Farm soil could not be separated by filtration from the chelation solution. Because of this obstacle, chelation tests with whole soil were terminated; however, these experiments confirmed the solid/liquid separation problems PEI Associates encountered when processing Lee Farm soil and confirmed the need for soil classification.

During the liquid/solid separation following chelation, filter papers used for separation immediately and severely blinded due to the fine soil particles plugging the papers' 15 and 35 micron pores. Filter cloth (5 micron nominal pore size) was also unsuccessful. PEI Associates used a filter press on site with similar results. Another whole soil chelation was attempted on a smaller scale so less solid/liguid volume would have to be separated. Again, dewatering the soil was very difficult. The use of whole, unclassified Lee Farm soil in chelation experiments was abandoned.

A chelation control experiment performed as expected. No reductions in test soil lead levels occurred. The EDTA-free experiment with classified soil utilized: 0% EDTA chelation, 0% EDTA polish, and three water rinses. Figure 8 and Table B-7 indicate no soil lead reduction soil after the second or third rinse, and only trace quantities of lead appeared in the EDTA-free water. EP Tox for lead was relatively unchanged.

All chelation were successful in achieving large reductions of lead without significantly reducing chelation-interfering metals. Chelation with 45% soil mixture yielded similar mean values of total lead remaining in soil: 1,690, 1,752, and 868 ppm (Figure 8 and Tables B-8 - B-10). Experiments with 25% mixtures further reduced total lead levels in treated soil to 736,696 and 774 ppm (Figure 9 and Tables B-11 - B-13). Lead reduction averaged 95%. Concurrently, ammonium carbonate-fluosilicic acid extraction (8,9) of EI-supplied classified soil was performed by Dr. Ernest Cole at the US Bureau of Mines, Rolla, Missouri. In his experiments, Dr. Cole reduced total soil lead to 500-800 ppm, a 94% reduction (Figure 9). These reduction values agreed with laboratory results of Ellis and Fogg and field results at Leeds, Alabama by Trevor (see Introdustion).

Figure 8
Effect of 20% EDTA chelation on lead concentration in sand fraction 45% soil mixture

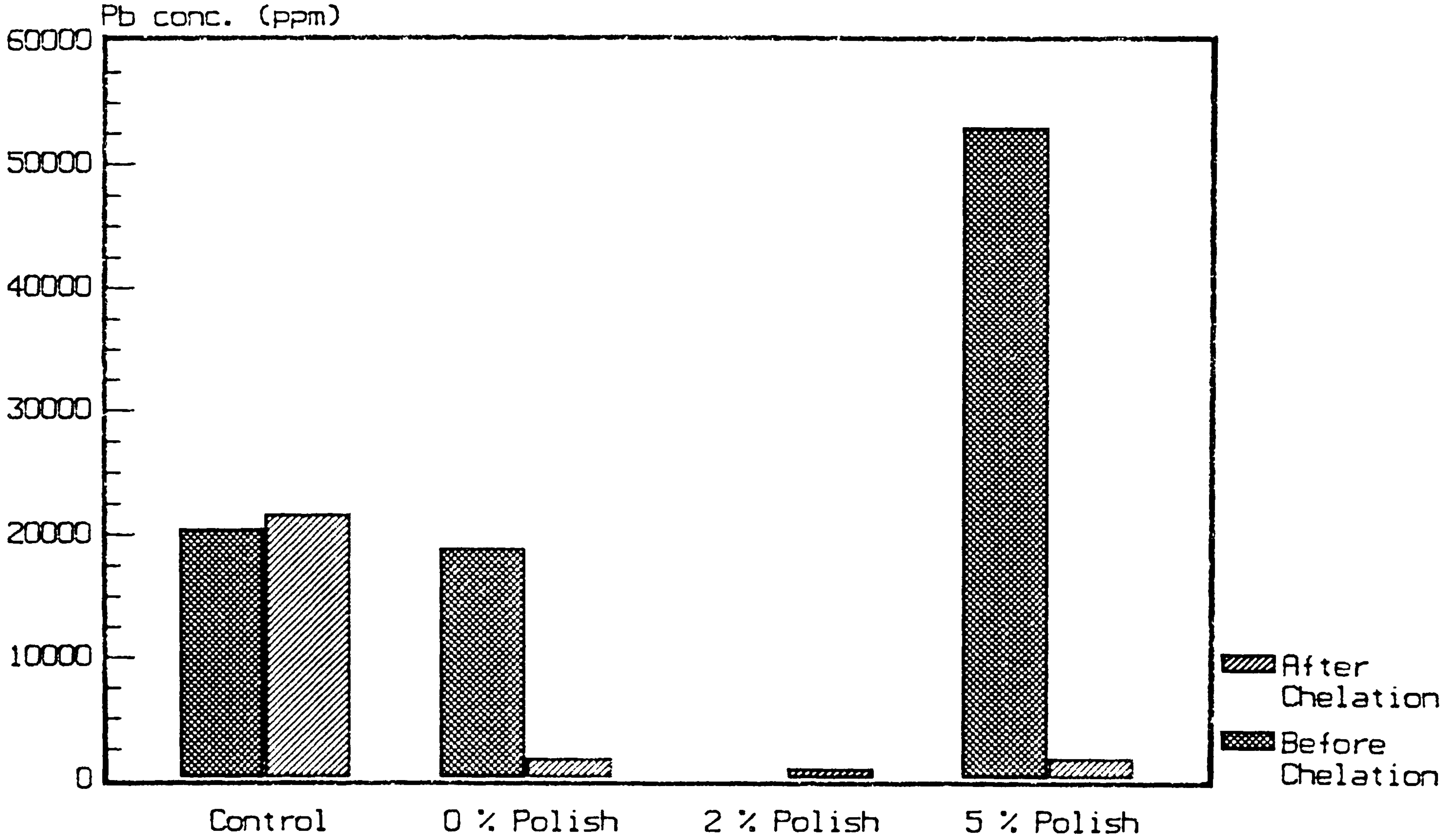
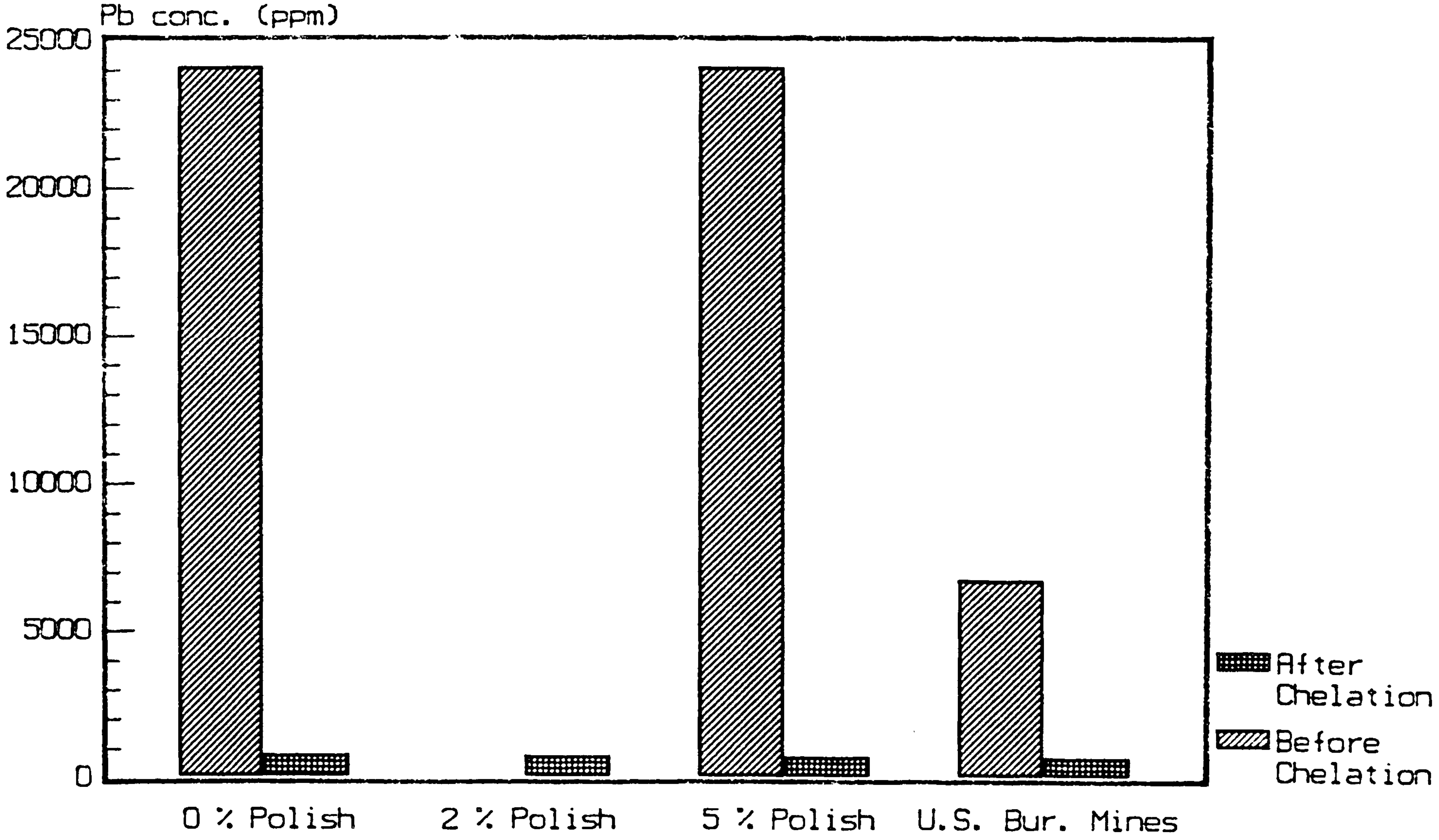


Figure 9
Effect of 20% EDTA chelation on lead
concentration in sand fraction
25% soil mixture



High soil leading (45%) chelations were carried out to determine if reactor volume could be reduced. Resulting soil, contained higher residual lead levels (approximately 1,400 ppm) compared with 25% soil loading chelation lead levels (approximately 700 ppm). The reduced soil loading produced consistently better results.

The EDTA polish rinse should be eliminated because increasing EDTA concentration in this rinse solution did not decrease the soil lead concentration, as hypothesized, and resulted in increased treated soil EP tox lead. Figures 8 and 9 graphically present results of experiments designed to explore the effect of the EDTA concentration in the polish rinse. As polish rinse EDTA increase, EP Tox Pb also increased (Figure 10). This resulted from increased amounts of mobile EDTA-lead species remaining in the treated and rinsed soil. The EDTA polish rinse is not only unnecessary but detrimental to the process.

Monitored hydrometer readings of EDTA chelation solutions indicated that specific gravity could not be utilized as a process control on the chelation unit for removal of solution to EDTA recovery due to the very small change in specific gravity as lead concentration increased and to the effect of soil moisture on the chelation solution specific gravity. (Table 6).

Table 6. HYDROMETER READINGS OF EDTA SOLUTIONS

EDTA Conc. (%)	Pb (ppm)	Specific Gravity	Temperature (^{O}F)	Sample No.
22	0	1.150	78	--
22.7, 22.6	0	1.151, 1.148	80, 85	252E
11.7	37,200	1.149	--	107R
11.4	30,300	1.153	--	107L
14.0	8,810	1.140	--	153R
14.3	10,600	1.148	--	153L
9.6	4,200	1.145 (a)	80	253R
18.9	4,880	1.146 (a)	80	253L
14.8	9,800	1.128 (b)	80	265R
10.3	8,310	1.132 (b)	80	265L
13.4	16,000	1.125 (c)	80	271R
12.8	11,800	1.129 (c)	80	271L

(a) first chelation in series
(b) second chelation in series
(c) third chelation in series

Figure 10
Effect of 20% EDTA chelation, soil mixture, and polish rinse on EP Tox Pb concentration

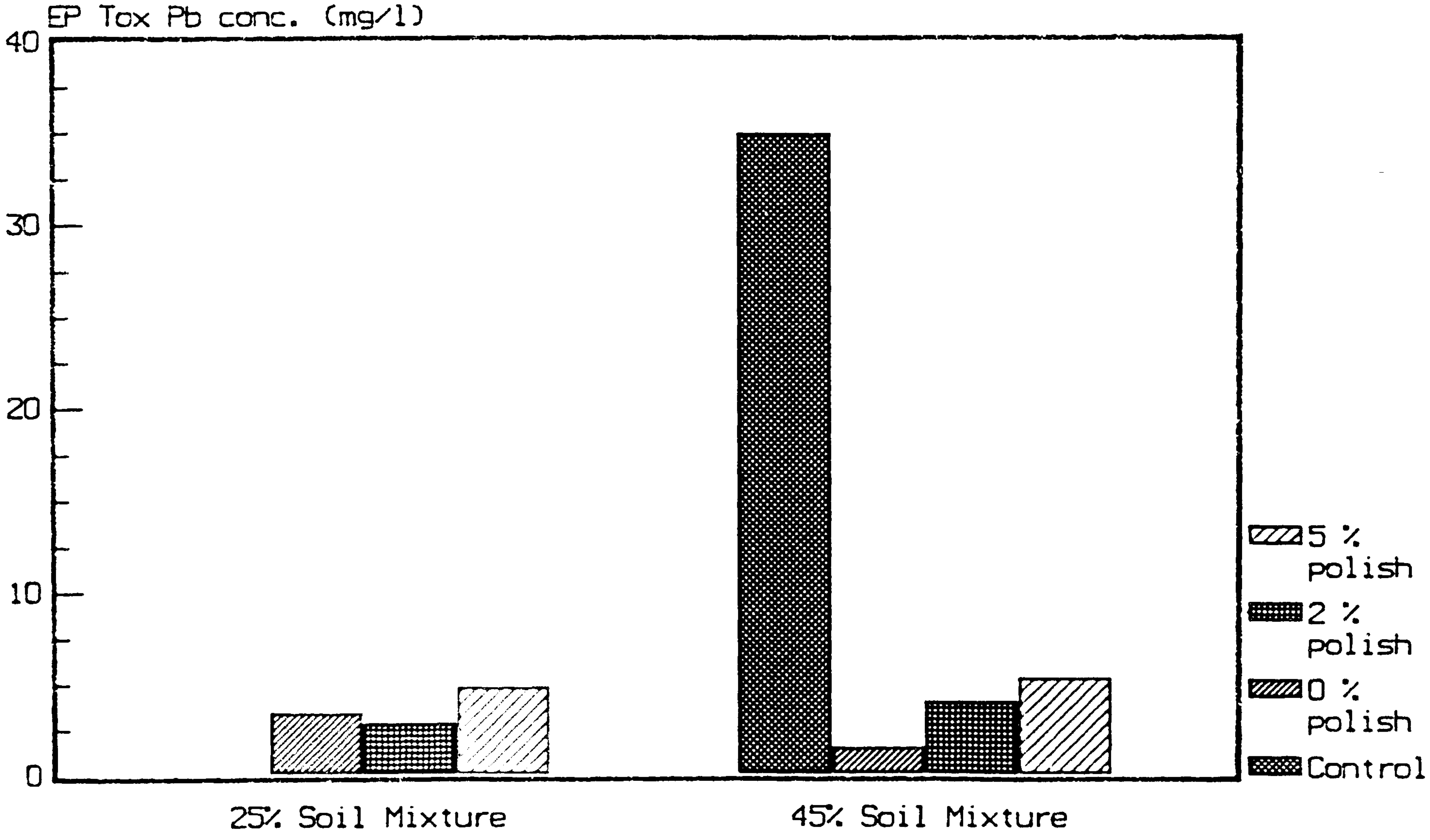


Figure 11. Chelation solution lead uptake
45% soil mixture

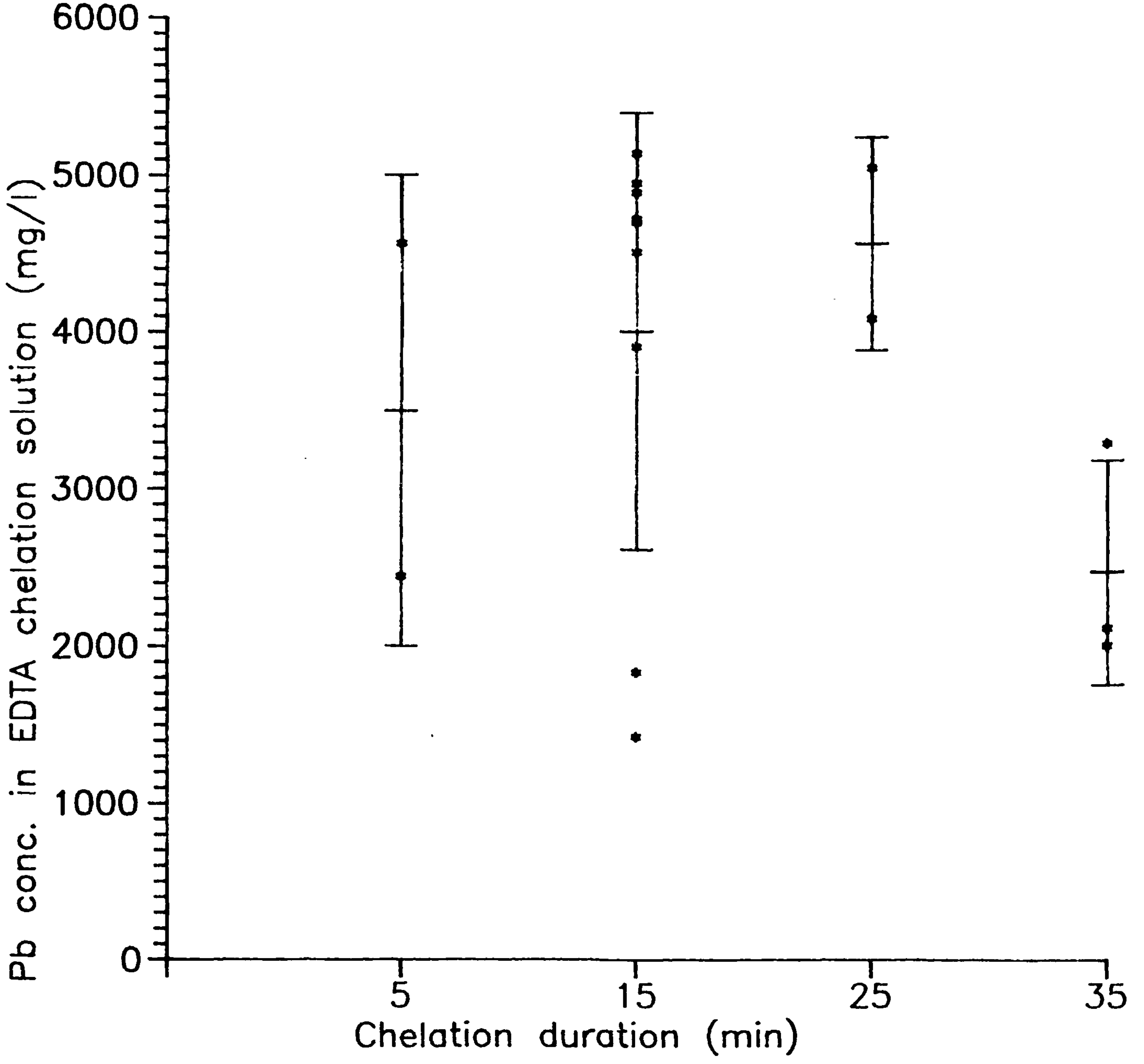


Figure 12. Chelation solution lead uptake – 45% soil mixture

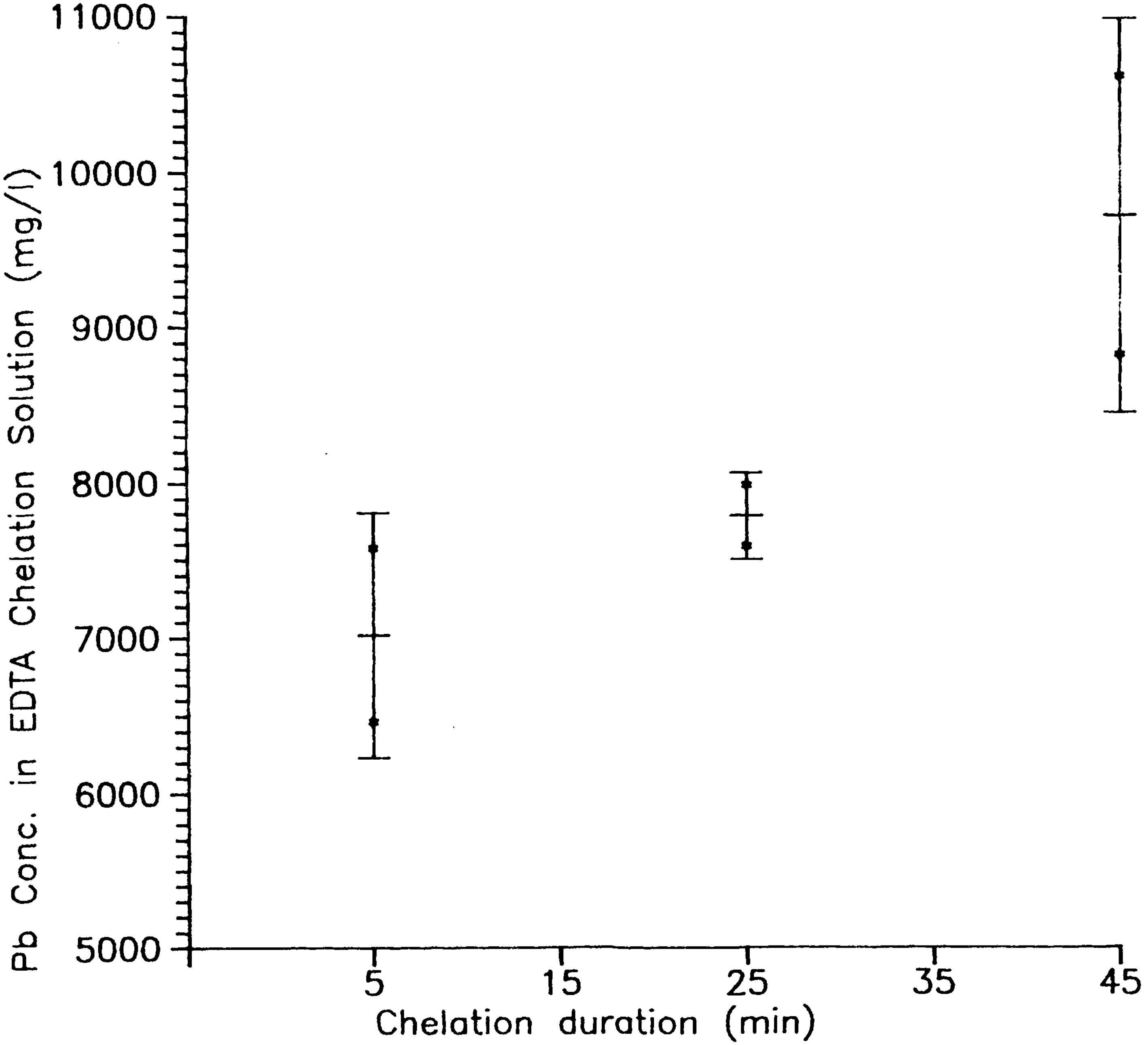


Figure 13
Effect of chelation time on lead uptake
during sequential chelations

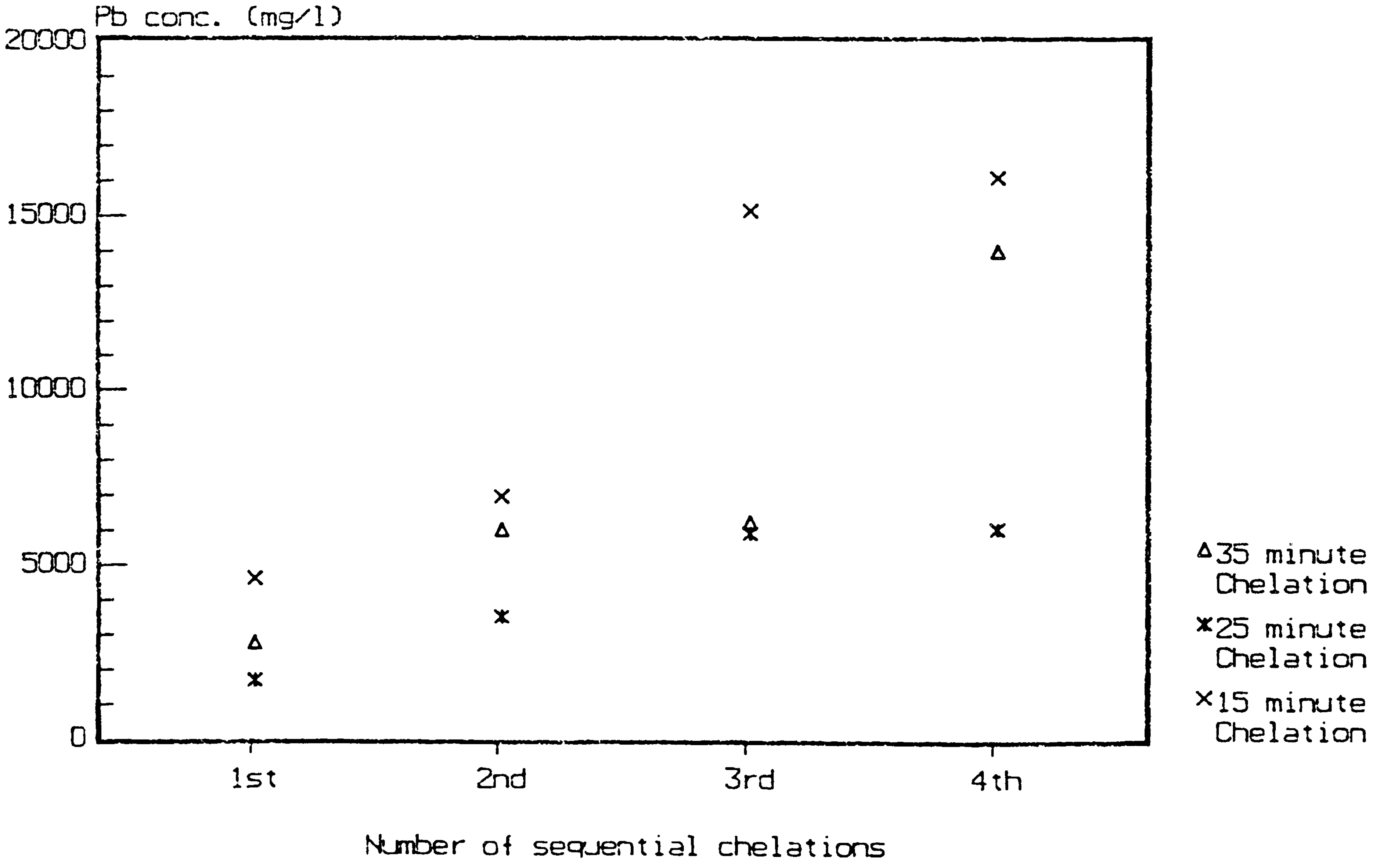


Figure 14. Lead concentration in chelation solution during sequential equilibrium chelations

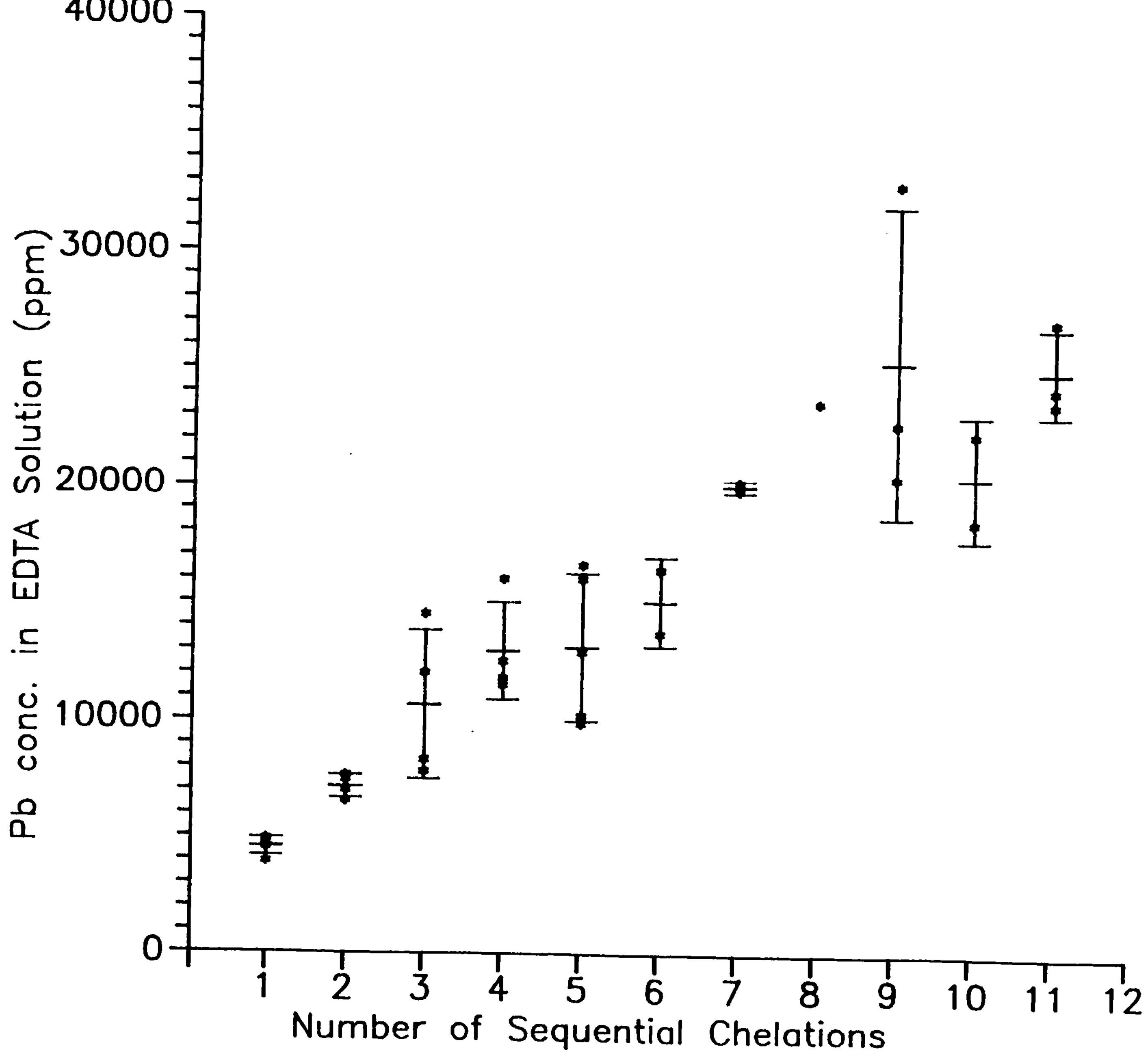


Figure 15. Free EDTA concentration in chelation solution during sequential equilibrium chelations

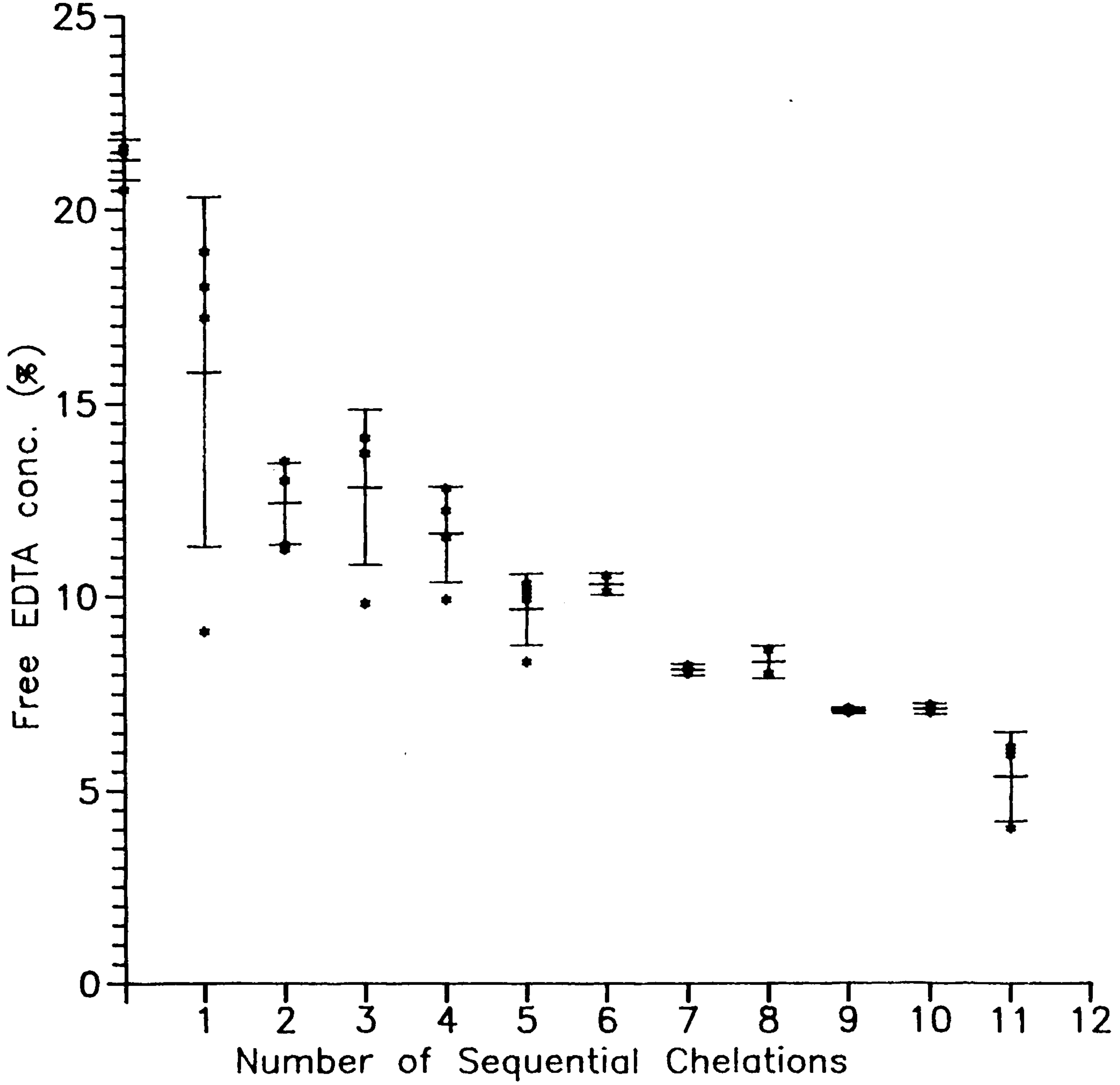


Figure 16. Lead concentration in soil during sequential equilibrium chelatoins

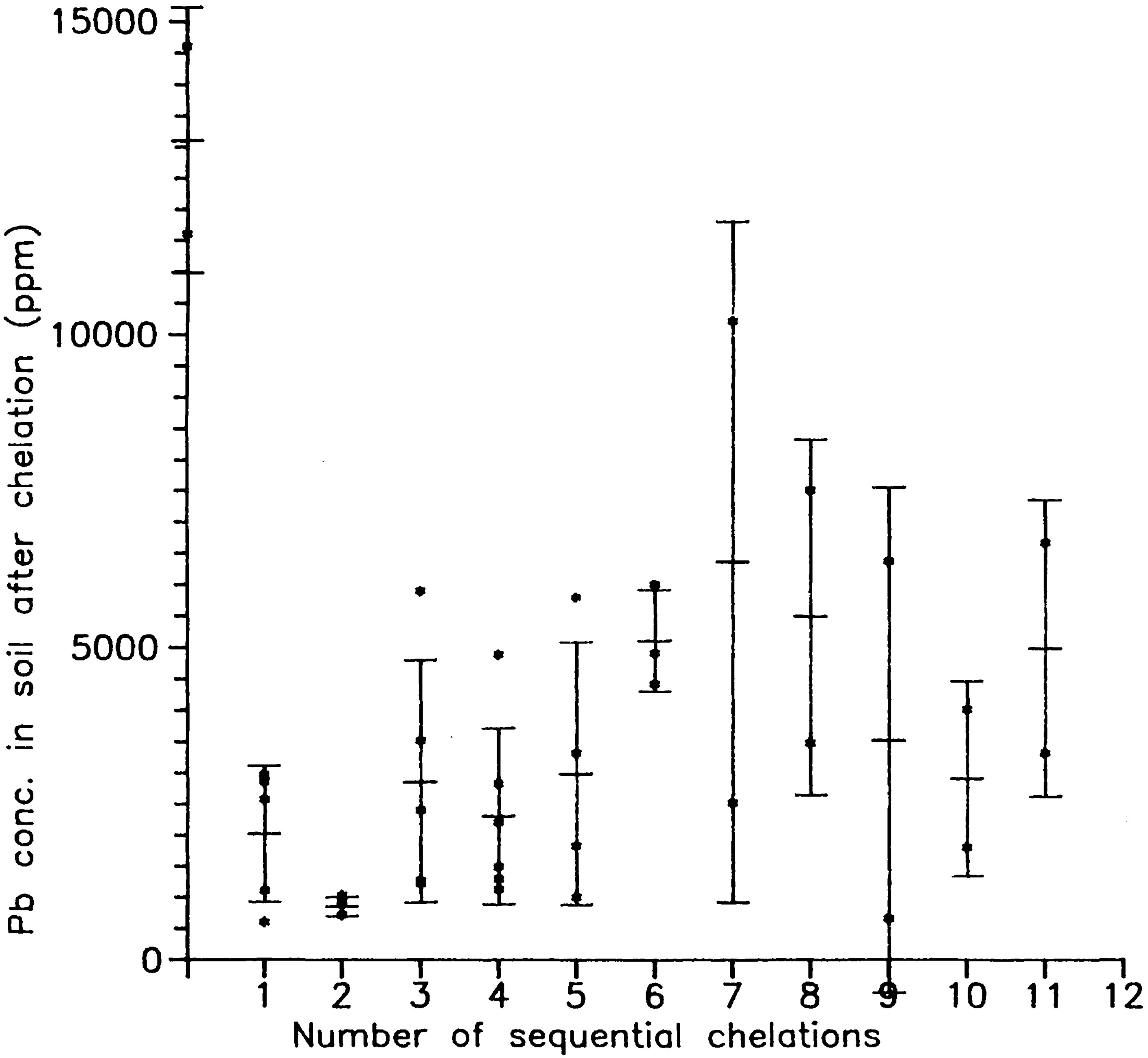
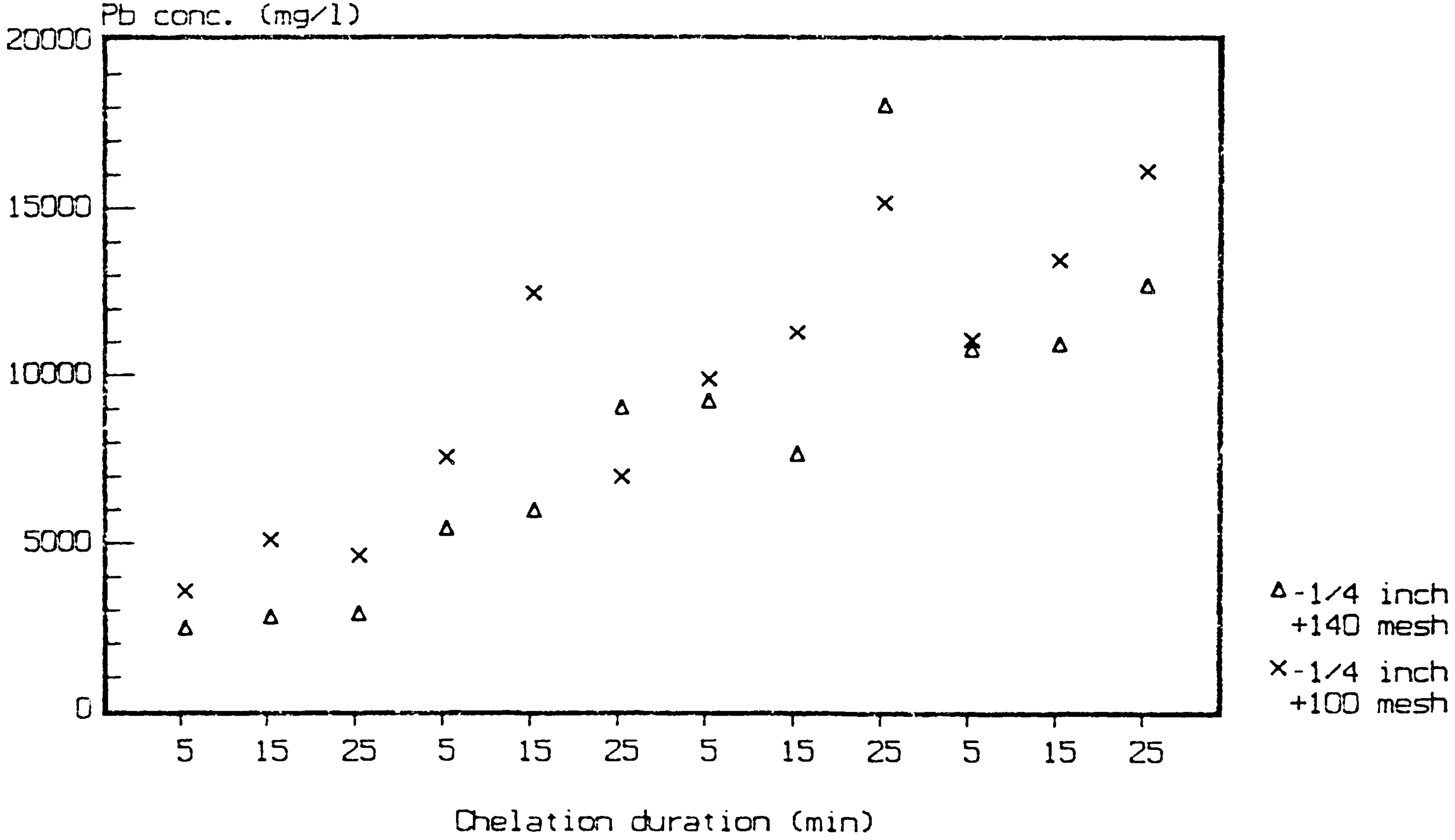


Figure 17
Chelation solution lead uptake for sand
fraction classified with different
mesh screens



SPRAY WASH OF OVERSIZED (+0.25 in) MATERIAL

Introduction

The purpose of these tests was to explore the possibility of delisting the +0.25 inch oversized material (rocks and broken battery casings) by an effective and economical rinsing and/or washing technique to remove the contaminated soil (lead content) from these pieces.

Procedure

Approximately 3,000 g of whole Lee Farm soil were placed in a 5 gal hopper containing a 0.25 inch stainless steel screen. The soil was spoon agitated and rinsed with DI water spray at 25 psi. Several water:soil ratios were tested: 1.75:1, 3:1 and 3.5:1. No chelation agents were present in the rinse water. EP Tox analysis for lead was performed on the rock and battery casings samples after the rinsing.

Another set of experiments was performed to determine if a rinse/wash/rinse technique could effectively remove soil. Approximately 3,000 g of weighed whole Lee Farm soil was placed in this hopper, spoon agitated, and rinsed with 25 psi DI water at a water:soil ratio of 3.5:1. After rinsing 200-g samples of rock and casings were washed with 800 ml of agitated DI water in a 2000-ml beaker for a varied duration: 0, 3, 15, 30, and 45 minutes. After washing and decanting water, the rocks and casings were rinsed with 800 ml of DI water spray. After treatment, the rock and casing samples were subjected to EP Tox analysis for lead.

Results

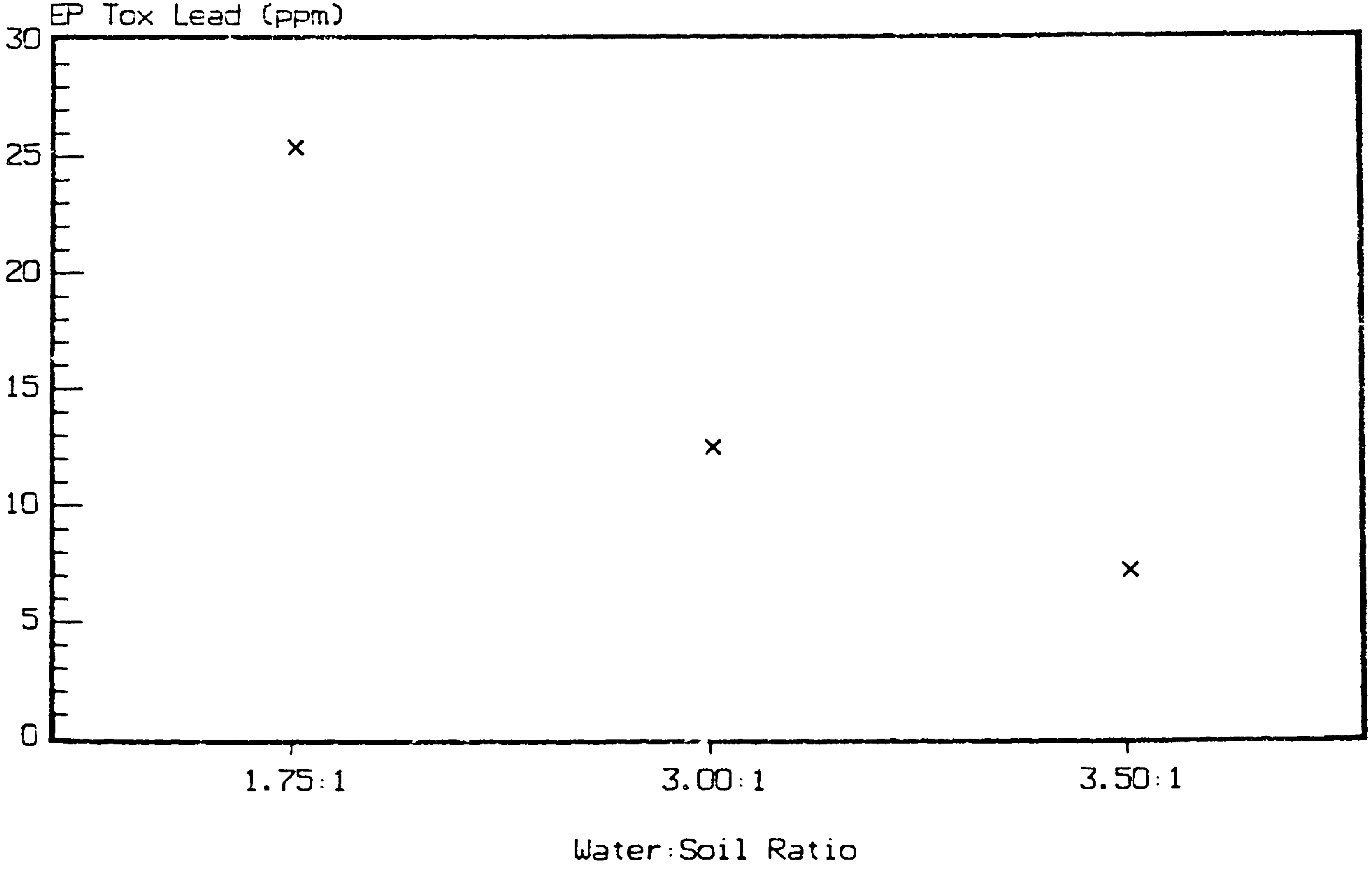
Figure 18 shows that washing the +0.25-inch material will not produce a material which passes EP Tox. However, the results are encouraging. As the amount of water used to spray the soil increased, the EP Tox for lead decreased. Even though no samples met the 5 ppm upper limit allowed for lead, the trend appeared promising.

For the rinse/wash/rinse experiments (Table 7), there was no correlation between EP Tox lead concentration and the duration of washing. Only one sample passed EP Tox for lead. The large differences in the surface characteristics and dimensions among the +0.25-inch rock and battery casing pieces may cause soil to adhere more strongly to some pieces than others. Gentle washing did little to dislodge the embedded contaminated soil. A more aggressive washing or spray technique will nave to be tried.

TABLE 7. PLUS 0.25 INCH ROCK & CASING RINSE AND WASH

Lead extraction process analysis				Exerimental parameters	
Sample	Sample #	EP tox Pb (ppm)	1ST spray wash	Water bath soak (min)	2nd spray wash
ROCK & CASING (+1/4")	185	14.2	YES	0	NO
ROCK & CASING (+1/4")	186	20.0	"	0	NO
ROCK & CASING (+1/4")	187	47.9	"	3	YES
ROCK & CASING (+1/4")	188	0.5	"	3	YES
ROCK & CASING (+1/4")	189	7.5	"	15	YES
ROCK & CASING (+1/4")	190	10.4	"	15	YES
ROCK & CASING (+1/4")	191	6.3	"	30	YES
ROCK & CASING (+1/4")	192	9.5	"	30	YES
ROCK & CASING (+1/4")	193	14.4	"	45	YES
ROCK & CASING (+1/4")	194	6.6	"	45	YES

Figure 18
The effect of spray water volume on the
EP Tox Pb concentration
Oversized (+1/4 in) material



DISCUSSION

Soil classification is an important component of the modified Lee Farm process. It will eliminate much of the solid/liquid separation problems PEI Associates experienced at Woodville, Wisconsin and EI experienced during chelation experiments with unclassified soil. A bench-scale hydroclassification technique -- wet screening with flotation -- that generated reproducible classified soil was developed. The reproducibility of results in the soil classification process was extremely important to the final precision of the experimental data. An interesting discovery during classification was that most classified sand fraction samples passed EP Tox lead analysis even though they contained high total lead concentration. This development warrants further investigation to determine if this fraction can consistently meet EP Tox and if a water balance may determine feasibility.

Tests show that Lee Farm soil varies widely in composition. PEI Associates reported that a composite soil sample contained 4.5-5% silt fraction. They believed that this sample was representative of the site. The initial sample (lot 1) and second sample (lot 2) received from Lee Farm by EI contained 25% and 10% fines, respectively. If soil from a single site can vary, soil from other sites may vary even more. If the treatment process is to be transportable, any new technology must be designed to handle a wide variation in soil composition. Consideration should be given to obtaining soil samples from other sites for evaluation.

Oversized materials (greater than 0.25-inch), containing mostly rocks and broken battery casings, comprised approximately 25% of the Lee Farm soil. Even though spray washing attempts were not successful in reducing the fraction's EP Tox lead below 5 ppm, results were encouraging. Since this fraction comprises such a large portion of the Lee Farm soil, efforts should be devoted to non-chemical decontamination. One possible option would be high pressure (+100 psi) spray wash.

Lead analysis of the soil distribution shows that most of the lead is associated with the finer particle sizes. This may have been a cause of PEI Associates' failure to decontaminate the fraction. Again, this demonstrates the necessity of soil classification to separate the silt fraction for separate treatment.

EDTA chelation treatment of the sand fraction reduced total lead concentration to approximately 700 ppm - a 95% reduction. These results agreed with separate experiments performed by the U.S. Bureau of Mines and other researchers (3, 7, 8, 9). EP Tox was lowered below the required 5 ppm lead level in the tests' leachate. Results present the question of what end product is desired - a total soil lead maximum ceiling or EP Tox requirement.

The results obtained thus far present questions as to what is being achieved and what end product is desired. It has been demonstrated that, after classification and very thorough washing, the sand fraction will pass the EP Tox test for lead. However, the material has a total lead content of approximately 2,000 ppm. When this material is thoroughly reacted with EDTA chelating solution, and provided it is very thoroughly washed, it will pass the EP Tox test for lead, but has a total lead content of 700 to 1,000 ppm. Therefore, it is necessary to define the desired objective. If the objective is to achieve a maximum lead content, the maximum lead content needs to be defined. If the objective is to meet the EP Tox test, it may be possible to treat the heavy material by classification and thorough washing.

Laboratory experiments indicate that the EDTA polish rinse, proposed at the Lee Farm site, is detrimental to soil treatment. The EDTA polish rinse increases the EP Tox lead values of the final soil and does not reduce residual total lead values. Thorough water washing of the chelated soil is critical to successfully passing the EP Tox test. All mobile lead - EDTA species must be removed. Material balance calculations indicate that the water balance may determine whether or not the process is practical. The ability to achieve a high degree of dewatering between rinsing stages appears to be critical; therefore, tests are planned to determine the degree of dewatering of the sand fraction that can be obtained with a screw, the degree of dewatering of the silt fraction that can be obtained with a centrifuge, and the degree of dewatering of the whole soil (with a filter aid) that can be obtained with a filter press.

Preliminary calculations indicate that, if the fresh make-up rinse water is added to the last rinse stage, and if the rinse water make-up is moved progressively from the fourth to the third to the second and the first, the rinse water in the first stage will contain more than 2% unchelated EDTA. (Some of the assumptions used in these calculations require confirmation.) The purpose of the calculations is to point out that four rinse stages may not be sufficient.

Experiments to determine reactions (chelation kinetics) necessary for chelation reactor design and soil chelation retention time were inconclusive. The variations of results in a small data pool warrants prudent interpretation of results.

A series of tests designed to determine the optimum lead and free EDTA contents to be maintained in the chelation reactor were inconclusive. Even after eleven successive chelations with fresh soil, the lead content of the chelation solution was less than 3%. Additional tests are required to determine the rate of chelated, "spent" EDTA solution removal from the reactor and the rate of unchelated, "fresh" EDTA addition. These chemical equilibrium considerations will allow the design of a system that utilize the chelation power of EDTA to its fullest potential.

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2. Report obtained from files of PEI Associates
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4. Personal observation by EI staff of grain auger with holes out into sides to remove entrained water.
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9. Cole, Jr., E.R., Lee, A.Y., and Paulson, D.L. Update on Recovering Lead from Scrap Batteries. Journal of Metals, February, 1985.

SECTION VII

VENDOR TESTING

Some of the exploratory tests performed to date have involved outside vendors. In addition, other firms have been contacted to discuss the feasibility of certain unit processes. This section summarizes these vendor tests and discussions.

Vendors

1. Joy Denver Equipment
   621 South Sierra Madre
   P.O. Box 340
   Colorado Springs, CO 80901

The initial contact with Joy Denver Equipment (JDE) was to arrange for a test to obtain parameters for the design of a classifier. Initially, JDE agreed to perform these tests, and quoted a price for doing so, but later declined to perform these tests. JDE did, however, classify soil from the site, and performed some additional tests. These results showed that 21.6% of the original soil sample received by EI is smaller than 325 mesh and that 70% of the lead in the total soil sample is contained in this portion.

2. Centrico, Inc.
   Northvale, NJ

A sample of fines (smaller than 150 mesh) obtained by wet screening of soil from the site was taken to Centrico where it was fed to a laboratory centrifuge. The test showed that the fines can be dewatered fairly well by centrifugation. The laboratory centrifuge produced two dewatered solid fractions, one of which contained 68% solids, the other 44% solids. A commercial centrifuge will produce one solid fraction of approximately 55% solids. The filtrate contained approximately 0.3% (vol.) solids, which is acceptable.

3. Dow Chemical U.S.A.
   Midland, MI 48674

Dow supplied a copy of Patent Number 3,033,214, Recovery and Reuse of Complexing Agents from spent solution, which describes the recovery of lead from a chelating agent using sodium sulfide or hydrogen sulfide. The combined result of adding the sulfide to an alkaline solution and the competition between the complexing agent and the sulfide ion can cause high concentrations of sulfide ion in solution. This excess sulfide must be removed by acidification after the lead sulfide is precipitated. This causes the evolution of toxic hydrogen sulfide gas, which must then be disposed of in an acceptable manner.

4. Dorr-Oliver
   Stamford, CN

Development of the revised process scheme considered the use of hydroclones for dewatering the 0.5 in x 250 mesh material. Data describing the slurry that could be expected as charge to Dorrclones for dewatering were supplied to Dorr-Oliver, who recommended that sufficient water be removed so that the slurry contains 20% solids (not possible without major design modification). Furthermore, Dorr-Oliver recommended that the underflow consist of 35% solids (unacceptable to the success of the process). As a result, use of hydroclones was abandoned.

5. Scada Systems, Inc.
   Resdale, Ontario

Scada Systems is a small company that produces system, primarily electrolysis units, for recovery of metals and wastewater treating. Scada Systems has stated a willingness to develop a system for the recovery of lead and EDTA.

6. Lancy International, Inc.
   525 West New Castle Street
   P.O. Box 490
   Zelienople, PA 16063

Lancy Systems, a subsidiary of Alcoa, specializes in the electrolytic recovery of metals, but also manufactures adsorption systems. Lancy provided a tentative schematic design of a system for lead and EDTA recovery and wastewater treating.

COMMENTS AND CONCLUSIONS

PEI Associates reported approximately 5% fines and silts in the soil sample that they tested. The first soil sample received by EI contained approximately 26% fines and silts, while the second soil sample, presumably from the same soil pile, contained approximately 13% fines and silt. Obviously, the size distribution was variable, and must be considered in the design of a treatment system.

Soil dewatering between treatment stages will be critical. With insufficient dewatering, the water balance will be unacceptable. Dewatering to 55% solids is bordering on being unacceptably low. A solid containing 35% solids is unacceptable. Unless additional data show that a much higher solids content can be attained, use of hydroclones is no longer being considered.

The available data in the area of lead and EDTA recovery and wastewater treating is miniscule. A great deal of investigation will be required to develop reliable systems to accomplish these tasks safely.

SECTION VIII

RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

Laboratory tests performed to date have concentrated on characterizing and classifying the soil, and chelating and rinsing the heavy portion of the soil. The chelation testing has focused on determining the optimum reaction time and the optimum concentration of chelated lead in the solution withdrawn to recovery. These experiments have not been completed.

Following completion of the tests on the heavy portion of the soil, there are several additional tests to be performed:

1. Preliminary results have suggested that, with sufficient washing and adequate classification, the heavy portion of the soil (greater than 150 mesh) with the slow-settling fines floated off will pass the EP Tox test without further treatment. Additional laboratory tests are needed to confirm this.

2. There is a trade-off between the number of rinse stages provided and the volume of rinse water required. Laboratory experiments designed to determine the optimum number of rinse stages, and the overall water balance and design flow rate of lead to recovery and wastewater to wastewater treatment are necessary.

3. Tests designed to define the degree of dewatering obtainable with a dewatering screw are planned using a small screw. Additionally, wash efficiency of the screw will be tested. These tests, combined with laboratory tests, are needed to determine the number of rinse steps and the amount of rinse water required for the heavy fraction.

4. The rinsing and dewatering of the fines must be investigated similarly to the tests planned for the heavier material as described above. These tests will be somewhat different from the tests on the heavier material due to the difficulty in dewatering the fines. The tests will be done with a laboratory centrifuge to provide the required dewatering between stages.

5. Laboratory results with the first sample received by EI, which contained approximately 22% fines passing 325 mesh, indicated that the majority of the lead in the soil (about 70%) is associated with the fines, silts and clays (smaller than 150 mesh). One test showed that centrifuging will produce a material containing approximately 55 wt. % solids. Additional tests are planned to determine the degree that the lead can be removed from the fines by chelation, and to
   mine if the chelation will produce a material that will pass the
   Tox test.

6. An experimental program will be performed by a vendor to produce a firm design and cost for a lead and EDTA recovery system and a wastewater treating system. Two vendors are being considered. The effort will be monitored and directed as necessary by EI.

7. Treatment of the fines will most likely be very expensive, and may not be feasible. Consideration is being given to solidification using gravel and Portland cement. If this investigation is pursued, the solidification tests can be performed by EI, or an appropriate vendor. Solidification will introduce the problem of determining appropriate test procedures to evaluate the toxicity of the solidified material. Materials other than Portland cement (such as Fujibeton) may be investigated. The solidification procedure and the amount and type of other material that must be added to achieve a suitably solidified material will be important because the volume of solidified material could become too great for reasonable disposal.

8. As an alternate to separation of the fines, silts, and clays from the remaining material before treatment, a suggestion has been made that the total soil be treated in a single train. Laboratory and field tests have demonstrated that the total soil cannot be dewatered successfully as is. Using diatomaceous earth as a filter aid in an attempt to make the material filterable may increase the filterability of the material, but also poses several additional problems:

    a. The filter aid will increase the volume of solid material by 5-20%, depending on the amount required.

    b. Diatomaceous earth is very porous and lead chelate and fines containing lead may be adsorbed. If so, it will be very difficult or impossible to remove the lead.

    c. Diatomaceous earth is very fine and light. When dry, it creates a very difficult dusting problem, and it dries readily. The material could create disposal difficulties, particularly if it is contaminated with lead.

    d. Using a filter aid is permits treating the material in one treating train rather than two, with the use of filters to dewater the soil between rinses. Assuming the unit is to be transportable, rotary vacuum filters and rotary vacuum precoat filters appear to be impractical. Plate and frame pressure filters may be used in this service, but they are very labor intensive. The classification of the soil charge and use of two treatment trains requires that the heavy portion be sized to 0.5 in by 0 in. Use of a filter aid and filters requires that the size of the larger particles be reduced to a size less than 0.5 in.

    e. If initial tests show that the soil can be made filterable by the addition of filter aid, additional tests will be performed to obtain the operating parameters for treating the whole soil. Whether this proves to be less expensive than a two-train system will probably depend on the achievable filter rate and on the degree of dewatering obtained.

f. Tests are planned to determine if the addition of diatomaceous earth and a single treating train is practical, and to prepare an estimate of the cost of this treating procedure.

9. Vigorous agitation is required to provide efficient reaction and rinsing. An investigation into agitator design and the effect of the degree of agitation on reaction efficiency is planned. Before purchasing equipment, experiments will be performed at vendor facilities to firm up mixer designs.

10. Additional centrifuge testing is planned at vendor facilities to firm up the model selection made for the initial estimate. Tests will also confirm guaranteed the unit's dewatering capabilities.

11. As an alternate to centrifuges, belt presses may be selected due to lower horsepower requirements. Vendor test facilities are available and may be used to determine unit capabilities, sizing, and unit cost for belt presses.

12. Testing is planned to verify the design for the wet trommel screen. Experiments are planned at the vendor's facilities to determine screen deck sizing and water usage rates.

As more tests are completed, the information may indicate that additional testing, not apparent now, will be required.

SECTION IX

ESTIMATED COSTS

The cost for electrolytic lead recovery from EDTA is a significant factor in determining overall plant cost. Unfortunately, we do not have reliable cost data from vendors at this time for this part of the plant. The rate of lead recovery from the soil fractions will determine how the cost for electrolytic recovery is apportioned to the two lead extraction sections of the plant.

UNIT	EQUIPMENT COST	BULK MATERIAL & INSTALLATION	TOTAL COST
Soil Preparation	1,080,000	135,000	1,215,000
Soil Extraction & Rinsing	410,000	165,000	575,000
Fines Extraction & Rinsing	1,260,000	220,000	1,480,000
Site Development	--	80,000	80,000
TOTAL	2,750,000	600,000	3,350,000
Contingency (20%)			670,000
TOTAL			4,020,000

This estimate includes: portable equipment; one water well; site leveling and gravelling, but no foundations; area lighting; rented trailer for office; rented flatbed for tanks; local motor starters and power wiring, but no electrical transformers or switchgear; local instrumentation, but no panel or wiring back to a panel; piping based on FRP specification. Details are available in Appendix D.

The estimate excludes all engineering and procurement costs, spare parts, chemicals, taxes, cost of land, any licenses, permits, wastewater treatment, the EDTA/Lead Removal System and escalation beyond the current date.

Additionally, the plant equipment cost breakdown for the EDTA/Lead Removal System (EMR's) is as follows (based on 12% fines in soil):

A.	Soil Extraction and Rinsing	$4,000,000
B.	Fines Extraction and Rinsing	2,000,000
	Total	$6,000,000

This estimate does not include equipment costings for the Wastewater Treatment System.

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Total	$6,000,000

This estimate does not include equipment costings for the Wastewater Treatment System.

APPENDIX A

EVALUATION OF ON-SITE EQUIPMENT

1. Portable conveyor with Feed Hopper

a. Service Intended:

Transport of soil from on-site storage pile to the Feed Preparation System.

b. Service Evaluated For:

Transport of soil from on-site storage pile to the Feed Preparation System.

c. Comments

The above Finlay 40/30 Portable Hydrascreen unit was rented as an integrated hopper/conveyor/screen system. It is complete with a 6 cu yd hopper with grizzly of carbon steel construction, a 30" wide by 39'-5" long belt conveyor, and 6'-0 x 4"-0 flat deck vibratory screen (screen evaluated in Section 2).

The hopper provides 6 cu yd of surge capacity, sufficient for most front end loader buckets feeding it. Carbon steel construction is suitable for the non-EDTA contact environment for which it was and is intended. A 4" bar grizzly is provided to separate unprocessable oversized rock and root masses in the soil.

The belt conveyor, which supports the screen, is a truss frame, 30" wide by 39'-5" long belt conveyor. This variable speed unit has a maximum speed of 230 feet per minute, which will provide a capacity higher than the required 20 tons per hour, if desired. The horsepower requirements for a belt conveyor are the lowest for suitable conveyoring devices, and conveyor availability factors approach 98%.

d. Conclusion

The above unit, or a similar rental unit, is suitable for use in transporting soil to the Feed Preparation System.

2. Vibrating Screen

a. Service Intended:

A processing step in the system to classify and size material to that suitable for processing.

b. Service Evaluated For:

A processing step in the system to classify and size material to that suitable for processing.

c. Comments

The vibrating screen is a 6'-0 by 4'-0 rectangular flat deck screen. This unit was rented as part of an integrated hopper/conveyor/screen system (hopper and conveyor evaluated in Section 2). The capacity of the screen portion of the Finlay 40/30 Portable Hydrascreen in this service is unknown in the configuration previously used, and is variable depending on the screen deck. With a bar or wedge-wire type screen deck installed and modified with the addition of water sprays the capacity should approach or exceed the required 20 ton per hour capacity. The carbon steel frame construction used in the previous configuration is suitable for the non-EDTA contract environment for which it was intended and evaluated. Power consumption is relatively low compared to other classification devices.

In the previous configuration, screening was attempted without water sprays (dry screening). With a punched-plate type screen, deck blinding was experienced due to agglomerated wet dirt and clay. When the plate decks were replaced by piano-wire type screen decks, breakage occurred due to impingement of heavy rocks and tramp metal. A bar or wedge-wire screen deck should be used to provide protection from blinding, with additional water sprays installed to wash agglomerates through the deck openings. Additional protection from breakage by impinging tramp metal may be provided by an installed magnetic separator.

d. Conclusions

The Finlay screen, with modification, would be suitable to provide a processing step to classify and size material to that suitable for processing. The revised treating system, however, utilizes a wet trommel to provide a wash and classifying step, and eliminates the need for the Finlay screen. It is therefore recommended the Finlay screen not be utilized in the revised system.

3. Impact Crusher

a. Service Intended:

To reduce the size of material passing over a two inch screen to that small enough to pass through the screen.

b. Service Evaluated For:

To reduce the size of material passing over a on-half inch screen to that small enough to pass through the screen.

c. Comments

The crusher used in the previous system is a Hazemag APK-30 impact crusher. The capacity of the unit in the previous configuration is unknown, however, in aggregate or coal crushing it will process up to 44 tons per hour, requiring a maximum 75 horsepower drive. Standard constuction is carbon steel with cast manganese hammers.

The required capacity for a crusher in the plant is approximately 5 tons per hour. Therefore, the Hazemag APK-30 crusher should have more than adequate capacity for the plant. In fact, it may be more cost effective to utilize a smaller unit to reduce utility costs.

The plant-required topsize of 0.5 inch is readily achievable with an impact crusher. Therefore, the type of crusher utilized is suitable for the application.

The materials of construction are suitable for crushing more abrasive material, and the unit would be operated in a non-EDTA environment. Therefore the materials of construction are suitable for the application.

Problems were encountered, however, when damp soil and clay tended to foil the crusher, requiring shut-down and manual cleanout. This problem may be minimized by the installation of water sprays to clear material from the rotor. Also, the trommel screw proposed for the revised plant will minimize the feed of damp soil and clay to the crusher, thus minimizing the fouling problem.

d. Conclusions

The Hazemag APK-30 Impact Crusher has sufficient capacity, will deliver the correct product topsize, and is of the proper material of construction for use in a revised plant.

Consideration should be given, however, to utilizing a suitable lower capacity/horsepower unit to save on utility costs. Also, water sprays should be installed to prevent fouling of the rotor by material build-up.

4. Transfer Conveyor

   a. Service Intended:

      Transport of soil to EDTA Treatment

   b. Service Evaluated For:

      Transport of soil to EDTA Treatment

   c. Comments

      The unit rented is a Hartman-Fabro 40'-0 long belt conveyor. The belt width is unknown, but even at the industrial standard minimum width of 18" should be of sufficient size to provide at least 20 ton per hour capacity. For the non-EDTA contact environment, standard conveyor construction is acceptable. Power requirements for a belt conveyor are low compared to other conveying devices, and availability factors approach 98%.

   d. Conclusions

      The unit rented, or a similar unit, is suitable for use in the revised system.

5. Washer - Dewatering Screen

   a. Service Intended:

      React soil/solids with EDTA solution, then discharge dewatered solids to a polish tank system.

   b. Service Evaluated For:

      React soil/solids with EDTA solution, then discharge dewatered solids to rinse dewatering screws.

c. Comments

The Washer-Dewatering Screw used is a 30-inch diameter, 25-foot long dewatering screw manufactured by Eagle Iron Works. It is equipped with a 15 horsepower, 26 rpm normal speed drive. In sand dewatering service it will retain normal 200 mesh material with a feedrate of 330 gallons per minute and 200 tons per hour solids. The unit is constructed of carbon steel. In service dewatering soil, it is anticipated by the manufacturer to have a capacity of approximately 18-20 tons per hour, dewatering to 30-35% moisture content.

For reacting soil under normal conditions the tub of the unit will provide approximately 1 minute surge capacity. This is not sufficient residence time for complete reaction of solids and EDTA. It has been determined that vigorous agitation is also required to react soil and EDTA, and this is not provided by the unit without an external device.

Because the unit is constructed of carbon steel, it is not suitable for use in EDTA service. Due to corrosion problems it must be used in a non-EDTA environment.

d. Conclusions

Due to the insufficient residence time, marginal capacity, and inadequate materials of construction, it is not a suitable reaction device.

6. Polish Tank System

a. Service Intended:

Provide final reaction stage of soil/solids with dilute EDTA solution, then discharge dewatered solids to a rinse tank system.

b. Service Evaluated For:

Provide final reaction stage of soil/solids with dilute EDTA solution, then discharge dewatered solids to a rinse system..

c. Comments

The polish tank system consists of a square, open-top, pyramid bottom former grain bin with a 6-inch diameter former grain screw conveyor used to dewater solids. The tank is coated with a resin to retard corrosion. No mixer is installed.

It was reported by PEI Associates that the tank will leak on all seams since it was not designed for liquid service. The square shape and pyramid bottom do not provide long-term corrosion protection.

Agitation is required for further reaction of EDTA solution and soil. No mixer was provided in the previous configuration but could probably be added in a revised system.

The auger was designed to handle dry grain. In service dewatering EDTA-reacted soil it was stated in the PEI Associates 1/17/86 report that the auger wears out quickly. This confirms that the construction is unsuitable for this application.

The maximum capacity of a 6-inch screw conveyor is approximately 2 tons per hour based on 30% loading and 30 rpm. This is insufficient capacity for the application.

d. Conclusion

Because the tank leaks, does not allow sufficient agitation, and is not provided with sufficient corrosion protection, it is unsuitable for the application. Agitation is required for reaction, but is not provided. Because the auger is of improper materials of construction and of insufficent capacity, it is unsuited for the application.

All components of the system as outlined above, are unsuited for the application. Therefore, the polish tank system is unsuitable for use in a revised plant.

7. Rinse Tank System

a. Service Intended:

Provide clean water rinse of solids prior to ultimate discharge from the process system, then discharge dewatered solids from the tank.

b. Service Evaluated For:

Provide clean water rinse of solids prior to ultimate discharge from the process system, then discharge dewatered solids from the tank.

c. Comments

The rinse tank system consists of a square, open-top,pyramid bottom former grain bin with a 6-inch diameter former grain screw conveyor used to dewater solids. The tank is coated will resin to retard corrosion. In all, the system is identical to the polish tank system.

It was reported by PEI Associates that the tank will leak on all seams since it was not designed for liquid service. The slurry handled will contain residual EDTA solution; although the resin coating will retard corrosion, it will not provide adequate long-term corrosion protection.

The system is not provided with a mixing device. A mixer, however, may not be required in a rinse service.

The auger was designed to handle dry grain. In service dewatering EDTA-reacted soil it was stated in the PEI Associates 1/17/86 report that the auger wears out quickly. This confirms the construction of the auger as unsuitable for this application.

The maximum capacity of 6-inch screw conveyor is approximately 2 tons per hour based on 30% loading and 30 rpm. This is insufficient capacity for the intended serice.

d. Conclusion

Because the tank leaks and is not provided with sufficient corrosion protection, it is unsuitable for the application. Because the auger is of improper materials of construction and insufficient capacity, it is unsuitable for the application.

All components of the system, as outlined above, are unsuitable for the application. Therefore, this rinse tank system is unsuitable for use in a revised plant.

8. Electolysis System (EMR'S)

a. Service Intended:

This system was intended to remove chelated lead from solution in the EDTA recycle stream by electrolysis.

b. Service Evaluated For:

This system was intended to remove chelated lead from solution in the EDTA recycle stream by electrolysis.

c. Comments

The system consists of hand-made electrolytic cells contained in rectangular carbon steel tanks. They are connected to bus bars for power supply by clamps and power cable. The cells are constructed of lead plate, membranes, and wooden slats. The bus bars are uninsulated and have no cover for personnel portection.

No quantitative operating data are available, therefore the capacity of the system is unknown and the power draw per unit material cannot be confirmed. One portion of the system was briefly run by PEI Associates, but the run only confirmed the ability to plate lead without regard to capacity or power consumption.

The theoretical maximum of the system is approximately 5 tons per day based on a 100% utilization factor and 24-hour-per-day operation. The theoretical power requirement at the plates is 720 kilowatts at 12 volts dc.

Because the system is not provided with pumps, piping, and other associated equipment normally provided with manfactured systems, the capacity is likely much less than theoretical. Because plates must be removed and cleaned manually, the utilization factor due to plate capacity being off-line will be considerably less than 100%. An optimistic capacity for the system would be estimated by EI as approximately 2.5 tons per day.

If the plant were to operate at the design rate of 20 tons per hour with the design soil lead control of 2.3% the plant will chelate 920 lb lead per hour. With an EMR system capacity of 2.5 tons per day, the plant may be operated for approximately 5.4 hr per day. Therefore, the EMR system is of insufficient capacity for the plant.

The EMR system, as built, is judged by EI to be hazardous. In operation, there are no devices installed to prevent workers from directly contacting the bus bars or other exposed electrical hardware. The cleaning of plates required manually disconnecting the plates from the circut, lifting them from the cells, and removing plated lead with a squeegee; this is another hazardous situation.

d. Conclusions

The Electrolysis System, as built, is of insufficient capacity for the plant requirements. It is difficult to operate due to the higher labor intensiveness involved, and is hazardous due to the lack of safety devices. Therefore, it is unsuitable for use in a revised plant.

9. Bird Centrifuges

a. Intended Service:

Remove silts and clays from Washer-Dewatering screw overflow stream as a preparation step prior to removing chelated lead in the EMR system.

b. Service Evaluated For:

Dewatering of silts and clays in the fines treating systems.

c. Comments

The centrifuges that were leased consist of two (2) 18-inch diameter, 28-inch long solid bowl continuous centrifuges as manufactured by Bird Machine Company, Inc.. Each centrifuge is constructed of 316 stainless steel, the internal conveyors hard-faced with colmony #6. They are equipped with adjustable wires, gear unit to provide differential speed between bowl and conveyor, V-belt drive, self-contained lube system, hopper and chute, and 30 horsepower TEFC motor with fluid clutch.

Following discussions with the manufacturer, it is anticipated the units are capable of processing 30 gallons per minute per centrifuge. Each centrifuge would dewater clays and silts to a 35% solids content with a minimum 90% recovery.

The combined capacity of all two units is approximately adequate to provide one dewatering stage in the fines treating system. The dewatering performance, however, is not sufficient for use in a revised system requiring 55% solids content.

The materials of construction provide sufficient corrosion protection in an EDTA environment, and the hard-facing on the conveyor will provide sufficient protection from erosion. The construction of the units is suitable for the application.

d. Conclusion

The construction of the units is suitable for the application in dewatering fines silts and clays from EDTA solution; however, the dewatering performance of each unit is inadequate for the evaluated service. Therefore, the units are not suitable for the application, and higher performance centrifuges should be used in a revised system.

10. C-M-I Centrifuge

a. Service Intended:

Provided secondary dewatering of soil discharged by the Washer-Dewatering Screw.

b. Service Evaluated For:

Dewatering of soil in both an EDTA and non-EDTA environment.

c. Comments

A C-M-I Fine Coal Centrifuge was quoted to PEI Associates for use in the previously configured plant, but was since purchased or leased (per Mr. Harry Derton, V.P. C-M-I, Inc.) for use at the site.

The centrifuge quoted was a C-M-I model EBWB-36 continuous centrifuge dryer. This basket centrifuge was quoted on 304 stainless steel construction, with a 60 mesh grizzly bar screen surface, and a 50 horsepower V-belt drive. The unit also included a 1/4 horsepower pressurized lubrication system, and would include all necessary support structure. For dewatering soil a 200 mesh screen could be substituted and would be necessary to retain the anticipated size soil.

According to the manufacturer, the unit is designed to dewater granular, free-draining material. In such an application it will dewater 200 mesh material to approximately 11% moisture with 30% recovery based on 50% moisture feed. The nominal capacity of the unit is 25 tons per hour based on 28 mesh by 150 mesh coal dewatered from 50% to 14.5% moisture, with 82-85% recovery. C-M-I has never run soil through a unit of this type, and therefore, could not estimate dewatering performance. Soil dewatering performance, however, was estimated to be considerably lower. The 304 stainless steel construction will provide adequate corrosion protection from EDTA solution. Therefore, the materials of construction are suitable for the application.

d. Conclusion

The C-M-I Fine Coal Centrifuge, with changes, may be capable of dewatering soil to some unknown moisture content and with an unknown recovery performances. The construction, however, is suitable for use in both an EDTA and non-EDTA service.

The proposed revised plant, however, utilizes dewatering screws provide a rinse of reacted soil, and deliver a dewatered product to the following process stage. Therefore, the G-M-I Fine Coal Centrifuge would be unnecessary in the revised plant.

TABLE B-1. SOIL AND CLASSIFICATION WATER

Sample	Lead extraction process analysis												Experimental parameters				Comments
	Sample #	Moisture (%)	Total metals (ppm ; mg/l) Pb	Fe	Ca	Mg	Ni	Zn	Cd	Cu	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	
LEE FARM SOIL (UNSCREENED)	001	12.5	48,800 45,100*	25,100 22,700*	8960 8270*	3710 3490*	18.5 19.6	141 108*	7.9 6.5*	102.0 61.1*	63.5 68.7*	—	—	—	—	—	
LEE FARM SOIL (UNSCREENED)	002	12.1	30,200 89,700*	13,500 12,500*	5,410 5,520	5410 3450*	25.9 23.2	98.4 120.0*	2.9 2.9*	54.1 64.8*	65.5	—	—	—	—	—	
SCREENED ROCKS/PLASTIC (+1/4")	003	2.6	—	—	—	—	—	—	—	—	25.3	—	—	—	—	—	WET SCREENING RINSE WATER : SOIL RATIO IS 1.75 : 1
UNFILTERED SUPERNATANT BEFORE 1ST DECANT (a)	004	99.65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
FILTERED SUPERNATANT BEFORE 1ST DECANT (a)	005	99.914	1.2	(0.04	55.9	10.9	(0.05	0.09	0.03	0.04	—	—	—	—	—	—	FILTER WITH WHATMAN #42 FILTER PAPER
HEAVY FRACTION AFTER 1ST DECANT	006	—	10,600	13,500	52,700	1,800	15.60	31.7	1.71	32.2	—	—	—	—	—	—	
SUSPENDED FINES FRACTION BEFORE 2ND DECANT	007	91.73	—	—	—	—	—	—	—	—	—	—	—	—	—	—	AFTER 10 MINUTES SETTLING TIME
SUSPENDED FINES FRACTION BEFORE 2ND DECANT	008	99.11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	AFTER 20 MINUTES SETTLING TIME
SUSPENDED FINES FRACTION BEFORE 2ND DECANT	009	98.33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	AFTER 30 MINUTES SETTLING TIME
UNFILTERED SUPERNATANT BEFORE 2ND DECANT (a)	010	99.66	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
FILTERED SUPERNATANT BEFORE 2ND DECANT (a)	011	99.87	3.4	0.05	42.3	7.2	(0.05	0.04	(0.01	0.03	—	—	—	—	—	—	
HEAVY FRACTION AFTER 2ND DECANT	012	—	4,810	12,700	4,740	2,060	11.9	32.3	2.1	18.7	—	—	—	—	—	—	FILTERED WITH WHATMAN #42 FILTER PAPER RE
FILTERED SUPERNATANT AFTER 2ND DECANT (a)	013	—	0.6	(0.04	43.9	7.9	(0.05	0.02	(0.01	0.06	—	—	—	—	—	—	SAMPLE SAT OVERNIGHT
HEAVY FRACTION AFTER 2ND DECANT	014	—	28,094	14,147	8,756	3,652	17.6	55.5	12.5	37.4	—	—	—	—	—	—	SAMPLE SAT OVERNIGHT, SAMPLE CONTAIN MORE FINES THAN OIL DUE TO OVERNIGHT SETTLING

* Duplicate analysis by chemist

(a) Supernatant is "clear" top level of water after settling

TABLE B-1 (continued)

TABLE B-1. SOIL AND CLASSIFICATION WATER

Sample	Lead extraction process analysis													Experimental parameters				Comments
			Total metals (ppm ; mg/l)															
	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	Ni	Zn	Cd	Cu	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses		
UNFILTERED SUPERNATANT BEFORE 3RD DECANT	015	99.962	6.2	3.1	31.0	7.4	(0.09	(0.02	(0.02	0.04	—	—	—	—	—	—		
SUSPENDED FINES FRACTION BEFORE 3RD DECANT	016	86.57	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
FILTERED SUPERNATANT BEFORE 3RD DECANT	017	99.934	1.6	0.1	41.4	6.0	(0.09	(0.02	0.02	0.04	—	—	—	—	—	—		

* Duplicate analysis by chemist

(a) Supernatant is "clear" top level of water after settling

TABLE B-2. SOIL PARTICLE SIZE DISTRIBUTION

Analytical Technique					Whole Soil						1/4" Dry Screened Soil								Screened classififed heavy fraction	
Wet screening			Coulter counter		Wet screen (a,b)		Wet screen (c)		Coulter counter c		Wet screen (b)		Coulter counter b		Wet screen (c)		Coulter Counter c		Wet Screen	Coult Count
in	mm	U.S. nos.	mm	channel	Btwn screen %	cum %	Btwn screen %	cum %	Btwn channel %	cum %	Btwn screen %	cum %	Btwn channel %	cum %	Btwn screen %	cum %	Btwn channel %	cum %	Btwn screen %	Btwn channel %
0.250	+6.35	1/4"			19.0	100					7.9	100.3								
0.187	4.76	4			3.1	81	50.9	99.8			3.7	92.4			5.4	100.0			7.3	
0.094	2.38	8			8.2	77.9	8.8	48.9			10.2	88.7			30.3	94.6			14.1	
0.047	1.19	16			9.8	69.7	6.8	40.1			9.8	78.5			28.2	64.3			15.9	
0.023	0.59	30			8.0	59.9	6.1	33.3			9.1	68.7			15.3	36.1			15.5	
0.012	0.297	50			9.6	51.9	6.6	27.2			9.6	59.6			6.3	20.8			16.8	
0.006	0.149	100			14.0	42.3	8.7	20.6			15.6	50.0			5.8	14.5			24.7	
0.004	0.105	140			2.8	28.3	1.7	11.9			3.0	34.4			2.4	8.7			4.2	
0.003	0.074	200			1.8	25.5	1.6	10.2			2.0	31.4			1.6	6.3			0.6	
0.002	0.053	270			1.6	23.7	1.0	8.6			2.2	29.4			0.6	4.7			0.2	
0.002	0.044	325			0.5	22.1	1.3	7.6			1.3	27.2			0.7	4.1			0.1	
-0.002	-0.044	-325			21.6	21.6	6.3	6.3			25.9	25.9			3.4	3.4			0.3	
			0.081	25					0.042	0.40			0.0	0.0			0.0	0.0		0.0
			0.064	24					0.04	0.4			0.2	0.2			0.0	0.0		0.1
			0.051	23					0.24	0.7			0.9	1.1			0.0	0.0		0.8
			0.040	22					4.9	5.6			3.2	4.3			3.2	3.2		11.0
			0.032	21					7.4	13.0			6.9	11.2			10.8	14.1		19.1
			0.025	20					9.0	22.0			9.3	20.5			12.4	26.6		18.5
			0.020	19					8.6	30.6			10.1	30.6			11.7	38.2		16.1
			0.016	18					7.6	38.2			8.8	39.5			9.0	47.3		11.5
			0.013	17					6.8	45.1			8.8	48.3			6.8	54.0		7.3
			0.010	16					5.8	50.8			7.4	55.8			5.2	59.3		4.2
			0.008	15					4.9	55.7			6.5	62.3			4.0	63.2		2.3
			0.006	14					3.7	59.4			4.7	67.1			3.0	66.2		1.3
			0.005	13					4.4	63.9			5.7	72.8			3.9	70.1		2.0
			0.004	12					4.6	68.5			6.1	78.9			8.3	78.4		0.9
			0.003	11					9.0	77.5			4.8	83.7			4.9	83.2		1.0
			0.0025	10					6.8	84.3			3.7	87.4			3.8	87.1		0.7
			0.0020	9					5.1	89.5			2.9	90.3			3.2	90.3		0.7
			0.0016	8					3.9	93.4			2.4	92.7			2.6	92.8		0.6
			0.0013	7					4.0	97.4			2.6	95.3			2.9	95.7		0.7
			0.0010	6					2.6	100.0			2.1	97.4			2.1	97.9		0.6
			0.0008	5					0.0	100.0			2.5	100.0			2.1	100.0		0.7
			0.0006	4					0.0	100.0			0.0	100.0			0.0	100.0		0.0

a This sample analyzed by Eagle Iron Works, Des Moines, Iowa.
All other samples analyzed by Foster Wheeler R&D, Livingston, NJ

b First lot of soil sent from Lee Farm

c Second lot of soil sent from Lee Farm

TABLE B-3. METAL CONCENTRATION BY SOIL SIZE DISTRIBUTION

Soil particle		Size	Eagle Iron Works Screening				Foster - Wheeler Screening			
in	mm	(" = inches NO. = mesh size)	Pb (ppm)	Fe (ppm)	Ca (ppm)	Mg (ppm)	Pb (ppm)	Fe (ppm)	Ca (ppm)	Mg (ppm)
		-1/4" + No. 4	184	1180	444	161	753	14200	2810	2930
0.250 to 0.187	6.35 to 4.76	- No. 4 + No. 8	13400	13700	8620	1130	3960	6620	46600	1840
0.187 to 0.094	4.76 to 2.38	- No. 8 + No. 16	2360	8110	2000	7190	6660	13400	18600	6540
0.094 to 0.047	2.38 to 1.19	- No. 16 + No. 30	3410	8490	13800	2860	4500	11500	7700	3320
0.047 to 0.023	1.19 to 0.59						* 2950	* 11400	* 12700	* 3910
0.023 to 0.012	0.59 to 0.297	- No. 30 + No. 50	7740	10700	6230	1970	11100	8870	4020	1580
0.012 to 0.006	0.279 to 0.149	- No. 50 + No. 100	4020	4400	1930	940	10600	8350	3090	1570
0.006 to 0.004	0.149 to 0.105	- No. 100 + No. 140	32900	9270	6700	4490	23500	13800	7780	5670
0.004 to 0.003	0.105 to 0.074	- No. 140 + No. 200	60100	12100	1100	7300	37600	20400	14900	10100
0.003 to 0.002	0.075 to 0.053	- No. 200 + No. 270	74700	14700	13400	8910	37600	21900	16200	11600
0.002	0.053 to 0.044	- No. 270 + No. 325	104000				65000	19500	15500	11200
-0.002	-0.044	- No. 325	139000	34000	9800	6530	77200	24800	13100	9430

NS = No sample

* = Duplicate analysis by chemist

TABLE B-4. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis												Experimental parameters					
			Total metals (ppm ; mg/l)															
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	Ni	Zn	Cd	Cu	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
SCREENED ROCKS/PLASTIC (+1/4")	018	—	—	—	—	—	—	—	—	—	7.1	—	—	—	—	—	—	WET SCREENING RINSE WATER: SOIL RATIO IS 3.5:1
SCREENED ROCKS/PLASTIC (1/4")	019	—	—	—	—	—	—	—	—	—	12.4	—	—	—	—	—	—	WET SCREENING RINSE WATER: SOIL RATIO IS 3.0:1
SUSPENDED FINES FRACTION BEFORE DECANT	020	94.94	1.7	0.17	39.5	8.0	0.02	(0.20	0.03-	0.05	—	—	—	—	—	—	—	
HEAVY FRACTION AFTER DECANT	023	14.2	29,256	33,732	10,761	3,643	18.5	52.7	4.8	28.7	—	—	~15	20	2	2	SAND FRACTION	pH OF 15% EDTA = 11.5
FILTERED EDTA AFTER CHELATION	024	—	4,780	7.6	308	14.5	0.3	2.9	0.04	1.0	—	13.2	•	•	•	•	•	
FILTERED EDTA AFTER POLISH	025	—	769	3.6	20.3	5.2	0.1	2.5	0.04	0.3	—	2.9	•	•	•	•	•	
1ST WATER RINSE	026	—	59.6	7.2	18.5	1.8	0.1	0.5	0.02	0.1	—	—	•	•	•	•	•	
2ND WATER RINSE	027	—	18	6	9.2	0.8	0.1	0.2	0.02	0.06	—	—	•	•	•	•	•	
HEAVY FRACTION AFTER 2ND WATER RINSE	028	12.3	1,075 44,175*	28,970 14,702*	14,593 41.0*	9,485 1,537*	21.7 10.7*	47.1 29.3*	6.7 2.1*	19.2 41.0*	5.3	—	•	•	•	•	•	

* Duplicate analysis by chemist

TABLE B-5. EDTA CHELATION OF UNCLASSIFIED SOIL

Sample	Lead extraction process analysis												Experimental parameters					COMMENTS
	Sample # (b)	Moisture (%)	Total metals (ppm ; mg/l)								EP tox Pb (mg/l)	Free EDTA (%) Zn	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg	Ni	Zn	Cd	Cu								
DRY SCREENED (1/4") UNCLASSIFIED SOIL BEFORE CHELATION	029	11.97	46,746	34,018	10,685	5,368	17.5	83.1	2.3	43.2	43.0	—	20	25	N/A (a)	N/A (a)	UNCLASSIFIED SOIL	
EDTA CHELATION SOLUTION	030L	—	6,570	26.1	399	51.6	0.5	5.0	0.1	3.4	—	—	•	•	•	•	•	5 MINUTES CHELATION TIME
EDTA CHELATION SOLUTION	031R	—	15,100	47.0	214	40.5	(0.09	(0.02	(0.02	3.4	—	—	•	•	•	•	•	12 MINUTES CHELATION TIME
EDTA CHELATION SOLUTION	033R	—	10.2	0.2	1.6	(0.01	(0.09	(0.02	(0.02	(0.03	—	—	•	•	•	•	•	30 MINUTES CHELATION TIME
EDTA CHELATION SOLUTION	035L	—	6,530	83.9	414	42.5	(0.09	(0.02	(0.02	(0.03	—	—	•	•	•	•	•	30 MINUTES CHELATION TIME
EDTA CHELATION SOLUTION	035R	—	13,500	211	771	99.4	(0.09	(0.02	(0.02	—	—	2.9	•	•	•	•	•	45 MINUTES CHELATION TIME
EDTA CHELATION SOLUTION	035L	—	6,780	117	335	65.6	(0.09	(0.02	(0.02	—	—	0.9	•	•	•	•	•	45 MINUTES CHELATION TIME
SOIL AFTER EDTA CHFLATION	036R	—	4,810	21,100	3,300	2,420	—	—	—	—	—	—	•	•	•	•	•	
SOIL AFTER EDTA CHELATION	036L	24.8	3,575	12,871	2,227	5,368	10.1	46	1.3	21.8	206	—	•	•	•	•	•	

N/A (a) = not applicable b L = left reactor, R = right reactor

NOTE : Due to difficulty in solid/liquid separation after the EDTA chelation step, the remainder of experiment was not performed.

This experiment performed with 4 gallons of soil-EDTA/water mixture.

TABLE B-6. EDTA CHELATION OF UNCLASSIFIED SOIL

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)											
Sample	Sample # (b)	Moisture (%)	Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
UNCLASSIFIED DRY SCREENED (1/4") SOIL BEFORE CHELATION	037	10.4	41,100	30,600	10.600	2,650	—	—	20	25	2	N/A (a)	UNCLASSIFIED SOIL	
EDTA CHELATION SOLUTION	039R	—	11,200	103	463	60.1	—	—	•	•	•	•	•	15 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	039L	—	10,700	86.5	561	56.3	—	—	•	•	•	•	•	15 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	014R	—	14,700	108	590	77.4	—	—	•	•	•	•	•	35 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	041L	—	15,900	109	644	72.5	—	—	•	•	•	•	•	35 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	042R	—	96,600	110	841	89.5	—	11.4	•	•	•	•	•	45 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	042L	—	68,500	103	769	84.8	—	7.6	•	•	•	•	•	45 MIN. CHELATION TIME
EDTA POLISH SOLUTION	043R	—	12,400	114	263	20.6	—	—	•	•	•	•	•	3 MIN. CHELATION TIME
EDTA POLISH SOLUTION	043L	—	1,260	60.7	290	14.8	—	—	•	•	•	•	•	3 MIN. CHELATION TIME
EDTA POLISH SOLUTION	044R	—	1,380	57.9	419	16.4	—	—	•	•	•	•	•	10 MIN. CHELATION TIME
EDTA POLISH SOLUTION	044L	—	1,700	60.6	419	20.1	—	—	•	•	•	•	•	10 MIN. CHELATION TIME
EDTA POLISH SOLUTION	045R	—	1,510	64.2	436	21.3	—	2.5	•	•	•	•	•	20 MIN. CHELATION TIME
EDTA POLISH SOLUTION	045L	—	1,750	89.0	422	27.7	—	1.9	•	•	•	•	•	20 MIN. CHELATION TIME
SOIL AFTER EDTA POLISH	046R	16.5	2,060	27,000	13,900	2,270	74.8	—	•	•	•	•	•	
SOIL AFTER EDTA POLISH	046L	15.2	2,290	27,000	13,900	2,270	71.5	--	•	•	•	•	•	

N/A (a) Not applicable b L = left reactor, R = right reactor

NOTE : Due to difficulty is solid/liquid separation after the EDTA polish step, the remainder of the experiment was not performed.

This experiment was the same as the previoous experiment (pasge 3), However it was performed on smaller scale, 1 liter of soil-EDTA/water mixture.

TABLE B-7. EXPERIMENTAL CONTROL FOR SAND FRACTION CHELATION

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)											
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
WET SCREENED HEAVY FRACTION BEFORE CHELATION (1/4")	124	29.7	20,4000	12,100	2,140	979	64.5	—	—	—	—	—		
EDTA CHELATION SOLUTION	125L	—	16.2	1.8	28.7	6.7	—	—	0	45	0	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	127L	—	5.1	0.3	54.4	10.4	—	—	"	"	"	"	"	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	129L	—	4.8	2.1	58.9	11.9	—	0	"	"	"	"	"	45 MIN. CHELATION TIME
0% EDTA POLISH	131L	—	17.9	0.83	18.1	3.6	--	—	"	"	"	"	"	4 MIN. 0% EDTA POLISH
0% EDTA POLISH	132L	—	4.5	0.26	19.0	3.7	—	—	"	"	"	"	"	10 MIN. 0% EDTA POLISH
0% EDTA POLISH	133L	—	8.8	1.3	29.7	5.0	—	0	"	"	"	"	"	20 MIN. 0% EDTA POLISH
1ST WATER RINSE	134L	—	6.2	1.8	10.2	2.0	—	—	"	"	"	"	"	4 MIN. 1ST RINSE
1ST WATER RINSE	136L	—	4.18	1.1	16.1	2.8	—	—	"	"	"	"	"	20 MIN. 1ST RINSE
2ND WATER RINSE	137L	—	4.3	2.4	7.9	1.63	—	—	"	"	"	"	"	4 MIN. 2ND RINSE
2ND WATER RINSE	139L	—	14.3	1.1	12.4	2.2	—	—	"	"	"	"	"	20 MIN. 2ND RINSE
HEAVY FRICTION AFTER 2ND RINSE	140L	14.4	23,600	26,900	3,700	1,540	34.3	—	"	"	"	"	"	
3RD WATER RINSE	141L	—	4.0	1.1	7.4	1.3	—	—	"	"	"	"	"	4 MIN 3RD RINSE
3RD WATER RINSE	143L	—	5.9	0.9	11.8	1.8	—	—	"	"	"	"	"	20 MIN 3RD RINSE
HEAVY FRICTION AFTER 3RD RINSE	144L	18.1	21,600	17,900	4,190	1,310	34.9	—	"	"	"	"	"	

L = left reactor, R = right reactor

TABLE B-8. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg								
WET SCREENED (-1/4") HEAVY FRACTION BEFORE CHELATION	102	19.2	24,300 13,300*	19,900 19,900*	7,780 5,050*	1,230 1,650*	8.3	—	—	—	—	—	—	
UNUSED EDTA CHELATION SOLUTION	102E	—	<1.0	3.6	29.1	1.3	—	—	—	—	—	—	—	CONTROL
EDTA CHELATION SOLUTION	103R	—	18,500	28.6	302	43.5	—	—	20	45	0	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	103L	—	19,700	41.7	340	44.4	—	—	"	"	"	"	"	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	105R	—	20,300	48.5	492	49.2	—	—	"	"	"	"	"	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	105L	—	39,000	498	732	474	—	—	"	"	"	"	"	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	107R	—	24,900	121	898	64.0	—	11.7	"	"	"	"	"	45 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	107L	—	3,750	151	912	79.6	—	11.4	"	"	"	"	"	45 MIN. CHELATION TIME
EDTA POLISH SOLUTION	108R	—	3,060	15.9	448	11.6	—	—	"	"	"	"	"	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	108L	—	3,440	25.9	487	11.4	—	—	"	"	"	"	"	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	109R	—	2,750	20.2	548	14.2	—	—	"	"	"	"	"	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	109L	—	3,670	28.9	638	137	—	—	"	"	"	"	"	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	110R	—	—	—	—	—	—	—	"	"	"	"	"	20 MIN. POLISH TIME
EDTA POLISH SOLUTION	110L	—	3,390	38.5	699	17.4	—	—	"	"	"	"	"	20 MIN. POLISH TIME
1ST WATER RINSE	112R	—	601	54.3	157	10.2	—	—	"	"	"	"	"	10 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	112L	—	708	35.2	130	5.8	—	—	"	"	"	"	"	10 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	113R	—	589	81.1	162	11.6	—	—	"	"	"	"	"	20 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	113L	—	741	92.5	130	10.1	—	—	"	"	"	"	"	20 MIN. RINSE TIME, 1ST RINSE

b L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-8 (continued)

TABLE B-6. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)											
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
2ND WATER RINSE	114R	—	94.5	10.6	24.6	1.1	—	—	*	*	*	*	*	4 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	114L	—	111	13.5	18	1.4	—	—	*	*	*	*	*	4 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	116R	—	124	31.7	31.7	3.1	—	—	*	*	*	*	*	20 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	116L	—	123	12.9	19.4	1.2	—	—	*	*	*	*	*	20 MIN. RINSE TIME, 2ND RINSE
3RD WATER RINSE	118R	—	21.8	16.1	5.9	1.3	—	—	*	*	*	*	*	4 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	118L	—	24	17.8	5.9	2.6	—	—	*	*	*	*	*	4 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	120R	—	52.7	22.5	10.2	2.2	—	—	*	*	*	*	*	20 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	120L		30.7	20.6	6.7	2.2			*	*	*	*	*	20 MIN. RINSE TIME, 3RD RINSE
SOIL AFTER 3RD WATER RINSE	121R	17.0	1,328 3,411*	14,411 10,079	4,735 4,160	2,495 2,080	2.0	—	*	*	*	*	*	
SOIL AFTER 3RD WATER RINSE	121L	13.8	1,000 1,023	10,673 13,004*	4,389 4,091	2,495 2,713	0.9	—						

b L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-9. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l) Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
WET SCREENED (-1/4") HEAVY FRACTION BEFORE CHELATION	083	—		—	—	—	21.8	—	—	—	—	—	—	
EDTA CHELATION SOLUTION	084R	—	25,100	49.2	49.2	5.7	—	—	20	45	2	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	084L	—	18,800	85.9	284	35.2	—	—	•	•	•	•	•	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	086R	—	1,640	23.6	96.6	4.0	—	—	•	•	•	•	•	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	086L	—	—	—	—	—	—	—	•	•	•	•	•	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	088R	—	1,430	21.4	90.5	2.9	—	3.5	•	•	•	•	•	45 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	088L	--	1,810	29.1	230	6.1	—	11.6	•	•	•	•	•	45 MIN. CHELATION TIME
EDTA POLISH SOLUTION	089R	--	1,910	0	420	0	—	—	•	•	•	•	•	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	089L	--	3,280	17.2	298	7.2	—	—	•	•	•	•	•	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	090R	--	2,980	0	540	0	—	—	•	•	•	•	•	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	090L	—	2,220	31.2	631	13.9	—	—	•	•	•	•	•	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	091R	—	3,180	35.9	480	11.0	—	—	•	•	•	•	•	21 MIN. POLISH TIME
EDTA POLISH SOLUTION	091L	—	2,570	30.4	1,130	23.9	—	—	•	•	•	•	•	21 MIN. POLISH TIME
1ST WATER RINSE	092R	--	453	33.9	149	3.4	—	—	•	•	•	•	•	4 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	092L	—	304	61.5	231	9.2	—	--	•	•	•	•	•	4 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	094R	—	515	65.0	185	5.7	—	—	•	•	•	•	•	20 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	094R	—	296	12.1	223	3.3	—	—	•	•	•	•	•	20 MIN. RINSE TIME, 1ST RINSE

b L = left reactor , R = right reactor

TABLE B-9 (continued)

TABLE B-9. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg								
2ND WATER RINSE	095R	—	178	19.3	61.7	1.3	—	—	20	45	2	3	SAND FRACTION	4 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	095L	—	103	13.6	80.7	1.7	—	—	•	•	•	•	•	4 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	096R	—	119	27.3	53.8	2.1	—	—	•	•	•	•	•	20 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	096R	—	74.7	21.9	49.9	1.6	—	—	•	•	•	•	•	20 MIN. RINSE TIME, 2ND RINSE
SOIL AFTER 2ND WATER RINSE	102R	5.8	1,170	14,100	9,710	1,480	11.5	—	•	•	•	•	•	
SOIL AFTER 2ND WATER RINSE	102L	15.1	281	10,500	2,750	895	5.8	—	•	•	•	•	•	
3RD WATER RINSE	098R	—	108	16.3	37.8	1.9	—	—	•	•	•	•	•	2 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	098L	—	19.1	12.0	10.6	1.0	—	—	•	•	•	•	•	2 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	099R	—	132	25.1	41.7	2.3	—	—	•	•	•	•	•	10 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	099L	—	23.5	15.3	11.3	1.1	—	—	•	•	•	•	•	10 MIN. RINSE TIME, 3RD RINSE
SOIL AFTER 3RD WATER RINSE	101R	17.1	656	15,800	1,180	835	4.6	—	•	•	•	•	•	
SOIL AFTER 3RD WATER RINSE	101L	18.2	1,080	13,000	2,230	1,000	3.3	—	•	•	•	•	•	

b L = left reactor , R = right reactor

TABLE B-10. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l) Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
WET SCREENED (-1/4") HEAVY FRACTION BEFORE CHELATION	124	29.7	53,000	10,200	21,130	1,090	64.6	—	—	—	—	—	—	
UNUSED 20% EDTA SOLUTION	122	—	<1.0	4.8	259	2.8	—	15.4	—	—	—	—	—	CONTROL
UNUSED 5% EDTA SOLUTION	123	—	<1.0	1.7	45.9	2.0	—	7.9	—	—	—	—	—	CONTROL
EDTA CHELATION SOLUTION	125R	—	21,600	37.6	489	37.1	—	—	20	45	5	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	127R	--	28,700	38.4	536	38.8	—	--	"	"	"	"	"	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	129R	--	4,550	55.1	1070	34.2	—	4.7	"	"	"	"	"	45 MIN. CHELATION TIME
5% EDTA POLISH	131R	--	3,430	37.6	489	37.1	--	—	"	"	"	"	"	4 MIN. 5% EDTA POLISH
5% EDTA POLISH	132R	--	28,700	38.4	536	38.8	--	—	"	"	"	"	"	10 MIN. 5% EDTA POLISH
5% EDTA POLISH	133R	—	4,550	55.1	1,070	34.2	—	4.7	"	"	"	"	"	20 MIN. 5% EDTA POLISH
1ST WATER RINSE	134R	--	1,120	19	319	14.5	—	—	"	"	"	"	"	4 MIN. 1ST RINSE
1ST WATER RINSE	136R	—	1,150	21.4	308	9.8	--	--	"	"	"	"	"	20 MIN. 1ST RINSE
2ND WATER RINSE	137R	—	228	21.3	46.9	2.6	—	—	"	"	"	"	"	4 MIN 2ND RINSE
2ND WATER RINSE	139R	--	305	30.1	34	3.3	—	—	"	"	"	"	"	20 MIN 2ND RINSE
HEAVY FRACTION AFTER 2ND RINSE	140R	17.4	2,674 2,507*	16,662 20,227*	4,259 7,670*	1,828 2,948	11.8 12.8*	—	"	"	"	"	"	
3RD WATER RINSE	141R	—	--	--	—	—	--	—	"	"	"	"	"	4 MIN. 3RD RINSE
3RD WATER RINSE	143R	—	--	—	—	—	—	—	"	"	"	"	"	20 MIN. 3RD RINSE
HEAVY FRACTION AFTER 3RD RINSE	144R	17.4	1,983 1,522*	16,632 8,122*	5,153 14,737*	2,877 2,144*	5.3	—						

* Duplicate analysis by chemist

R = right reactor

TABLE B-11. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis									Experimental parameters					
			Total metals (ppm ; mg/l)				EP tox Pb	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	(mg/l)							COMMENTS
UNUSED EDTA CHELATION SOLUTION	145	—	(1.030	2.6	98	1.4	—	22.5 22.5*	—	—	—	—	—	CONTROL
UNUSED EDTA POLISH SOLUTION	146	—	(1.030	1.1	27.5	0.6	—	5.44 5.51*	—	—	—	—	—	
EDTA CHELATION SOLUTION	148R	—	7570	10.7	172	237	—	—	20	25	0	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	150R	—	7580	17.1	311	29.0	—	—	*	*	*	*	*	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	152R	—	8810	24.5	432	38.7	—	14.0	*	*	*	*	*	45 MIN. CHELATION TIME
EDTA POLISH SOLUTION	154R	—	445	20.9	127	7.5	—	—	*	*	*	*	*	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	155R	—	439	18.6	147	8.11	—	—	*	*	*	*	*	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	156R	—	782	22.7	235	10.7	—	0.5	*	*	*	*	*	20 MIN. POLISH TIME
1ST WATER RINSE	157R	—	241	12.6	72.7	4.6	—	—	*	*	*	*	*	4 MIN. WATER RINSE, 1ST RINSE
1ST WATER RINSE	159R	—	243	11.2	66.3	2.9	—	—	*	*	*	*	*	20 MIN. WATER RINSE, 1ST RINSE
2ND WATER RINSE	160R	—	39.6	5.8	8.1	0.8	—	—	*	*	*	*	*	4 MIN. WATER RINSE, 2ND RINSE
2ND WATER RINSE	162R		39.6	6.1	7.9	0.8			*	*	*	*	*	20 MIN. WATER RINSE, 2ND RINSE
SOIL AFTER 2ND WATER RINSE	163R	20.0	25,000	27,600	1,920	1,370	3.9	—	*	*	*	*	*	
3RD WATER RINSE	164R	—	6.5	2.6	2.0	0.3	—	—	*	*	*	*	*	4 MIN. WATER RINSE, 3RD RINSE
3RD WATER RINSE	166R	—	3.4	5.2	2.9	0.5	—	—	*	*	*	*	*	20 MIN. WATER RINSE, 3RD RINSE
SOIL AFTER 3RD WATER RINSE	167R	14.8	774	45,400	2,170	1,610	3.4	—	*	*	*	*	*	

* Duplicate analysis by chemist

TABLE B-12. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg								
LEE FARM (UNSCREENED)	058	7.3	—	—	—	—	—	—	—	—	—	—	—	
SCREENED ROCKS/PLASTIC (+1/4")	059	2.7	—	—	—	—	—	—	—	—	—	—	—	
WET SCREENED (-1/4") HEAVY FRACTION BEFORE CHELATION	060	17.7	—	—	—	—	—	—	—	—	—	—	—	
UNUSED EDTA CHELATION SOLUTION	063	—	—	—	—	—	—	16.3	20	25	2	3	SAND FRACTION	
UNUSED EDTA POLISH SOLUTION	064	—	—	—	—	—	—	2.20	"	"	"	"	"	
EDTA CHELATION SOLUTION	065	—	31,800	45.1	409	43.3	—	—	"	"	"	"	"	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	067	—	87,300	85.6	543	47.9	—	—	"	"	"	"	"	15 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	069	—	106,000	111	960	59.2	—	14.8	"	"	"	"	"	45 MIN. CHELATION TIME
EDTA 2% POLISH SOLUTION	070	—	6,870	33.2	424	19.2	—	—	"	"	"	"	"	2 MIN. POLISH TIME
EDTA 2% POLISH SOLUTION	071	—	8,230	43.5	596	23.2	—	—	"	"	"	"	"	10 MIN. POLISH TIME
EDTA 2% POLISH SOLUTION	072	—	8,770	52.7	1060	36.2	—	—	"	"	"	"	"	20 MIN. POLISH TIME
1ST WATER RINSE	073	--	1,350	54.7	498	15.3	—	—	"	"	"	"	"	3 MIN. RINSE TIME 1ST RINSE
1ST WATER RINSE	075	—	13,500	26.6	498	26.8	—	—	"	"	"	"	"	20 MIN. RINSE TIME 1ST RINSE
2ND WATER RINSE	076	—	228	64.9	119	7.9	—	—	"	"	"	"	"	3 MIN. RINSE TIME 2ND RINSE
2ND WATER RINSE	078	—	322	102	153	8.07	—	—	"	"	"	"	"	20 MIN. RINSE TIME 2ND RINSE
3RD WATER RINSE	079	—	88.7	62.1	43.4	5.61	—	—	"	"	"	"	"	3 MIN. RINSE TIME 3RD RINSE
3RD WATER RINSE	081	—	115	91.3	54.3	8.3	—	—	"	"	"	"	"	20 MIN. RINSE TIME 3RD RINSE
SOIL AFTER CHELATION, POLISH AND 3 RINSES	082	17.5	736	16,600	3,790	1,030	2.8 2.8*	—	"	"	"	"	"	

* Duplicate analysis by chemist

TABLE B-13. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis									Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%) (%)		Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg									
WET SCREENED (-1/4") HEAVY FRACTION BEFORE CHELATION	147	19.8	24,100	14,800	2,130	1,190	36.6	—		—	—	—	—	—	
UNUSED EDTA CHELATION SOLUTION	145	—	<1.030	2.6	98	1.4	—	22.5 22.5*		—	—	—	—	—	CONTROL
UNUSED EDTA POLISH SOLUTION	146	—	<1.030	1.1	27.5	0.6	—	5.44 5.51*		—	—	—	—	—	CONTROL
EDTA CHELATION SOLUTION	148L	—	6,460	11.3	198	25.4	—	—		20	25	5	3	SAND FRACTION	5 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	150L	—	7,980	20.8	319	31.1	—	—		"	"	"	—	"	25 MIN. CHELATION TIME
EDTA CHELATION SOLUTION	152L	—	10,600	31.1	443	37.0	—	14.3		"	"	"	—	"	45 MIN. CHELATION TIME
EDTA POLISH SOLUTION	154L	—	69.8	7.6	156	8.7	—	—		"	"	"	—	"	4 MIN. POLISH TIME
EDTA POLISH SOLUTION	155L	—	646	8.5	195	9.8	—	—		"	"	"	—	"	10 MIN. POLISH TIME
EDTA POLISH SOLUTION	156L	—	5,790	12.4	242	15.1	—	—		"	"	"	—	"	20 MIN. POLISH TIME
1ST WATER RINSE	157L	—	91.1	13.3	87.2	5.6	—	—		"	"	"	1	"	4 MIN. RINSE TIME, 1ST RINSE
1ST WATER RINSE	159L	—	109	22.8	97.9	9.4	—	—		"	"	"	"	"	20 MIN. RINSE TIME, 1ST RINSE
2ND WATER RINSE	160L	—	13.8	19.1	13.2	1.4	—	—		"	"	"	2	"	4 MIN. RINSE TIME, 2ND RINSE
2ND WATER RINSE	162L		17.4	15.4	14.3	1.8				"	"	"	"	"	20 MIN. RINSE TIME, 2ND RINSE
SOIL AFTER 2ND WATER RINSE	163L	17.1	900	13,600	3,390	1,890	4.0	—		"	"	"	"	"	
3RD WATER RINSE	164L	—	3.3	4.1	2.7	—	—	—		"	"	"	3	"	4 MIN. RINSE TIME, 3RD RINSE
3RD WATER RINSE	166L	—	3.5	5.2	2.9	—	—	—		"	"	"	"	"	20 MIN. RINSE TIME, 3RD RINSE
SOIL AFTER 3RD WATER RINSE	167L	15.6	696	13,600	13,900	—	4.8	—		"	"	"	"	"	

* Duplicate analysis by chemist

TABLE B-14. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l) Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
HEAVY FRACTION BEFORE CHELATION	203	17.4	8,950	15,800	3,360	1,220	14.4	—	—	—	—	—	—	CONTROL
UNUSED EDTA CHELATION SOLUTION	202	—	—	—	—	—	—	—	—	—	—	—	—	
EDTA CHELATION SOLUTION	204R	—	2,260	12.9	188	8.2	—	—	20	25	—	—	SAND FRACTION (-1/4" + 100 MESH)	5 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	204L	—	2,520	15.6	209	9.9	—	—	"	"	"	"		5 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	205R	—	2,610	17.8	262	9.7	—	—	"	"	"	"	"	15 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	205L	—	2,840	18.4	285	10.7	—	—	"	"	"	"	"	15 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	206R	—	2,630	20.4	319	10.0	—	15.4	"	"	"	"	"	25 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	206L	—	3,010	23.1	387	12.6	—	15.3	"	"	"	"	"	25 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	207R	—	4,840	114	398	19.2	—	—	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	207L	—	6,270	41.8	494	22.3	—	—	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	208R	—	4,910	25.1	308	16.1	—	—	"	"	"	"	"	5 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	208L	—	5,820	34.2	347	24.0	—	—	"	"	"	"	"	5 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	209R	—	6,280	34.44	403	21.1	—	—	"	"	"	"	"	15 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	209L	—	5,530	30.3	351	18.8	—	—	"	"	"	"	"	15 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	210R	—	10,200	44.1	697	28.8	—	13.4	"	"	"	"	"	25 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	210L	—	7,710	35.0	525	21.9	—	12.4	"	"	"	"	"	25 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	211R	—	8,740	115.0	653	29.3	—	—	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	211L	—	13,600	50.9	1,070	32.2	—	—	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION

b L = left reactor, R = right reactor

TABLE B-14 (continued)

TABLE B-14. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)											
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
EDTA CHELATION SOLUTION	212R	—	9,300	42.3	587	31.2	—	—	*	*	*	*	*	5 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	212L	—	9,010	35.0	531	24.9	—	—	*	*	*	*	*	5 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	213R	—	11,100	37.3	691	25.1	—	—	*	*	*	*	*	15 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	213L	—	4,080	40.1	228	27.9	—	—	*	*	*	*	*	15 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	214R	—	17,200	41.5	1,220	27.5	—	10.6	*	*	*	*	*	25 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	214L	—	18,800	39.9	1,370	26.7	—	11.2	*	*	*	*	*	25 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	215R	—	13,000	220	1,090	59.6	—	—	*	*	*	*	*	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	215L	—	13,300	221	1,170	54.2	—	—	*	*	*	*	*	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	216R	—	12,400	62.1	927	39.3	—	—	*	*	*	*	*	5 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	216L	—	9,010	56.0	612	37.2	—	—	*	*	*	*	*	5 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	217R	—	12,300	66.2	958	47.0	—	—	*	*	*	*	*	15 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	217L	—	9,430	67.8	679	47.3	—	—	*	*	*	*	*	15 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	218R	—	12,200	67.8	929	46.4	—	7.2	*	*	*	*	*	25 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	218L	—	13,100	67.9	1,090	38.5	—	9.6	*	*	*	*	*	25 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	219	—	—	—	—	—	—	—	*	*	*	*	*	ALL REACTORS COMBINED AFTER SOLID/LIQUID SEPARATION

L = left reactor, R = right reactor

TABLE B-15. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample # (a)	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg								
WET SCREENED (-1/4" + 150 MESH) HEAVY FRACTION BEFORE CHELATION	168S	17.9	12,500	32,900	1,350	4,250	6.5	—	—	—	—	—	—	CONTROL
UNUSED EDTA CHELATION SOLUTION	168E	—	—	—	—	—	—	22.5	—	—	—	—	—	
EDTA CHELATION SOLUTION	169R	—	12,440	17.4	214	13.3	—	19.4*	20	25	NO POLISH	NONE	SAND FRACTION (-1/4" + 100 MESH)	5 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	169L	—	4,560	16.2	195	13.4	—	18.4	"	"	"	"		5 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	170R	—	5,130	18.4	254	13.0	—	15.4 15.5*	"	"	"	"		15 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	170L	—	4,940	21.3	282	14.2	—	15.6	"	"	"	"	"	15 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	171R	—	4,080	26.5	361	15.1	—	15.6	"	"	"	"	"	25 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	171L	—	5,040	25.1	389	15.2	—	11.9	"	"	"	"	"	25 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	173R	—	4,080	50.3	463	33.1	—	19.6	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	173L	—	6,230	43.2	531	25.0	—	19.6	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	174R	—	6,440	32.9	301	25.2	—	12.6	"	"	"	"	"	5 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	174L	—	8,530	36.0	486	26.2	—	12.9	"	"	"	"	"	5 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	175R	—	11,100	43.8	531	30.6	—	12.1	"	"	"	"	"	15 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	175L	—	13,700	60.4	756	29.9	—	12.2	"	"	"	"	"	15 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	176R	—	8,000	42.0	649	26.8	—	12.0	"	"	"	"	"	25 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	176L	—	5,800	39.9	283	26.0	—	12.2	"	"	"	"	"	25 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	177R	—	8,440	54.4	490	39.3	—	15.4	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	177L	—	11,800	63.9	711	36.3	—	13.9	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION

(a) L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-15 (continued)

TABLE B-15. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample # (a)	Moisture (%)	Total metals (ppm ; mg/l)				EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
			Pb	Fe	Ca	Mg								
EDTA CHELATION SOLUTION	178R	—	10,600	40.1	501	32.7	—	10.0	20	25	NO POLISH	NONE	SAND FRACTION (-1/4" + 100 MESH)	5 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	178L	—	9,020	45.9	405	35.5	—	8.4 8.5*	"	"	"	"		5 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	179R	—	9,250	59.6	437	45.3	—	9.2	"	"	"	"	"	15 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	179L	—	13,200	70.9	655	35.5	—	9.9	"	"	"	"	"	15 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	180R	—	10,900	55.7	588	41.3	—	9.4	"	"	"	"	"	25 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	180L	—	19,300	42.6	1,110	27.0	—	9.2	"	"	"	"	"	25 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	181R	--	14,100	93.4	884	60.4	—	12.3	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	181L	—	19,600	102	1,500	75.0	—	11.9	"	"	"	"	"	AFTER SOLID/LIQUID SEPARATION
EDTA CHELATION SOLUTION	182R	—	9,970	54.4	617	43.4	—	6.7	"	"	"	"	"	5 MIN. CHEALTION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	182L	—	12,000	54.7	704	42.2		6.7 6.7*	"	"	"	"	"	5 MIN. CHEALTION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	183R	—	11,700	60.3	812	46.4	—	6.6	"	"	"	"	"	15 MIN. CHEALTION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	183L	—	15,100	61.8	1,000	45.2	—	6.5	"	"	"	"	"	15 MIN. CHEALTION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	184R	—	12,900	81.1	857	61.3	—	5.5	"	"	"	"	"	25 MIN. CHEALTION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	184L	—	19,200	71.2	1,210	51.8	—	6.0	"	"	"	"	"	25 MIN. CHEALTION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	201	—	17,300	132	1,480	89.0	—	9.2	"	"	"	"	"	R&L REACTORS COMBINED AFTER AFTER SOLID/LIQUID SEPARATION

(a) L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-16. EDTA CHELATION OF SAND FRACTION

Sample	Lead extraction process analysis								Experimental parameters					COMMENTS
	Sample #	Moisture (%)	Total metals (ppm ; mg/l): Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	
UNUSED EDTA CHELATION SOLUTION	220	—	412 475*	4.0 5.8*	83.6 102*	3.0 3.7*	—	22.9	—	—	—	—	—	
WET SCREENED (-1/4" + 140 MESH) HEAVY FRACTION BEFORE CHELATION	221	14.1	13,400 23,200*	15,100 13,200	6,630 4,990	2,860 2,170	—	—	—	—	—	—	—	
EDTA CHELATION SOLUTION	222R	—	—	—	—	—	—	21.1	20	25	—	—	SAND FRACTION (-1/4" + 150 MESH)	5 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	222L	—	—	—	—	—	—	18.3	"	"	"	"		5 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	223R	—	1,420	49.3	96.7	8.2	—	13.7 12.5*	"	"	"	"	"	15 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	223L	—	1,830	8.6	65.7	4.5	—	13.4 14.6*	"	"	"	"	"	15 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	224R	—	—	—	—	—	—	12.1	"	"	"	"	"	5 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	224L	—	—	—	—	—	—	12.9	"	"	"	"	"	5 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	225R	—	3,560	5.8	103.0	6.1	—	13.6	"	"	"	"	"	15 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	225L	—	3,380	7.0	95.0	5.1	—	11.9	"	"	"	"	"	15 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	226R	—	—	—	—	—	—	12.2	"	"	"	"	"	5 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	226L	—	—	—	—	—	—	10.3	"	"	"	"	"	5 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	227R	—	6,860	11.9	666	20.8	—	12.1	"	"	"	"	"	15 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	227L	—	4,870	68.8	43.6	37.5	—	9.7	"	"	"	"	"	15 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	228R	—	—	—	—	—	—	9.5	"	"	"	"	"	5 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	228L	—	—	—	—	—	—	8.9	"	"	"	"	"	5 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	229R	—	7,000 6,080*	56.8 53.4*	402 359*	37.2 35.2	—	9.6	"	"	"	"	"	15 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	229L	—	4,900	39.0	—	—	—	8.7	"	"	"	"	"	15 MIN. CHELATION TIME, 3RD CHELATION

L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-17. EDTA CHELATION OF SAND FRACTION

SAMPLE	LEAD EXTRACTION PROCESS ANALYSIS								EXPERIMENTAL PARAMETERS					COMMENTS
	SAMPLE #	MOISTURE (%)	TOTAL METALS (ppm ; mg/l)				EP TOX Pb (ppm)	FREE EDTA (%)	CHELATION FREE EDTA (%)	SOIL IN MIXTURE (%)	POLISH FREE EDTA (%)	# OF WATER RINSES	SOIL TYPE	
			Pb	Fe	Ca	Mg								
UNUSED EDTA CHELATION SOLUTION	141	—	—	—	—	—	—	23.4	—	—	—	—	—	
EDTA CHELATION SOLUTION	235R	—	3,290	9.2	258	8.2	—	13.0 12.6	20	25	—	—	SAND FRACTION (-1/4" + 150 MESH)	35 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	235L	—	2,110 2,000*	3.1 3.0*	189 181*	12.5 181*	—	8.5	•	•	•	•		35 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	239R	—	5,950	11.8	401	14.2	—	8.5	•	•	•	•	•	35 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	239L	—	—	—	—	—	—	8.6	•	•	•	•	•	35 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	243R	—	6,070	19.2	621	33.8	—	5.9	•	•	•	•	•	35 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	234L	—	6,270	15.0	625	36.4	—	6.6	•	•	•	•	•	35 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	247R	—	15,500	37.3	1,460	61.9	—	—	•	•	•	•	•	35 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	247L	—	12,900 13,000*	38.6 34.6*	1,220 1,221*	69.5 66.6	--	3.7 5.0	•	•	•	•	•	35 MIN CHELATION TIME, 4TH CHELATION

L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-18. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)											
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	EP tox Pb (mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
WET SCREENED (-1/4" + 150 MESH) HEAVY FRACTION BEFORE CHELATION	252	8.1	11,600	8,480	7,450	1,960	10.3 13.0	—	—	—	—	—	—	CONTROL
UNUSED EDTA CHELATION SOLUTION	252E	—	—	—	—	—	—	21.6*	—	—	—	—	—	
EDTA CHELATION SOLUTION	253R	—	4,500 3,900	11.4 12.2*	426 431*	19.2 19.8*	—	9.6	20 INITIAL CONC.	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	253L	—	4,880	114	402	23.8	—	18.9	"	"	"	"		15 MIN CHELATION TIME, 1ST CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	258R	—	2,971 2,860*	15,870 14,160*	10,546 10,400*	2,339 2,089*	3.7	—	"	"	"	"	"	
SOIL AFTER CHELATION POLISH AND 3 RINSES	258L	—	—	594	2,470	2,260	4.7	—	"	"	"	"	"	
EDTA CHELATION SOLUTION	259R	—	7,630	15.2	513	26.9	—	14.2	"	"	"	"	"	15 MIN CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	259L	—	6,530	11.4	419	21.8	—	13.6	"	"	"	"	"	15 MIN CHELATION TIME, 2ND CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	264R	—	713	11,800	2,430	2,590	3.3	—	" "	" "	" "	" "	" "	
SOIL AFTER CHELATION POLISH AND 3 RINSES	264L	—	1,030	7,600	2,580	2,010	2.7	—	" "	" "	" "	" "	" "	
EDTA CHELATION SOLUTION	265R	—	—	—	—	—	—	14.8	"	"	"	"	"	15 MIN CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	265L	—	—	—	—	—	—	10.3	"	"	"	"	"	15 MIN CHELATION TIME, 3RD CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	270R	—	—	—	—	—	4.2 3.8*	—	" "	" "	" "	" "	" "	
SOIL AFTER CHELATION POLISH AND 3 RINSES	270L	—	—	—	—	—	2.3	—	" "	" "	" "	" "	" "	

L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-18 (continued)

TABLE B-18. EDTA CHELATION OF SAND FRACTION

	Lead extraction process analysis								Experimental parameters					
			Total metals (ppm ; mg/l)				EP tox Pb							
Sample	Sample #	Moisture (%)	Pb	Fe	Ca	Mg	(mg/l)	Free EDTA (%)	Chelation free EDTA (%)	SOIL in mixture (%)	POLISH free EDTA (%)	# OF water rinses	Soil type	COMMENTS
EDTA CHELATION SOLUTION	271R	—	7,800	23.6	625	39.4	—	13.4	20 INITIAL CONC.	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	271L	—	8,310	15.8	677	25.7	—	12.8	•	•	•	•		15 MIN CHELATION TIME, 4TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	272R	—	2,822 1,484	6,500 17,366*	11,135 6,536*	3,150 2,445*	3.9	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	272L	—	1,290 1,119*	5,651 16,358*	3,065 9,565	1,538 2,745*	3.2	—	• •	• •	• •	• •	• •	
EDTA CHELATION SOLUTION	273R	—	16,000	32.1	1,370	55.7	—	10.4*	•	•	•	•	•	15 MIN CHELATION TIME, 5TH CHELATION
EDTA CHELATION SOLUTION	273L	—	16,600	22.0	888	78.1	—	11.3	•	•	•	•	•	15 MIN CHELATION TIME, 5TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	274R	—	3,310	8,300	3,160	1,930	3.5 2.9	—	• •	• •	• •	• •	• •	
SOIL AFTER CHELATION POLISH AND 3 RINSES	274L	—	1,000	13,800	10,600	8,330	4.1 1.7*	—	• •	• •	• •	• •	• •	

L = left reactor, R = right reactor

* Duplicate analysis by chemist

TABLE B-19. EDTA CHELATION OF SAND FRACTION

SAMPLE	SAMPLE #	MOISTURE (%)	LEAD EXTRACTION PROCESS ANALYSIS: TOTAL METALS (ppm ; mg/l) Pb	Fe	Ca	Mg	EP TOX Pb (ppm)	FREE EDTA (%)	EXPERIMENTAL PARAMETERS: CHELATION FREE EDTA (%)	SOIL IN MIXTURE (%)	POLISH FREE EDTA (%)	# OF WATER RINSES	SOIL TYPE	COMMENTS
WET SCREENED (-1/4" + 150 MESH) HEAVY FRACTION BEFORE CHELATION	292	—	14,600	23,800	20,200	5,110	<0.2	—	—	—	—	—	—	
UNUSED EDTA CHELATION SOLUTION	291	—	—	—	—	—	—	22.7 22.6*	—	—	—	—	—	CONTROL
EDTA CHELATION SOLUTION	277R	—	4,710	34.7	411	39.7	—	19.8	20 INITIAL CONC.	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN. CHELATION TIME, 1ST CHELATION
EDTA CHELATION SOLUTION	277L	—	4,690	20.2	358	31.2	—	18.1		•	•	•		15 MIN. CHELATION TIME, 1ST CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	278R	—	2,570	16,900	40,600	2,690	5.6	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	278L	—	1,100	14,500	7,430	2,910	14.6	—	•	•	•	•	•	
EDTA CHELATION SOLUTION	279R	—	7,440	30.0	527	40.3	—	13.6	•	•	•	•	•	15 MIN. CHELATION TIME, 2ND CHELATION
EDTA CHELATION SOLUTION	279L	—	6,980	34.9	466	39.38	—	11.9 11.8*	•	•	•	•	•	15 MIN. CHELATION TIME, 2ND CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	280R	—	933	12,000	65,000	2,690	5.7 6.3*	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	280L	—	719	17,500	31,700	3,200	5.8	—	•	•	•	•	•	
EDTA CHELATION SOLUTION	281R	—	12,000	44.4	827	58.9	—	14.4	•	•	•	•	•	15 MIN. CHELATION TIME, 3RD CHELATION
EDTA CHELATION SOLUTION	281L	—	14,500	40.1	974	49.3	—	14.4	•	•	•	•	•	15 MIN. CHELATION TIME, 3RD CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	282R	—	1,270 5,890	15,300 13,400*	3,900 5,760*	1,390 1,630	5.3	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	282L	—	1,220	16,200	5,250	2,370	6.3	—	•	•	•	•	•	

R = right reactor, L = left reactor

* Duplicate analysis by chemist

TABLE B-19 (continued)

TABLE B-19. EDTA CHELATION OF SAND FRACTION

SAMPLE	SAMPLE #	MOISTURE (%)	LEAD EXTRACTION PROCESS ANALYSIS TOTAL METALS (ppm ; mg/l) Pb	Fe	Ca	Mg	EP TOX Pb (ppm)	FREE EDTA (%)	EXPERIMENTAL PARAMETERS CHELATION FREE EDTA (%)	SOIL IN MIXTURE (%)	POLISH FREE EDTA (%)	# OF WATER RINSES	SOIL TYPE	COMMENTS
EDTA CHELATION SOLUTION	283R	—	11,500	43.2	782	58.4	—	12.1	20 INITIAL CONC.	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN. CHELATION TIME, 4TH CHELATION
EDTA CHELATION SOLUTION	283L	—	4,880	50.7	870	58.8	—	11.3		•	•	•		15 MIN. CHELATION TIME, 4TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	284R	—	2,200	16,800	16,800	2,750	5.2	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	284L	—	12,300	13,800	51,700	2,580	6.1	—	•	•	•	•	•	
EDTA CHELATION SOLUTION	285R	—	12,900	46.6	897	65.4	—	10.6	•	•	•	•	•	15 MIN. CHELATION TIME, 5TH CHELATION
EDTA CHELATION SOLUTION	285L	—	10,200 9,870*	37.6 36.6*	718 698*	56.9 55.4*	—	8.7	•	•	•	•	•	15 MIN. CHELATION TIME, 5TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	286R	—	5,790	23,800	6,500	3,220	19.4	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	286L	—	1,820	23,000	8,540	4,600	3.2	—	•	•	•	•	•	
EDTA CHELATION SOLUTION	287R	—	13,700	51	1,340	78	—	11.0	•	•	•	•	•	15 MIN CHELATION TIME, 6TH CHELATION
EDTA CHELATION SOLUTION	287L	—	16,400	72.6	1,580	79.5	—	10.6	•	•	•	•	•	15 MIN CHELATION TIME, 6TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	288R	—	4,410 4,300*	12,100 18,300*	3,670 5,560*	2,020 3,030*	10.3	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	288L	—	5,990	6,140	2,170	2,170	8.7	—	•	•	•	•	•	

R = right reactor, L = left reactor

* Duplicate analysis by chemist

TABLE B-19 (continued)

TABLE B-19. EDTA CHELATION OF SAND FRACTION

SAMPLE	LEAD EXTRACTION PROCESS ANALYSIS								EXPERIMENTAL PARAMETERS					COMMENTS
	SAMPLE #	MOISTURE (%)	TOTAL METALS (ppm ; mg/l) Pb	Fe	Ca	Mg	EP TOX Pb (ppm)	FREE EDTA (%)	CHELATION FREE EDTA (%)	SOIL IN MIXTURE (%)	POLISH FREE EDTA (%)	# OF WATER RINSES	SOIL TYPE	
EDTA CHELATION SOLUTION	289R	--	20,200	52.0	2,000	79.2	—	8.6	20	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN CHELATION TIME, 7TH CHELATION
EDTA CHELATION SOLUTION	289L	--	19,800	43.2	2,050	64.9	—	8.4	INITIAL CONC.	•	•	•		15 MIN CHELATION TIME, 7TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	290R	--	2,510	18,100	12,900	2,760	2.3	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	290L	—	10,200	26,600	13,800	2,310	6.0 5.9*	--	•	•	•	•	•	
EDTA CHELATION SOLUTION	291R	--	169,000	61.9	3,300	135	--	8.4	•	•	•	•	•	15 MIN CHELATION TIME, 8TH CHELATION
EDTA CHELATION SOLUTION	291L	--	23,600	76.1	2,350	167	—	9.5	•	•	•	•	•	15 MIN CHELATION TIME, 8TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	292R	—	34,470	24,600	8,570	2,390	6.2	—	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	292L	—	7,490	18,200	9,370	2,230	1.3	—	•	•	•	•	•	
EDTA CHELATION SOLUTION	294R	—	22,700	66.2	2,770	143	—	7.5	•	•	•	•	•	15 MIN CHELATION TIME, 9TH CHELATION
EDTA CHELATION SOLUTION	294L	--	20,400 32,900*	103 81.9*	2,450 1,430	156 80.8*	—	7.3	•	•	•	•	•	15 MIN CHELATION TIME, 9TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	295R	--	655	15,000	26,000	1,890	1.9	--	•	•	•	•	•	
SOIL AFTER CHELATION POLISH AND 3 RINSES	295L	--	6,360	52,300	15,900	6410	9.9	—	•	•	•	•	•	

R = right reactor, L = left reactor

* Duplicate analysis by chemist

TABLE B-19 (continued)

TABLE B-19. EDTA CHELATION OF SAND FRACTION

SAMPLE	SAMPLE #	MOISTURE (%)	TOTAL METALS (ppm ; mg/l) Pb	Fe	Ca	Mg	EP TOX Pb (ppm)	FREE EDTA (%)	CHELATION FREE EDTA (%)	SOIL IN MIXTURE (%)	POLISH FREE EDTA (%)	# OF WATER RINSES	SOIL TYPE	COMMENTS
	LEAD EXTRACTION PROCESS ANALYSIS								EXPERIMENTAL PARAMETERS					
EDTA CHELATION SOLUTION	299R	—	18,500	60.6	1,630	104	—	7.3	20 INITIAL CONC.	25	2	3	SAND FRACTION (-1/4" + 150 MESH)	15 MIN CHELATION TIME, 10TH CHELATION
EDTA CHELATION SOLUTION	299L	—	22,300	74.3	2,130	118	—	7.6		"	"	"		15 MIN CHELATION TIME, 10TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	300R	—	1,790	12,700	4,070	2,000	5.5	—	" "	" "	" "	" "	" "	
SOIL AFTER CHELATION POLISH AND 3 RINSES	300L	--	4,060	25,300	3,960	1,980	2.5	—	" "	" "	" "	" "	" "	
EDTA CHELATION SOLUTION	301R	--	27,100	62.8	2,810	110	—	6.4 6.2*	"	"	"	"	"	15 MIN CHELATION TIME, 11TH CHELATION
EDTA CHELATION SOLUTION	301L	—	24,200 23,600*	63.3 64.3	2,360 2,330	112 114	—	--	"	"	"	"	"	15 MIN CHELATION TIME, 11TH CHELATION
SOIL AFTER CHELATION POLISH AND 3 RINSES	302R	—	6,640	14,400	16,300	1,880	6.7	—	" "	" "	" "	" "	" "	
SOIL AFTER CHELATION POLISH AND 3 RINSES	302L	—	3,300	16,200	4,280	2,230	2.7 2.7*	—	" "	" "	" "	" "	" "	

R = right reactor, L = left reactor

* Duplicate analysis by chemist

APPENDIX C

SUPPORTING ANALYTICAL DATA

ENVIRESPONSE, INC.
ENVIRONMENTAL EMERGENCY RESPONSE UNIT
GSA RARITAN DEPOT, WOODBRIDGE AVENUE, BUILDING 209, BAY F, EDISON, N.J. 08837
(201) 548-9660

LEAD EXTRACTION PROCESS

Enviresponse, Inc. (EI)

EI CHARGE NO.: 3 60 00510098

August 6, 1986

APPROVAL

Enviresponse, Inc.

8/11/86
John Michalowicz
EI-EERU Project Manager

8/6/86
Dan Chen, Ph.D.
EI-EERU Section Chief

8/5/86
John Giga, Ph.D.

July 29, 1986
pt/6262D:0268D

E.P.A.

Submitted to: R. E. Rayford
Submitted by:
Enviresponse, Inc.

Analysis by: Benjamin Shapiro
Paul Vecchione

Prepared by: Benjamin Shapiro

Reviewed by: Michael Miller, Ph.D.

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INTRODUCTION

On May 6, 1986, the first sample was received in conjunction with the pilot study to examine lead contamination removal from the soil at the Lee's Farm site. Ultimately, 437 samples were received for analysis. The analysis was completed the second week in July. Of these samples, 146 were soils or solid materials found on site. E.P. Toxicity was performed on 85 of the solid samples with the leachate being analyzed for calcium, magnesium, iron, and lead; 44 were analyzed for percent moisture, and 128 were analyzed for calcium, magnesium, iron and lead. Of these, 15 were analyzed in addition for zinc, nickel, cadmium, and copper. 291 samples were waters with 12 being analyzed for total solids, 103 for free EDTA, and 278 were analyzed for calcium, magnesium, iron, and lead.

All of the analysis was performed by Enviresponse, Inc. personnel.

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SECTION I

PROCEDURES AND RESULTS

Metals Analysis

Each soil sample was thoroughly mixed. A portion was placed in a small plastic weighing dish in a fume hood to dry for 8-10 hours. The samples were ground to as fine a powder as possible with the bottom of a glass vial. A 0.5 gram portion of each sample weighed to the nearest 0.001 grams and placed in a 70 ml teflon lined digestion bomb. Five milliliters of redistilled concentrated nitric acid were added to each digestion bomb. The sealed bombs were heated for one hour at 60°C and then for 12 hours at 120°C in an oven. The bombs were allowed to cool to room temperature.

The contents of each digestion bomb were quantitatively transferred to a 25 ml volumetric flask and diluted to volume with deionized water. A system blank was obtained by placing 5 ml of redistilled nitric acid in a digestion bomb. The acid was treated as a sample.

The sample solutions were analyzed using a Spectra-Scan multi-channel DC Plasma Emission Spectrometer.

The concentration of the metal in ug/g (ppm) was calculated as follows:

$$\frac{\text{(Instrument Readout, Conc. ug/ml)}}{\text{Weight of Sample, g}} \times 25 \text{ ml} = \frac{\text{ug of Metal}}{\text{g of Sample}}$$

The water samples were analyzed at the pH they were received. No acid was added due to the precipitation of the EDTA which many samples contained at percent levels. It was felt that co-precipitation of the metal ions could result giving erroneous results.

The concentration of the metals in ug/ml (ppm) was calculated as follows:

$$\text{(Instrument Readout, Conc. ug/ml)} \times \text{Dilution Factor}$$

$$= \text{ug of Metal/ml of Sample}$$

The instrument manufacturer defines the instrument detection limit as three times the standard deviation of the blank. This was determined every day. For the purposes of this report, the highest detection limits obtained were used throughout. Soil detection limits were taken as 50 times the aqueous detection limit (soils are diluted approximately 1/50 during analysis).

Results of the standard calibration ranges are shown in Table 1.

WATER SAMPLES

Metal	Symbol	Wavelength (nm)	Linear Dynamic Range (ug/ml)	Detector Limit (ug/ml)
Zinc	Zn	202.548	.27 - 20	.027
Iron	Fe	259.940	.48 - 200	.048
Cadmium	Cd	226.502	.21 - 20	.021
Nickel	Ni	231.604	1.02 - 20	.102
Magnesium	Mg	279.553	0.18 - 40	.018
Copper	Cu	324.754	0.09 - 10	.009
Lead	Pb	283.306	1.05 - 200	.105
Calcium	Ca	317.933	1.74 - 40	.174

SOIL SAMPLES

	Linear Dynamic Range	Detection Limit
Zn	13.5 - 1000	1.35
Fe	24.0 - 10000	2.40
Cd	10.5 - 1000	1.05
Ni	51.0 - 1000	5.10
Mg	9.00 - 2000	0.90
Cu	4.50 - 500	0.45
Pb	52.5 - 1000	5.25
Ca	87.0 - 2000	8.7

E.P. Tox Procedure

A representative 100 g sample was placed in a 2500 ml beaker. To this was added 16 times the sample weight in deionized water along with sufficient 0.5N acetic acid to maintain a pH of 5.0 ± 0.2 pH units. The sample was agitated at a speed sufficient to prevent stratification of the sample and extraction fluid, and to insure that all sample surfaces are continuously brought into contact with the well mixed extraction fluid.

At the end of the 24 hour extraction period, deionized water was added to the extractor according to the following equation:

$V = 20(W) - 16(W) - A$

V = ml of deionized water to be added
W = weight in grams of sample
A = ml of 0.5N acetic acid added during extraction

The sample was then filtered with the filtrate being analyzed as a water sample.

A more detailed description of this procedure is available in the federal register. (Vol. 45, No. 98/May 19, 1980/Appendix II).

Per Cent Moisture Analysis

A representative sample (approx. 20g) was placed on a tared metal dish. The total mass was measured and the sample was dried for 12 hours in an oven at 120°. The sample was removed from the oven, placed in a desiccator and allowed to cool. The mass was measured again. The per cent moisture was determined by the following equation.

$$\%M = 1.00 - \frac{(W_2 - T)}{(W_1 - T)} \times 100\%$$

W_2 = total weight after drying
W_1 = total weight before drying
T = tare weight of metal dish

EDTA Analysis

Reagents

1. Ammonium Oxalate - Due to the unavailability of Ammonium Oxalate, it was made up in the following manner. Forty-two grams of Oxalic Acid was put into a 500 ml beaker containing about 300 ml of distilled water. Next, Ammonia Hydroxide concentrate was added dropwise to bring the pH to just basic (7-7.5). The resulting solution was quantitatively transferred to a 1 liter volumetric flask and brought to volume.

2. Calcium Chloride Standard Solution (.5 M) - Dissolve approximately 73.5 g of Calcium Chloride dihydrate in 1 liter of distilled water.

3. Sodium Hydroxide, 50% - Dissolve 50g of reagent grade sodium hydroxide in approximately 50 ml of distilled water.

4. Buffer Solution - To a 1 liter volumetric flask add 800 ml of distilled water, 125 ml of concentrated Ammonium Hydroxide, 2.50 ml of concentrated Hydrochloric Acid and dilute to about 950 ml with distilled water. Adjust to a pH of 10 with either acid or base. Then dilute to final volume with distilled water.

5. Indicator - Weigh out 50-60 mg of Erichrome Black T and dissolve in 20 ml triethanolamine, 99%. Add 6-8 ml anhydrous ethanol. Mix and transfer to a brown bottle.

Analysis Procedure

Ten milliters or more of the sample to be analyzed was transferred to a 250 ml Erlenmeyer flask. Ten ml of the buffer solution, and 8-10 drops of indicator were added. The sample was titrated with the calcium chloride solution from the initial blue color to the first color change, a pink color. The result in molarity as EDTA was calculated by the following equation (1):

$$\text{(1)} \qquad \frac{M_{ca}\, V_{ca}}{V_{sample}} = M_{EDTA}\ (\text{moles/l})$$

where Mca is the Molarity of the Calcium Chloride,
Vca is the Volume of the Calcium Chloride titrated,
Vsample is the Volume of Sample used,
and M_{EDTA} is the Molarity of Unchelated EDTA.

The following equations (2) or (3) gives the result as percent EDTA-tetrasodium salt.

$$\text{(2)} \quad \text{Result Percent} = M_{EDTA} \text{ in moles/liters} \times 380.224\text{g/mole} \times \frac{1\%}{10{,}000 \text{ mg/l}} \times \frac{1000\text{mg}}{\text{g}}$$

or

$$\text{(3)} \qquad \text{Result Percent} = M_{EDTA} \times 38.0224$$

Standardization of Calcium Chloride

2.5 - 3.0 g of EDTA disodium dihydrate was placed in a 250 ml Erlenmeyer flask. 80 ml of distilled water was added. The pH was adjusted to 11 with 50% NaOH. 20 ml of Ammonium Oxalate was added. The sample was titrated with calcium chloride to the first permanent turbidity. The molarity was calculated by equation (4).

$$\text{(4)} \qquad \text{Molarity} = \frac{\text{grams of sample}}{\text{ml } CaCl_2 \text{ solution}} \times 2.687$$

Total Solids

The sample was shaken vigorously to insure that the solids were dispersed. A volume of the sample is measured in a graduated cylinder (approx. 25 ml) and then quantitatively transferred to a tared beaker. The beaker was then placed in an oven for 12 hours at 120^{0}. The beaker was removed from the oven and allowed to cool in desiccator. The mass was determined. Total solids were calculated according to the following equation.

$$\text{Total solids} = \frac{W-T}{V}$$

W = Weight of beaker after drying (ug)
T = Tare weight of beaker (ug)
V = Sample volume (ml)

Table 1. RESULTS OF LEAD CALIBRATION STANDARD ANALYSIS

Concentrations are in ug/ml (ppm Lead)

Std. Conc.	Number of Std. Analyzed	Average
0	35	0.05
2	5	2.09
5	26	4.70
10	58	9.83
20	45	20.0
100	104	100

EXPERIMENTAL STD. CURVE DATA FOR LEAD

Correlations	1.00
Slope	1.01
Intercept	-0.15

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Table 2. RESULTS OF METAL ANALYSIS OF WATERS

Concentrations as ug/ml (ppm)

Element

Sample No.	Zn	Fe	Cd	Ni	Mg	Cu	Pb	Ca
Det. Limit	.027	.048	.021	.10	.018	.009	.105	.174
005	.10	BDL	.03	BDL	10.9	.04	1.15	55.9
011	.04	.05	BDL	BDL	7.23	.03	3.41	42.3
013	.03	BDL	BDL	BDL	7.35	.06	.62	43.9
015	BDL	3.10	BDL	BDL	7.44	.04	6.24	31.0
017	BDL	.139	.016	BDL	5.96	.04	1.59	41.4
020	BDL	.17	.03	.195	8.03	.05	1.66	39.5
024	2.95	7.64	.04	.27	14.5	1.04	4780	308
025	2.53	3.60	.04	.14	5.19	.33	769	20.3
026	.46	7.20	.02	.111	1.78	.10	59.6	18.5
028	.18	5.97	.02	.14	.83	.06	18.0	9.19
30L	4.98	26.1	.11	.48	51.6	3.45	6570	399
31R	BDL	47.0	BDL	BDL	40.5	3.45	15100	214

BDL - Below Detection Limit

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
33R	.21	BDL	10.2	1.60
33L	83.9	42.5	6530	414
35R	211	99.4	13500	771
35L	117	65.6	6780	335
39R	103	60.1	11200	463
39L	86.5	56.3	10700	561
41R	108	77.4	14700	590
41L	109	72.5	15900	644
42R	110	89.5	96600	841
42L	103	84.8	68500	769
43R	114	20.6	12400	263
43L	60.7	14.8	1260	290
44R	57.9	16.4	1380	419
44L	60.6	20.1	1700	419
45R	64.2	21.3	1510	436
45L	89.0	27.7	1750	422
46R	22400	3400	2060	7910
56	.59	2.03	BDL	8750
57	BDL	.30	BDL	1650
65*	45.1	43.9	68000	409
67*	85.6	47.9	84600	543
69	110	59.2	101000	960
70	39.2	19.2	6870	424
71	43.5	23.2	8230	596
72	52.7	36.2	8770	1060
73	54.7	15.3	1350	498
75	26.6	26.8	13500	498
76	64.9	7.92	238	119
78	102	8.07	322	153
79	62.1	5.61	88.7	43.4
81	91.3	8.36	115	54.3
84R*	49.2	5.66	1750	78.9
84L*	134	35.2	15500	284
85L	34.6	32.5	16700	572
86R	23.6	3.99	1640	96.6
86L	44.1	48.2	17800	699
88R	21.4	2.90	1430	90.5

* Repeated Analysis, Refer to Section 3.

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
88L	29.1	6.11	1810	230
89R*	BDL	BDL	8200	420
89L*	17.2	7.2	1530	298
90R	BDL	BDL	2980	540
90L	31.2	13.9	2220	631
91R	34.9	11.0	3180	480
91L	30.4	23.9	2570	1130
92R	33.9	3.40	454	149
92L	61.5	9.15	304	231
94R	65.0	5.67	515	185
94L	12.1	3.26	296	223
95R	19.3	1.29	178	61.7
95L	13.6	1.36	103	80.7
97R	27.3	2.10	119	53.8
97L	21.9	1.60	74.8	49.9
98R	16.3	1.86	108	37.8
98L	12.0	1.03	18.9	106
99R	25.1	2.25	132	41.7
99L	15.3	1.10	10.4	21.8
102E	3.62	1.31	BDL	173
103R	28.6	43.5	18500	302
103L*	41.7	44.4	99700	340
105R	48.5	49.2	20300	499
105L	49.8	47.4	39000	732
107R	121	64.0	30300	898
107L*	151	79.6	37500	912
108R	15.9	11.6	3060	448
108L	25.9	11.4	3430	487
109R	20.2	14.2	2750	548
109L	28.9	13.7	3670	638
110L	38.5	17.5	3390	699
112R	54.3	10.2	601	157
112L	35.2	5.80	708	130
113R	81.1	11.6	588	162
113L	92.5	10.1	740.8	130
114R	11.4	1.11	93.2	22.5
114L	13.5	1.42	110	18

Repeated Analysis, Refer to Section 3.

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
116R	31.7	3.08	124	31.7
116L	12.9	1.24	123	19.4
118R	16.1	1.32	21.7	21.8
118L	17.8	2.64	23.9	5.86
120R	22.5	2.20	52.6	10.2
120L	20.6	2.20	30.6	6.66
122	4.80	2.83	BDL	259
123	1.69	2.00	BDL	45.9
125R*	58.2	88.1	67600	614
125L	1.81	6.68	16.1	28.7
127R*	91.8	87.1	87600	951
127L	.323	10.4	5.01	55.4
129R	115	104	25200	1080
129L	2.06	11.9	4.73	58.9
131R	37.6	37.1	3430	489
131L	.831	3.57	17.8	18.1
132R	38.4	38.8	2870	536
132L	.27	3.71	4.40	19.0
133R	55.1	34.2	4550	1070
133L	1.34	4.99	8.75	29.7
134R	19.0	14.5	1120	319
134L	1.81	2.05	6.10	10.2
136R	21.4	9.81	1150	308
136L	1.16	2.84	4.08	16.1
137R	21.3	2.63	228	46.9
137L	2.45	1.63	4.23	7.98
139R	30.1	3.29	305	34.0
139L	1.08	2.23	14.2	12.4
141R	9.13	1.14	79.2	6.11
141L	1.07	1.34	3.97	7.42
143R	6.84	0.84	77.5	5.84
143L	.95	1.85	5.83	11.8
145	2.66	1.44	BDL	980
146	1.08	.65	BDL	27.5
148R	10.7	23.7	7570	172
148L	11.3	25.4	6460	198
150R	17.1	29.0	7580	311
150L	20.8	31.1	7980	319

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
152R	24.5	38.7	8810	432
152L	31.0	37.0	10600	443
154R	20.9	7.53	445	127
154L	7.66	8.75	698	156
155R	18.6	8.11	438	147
155L	8.53	9.80	645	195
156R	22.7	10.7	782	235
156L	12.4	15.1	579	242
157R	12.6	4.59	231	72.7
157L	13.3	5.66	90.9	87.2
159R	11.2	2.90	243	66.3
159L	22.8	9.38	108	9.79
160R	5.87	.82	39.5	8.11
160L	9.14	1.48	13.7	13.2
162R	6.07	.78	39.5	7.94
162L	15.4	1.83	17.3	14.3
164R	2.65	.35	6.42	2.03
164L	4.14	.552	3.25	2.76
166R	5.24	.57	3.38	2.90
166L	4.88	.57	8.49	2.42
169R	17.4	13.3	2440	214
169L	16.3	13.4	4560	195
170R	18.4	13.0	5130	254
170L	21.3	14.2	4940	282
171R	26.5	15.1	4080	361
171L	25.1	15.2	5040	389
173R	50.3	33.1	4880	463
173L	43.2	25.0	6230	531
174R	32.9	25.2	6440	301
174L	35.9	26.2	8530	486
175R	43.8	30.6	11100	531
175L	65.4	29.9	13700	756
176R	42.0	26.8	8000	649
176L	39.9	26.0	5800	283
177R	54.4	39.3	8440	490
177L	63.9	36.3	11800	711
178R	40.1	32.7	10600	501
178L	45.9	35.5	9020	405

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
179R	59.6	45.9	9250	437
179L	70.9	35.5	13200	655
180R	55.7	41.3	10900	588
180L	42.6	27.0	19300	1110
181R	102	75.0	19600	1500
181L	93.4	60.4	14100	884
182R	54.4	43.4	9970	617
182L	54.7	42.2	12000	704
183R	60.3	46.4	11700	812
183L	61.8	45.2	15100	1000
184R	81.0	61.3	12900	857
184L	71.2	51.8	19200	1210
201	132	89.0	17900	1480
202	4.16	.85	73.6	88.7
204	12.9	8.23	2260	188
204L	15.6	9.87	2520	209
205R	17.8	9.74	2610	262
206R	20.4	9.99	2630	319
206L	23.1	12.6	3010	397
207R	114	19.2	4840	.398
207L	41.8	22.3	6270	494
208R	25.1	16.1	4910	308
208L	34.2	24.0	5820	347
209R	34.4	21.0	6280	403
209L	30.3	18.8	5530	351
210R	44.1	28.8	10200	697
210L	34.9	21.9	7710	525
211R	115	29.3	8740	653
211L	50.9	32.2	13600	1070
212R	42.3	31.2	9300	587
212L	35.0	24.9	9010	531
213R	37.3	25.1	11100	691
213L	40.1	27.9	4080	228
214R	41.5	27.5	17200	1220
214L	39.9	26.7	18800	1370
215R	220	59.6	13000	1090
215L	221	54.2	13900	1170
216R	62.1	39.3	12400	927
216L	56.0	37.2	9010	612

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
217R	66.2	47.0	12300	958
217L	67.8	47.3	9430	679
218R	56.5	38.5	13100	1090
218L	67.9	46.4	12200	929
220	4.00	3.04	412	83.6
223R	49.3	8.24	1420	96.7
223L	8.58	4.54	1830	65.7
225R	6.95	5.18	3380	95.0
225L	5.77	6.08	3560	103
227R	11.9	20.8	6860	666
227L	68.8	37.5	4870	43.6
229R	56.8	37.2	7000	402
229L	39.0	23.2	4900	304
235R	9.15	8.22	3290	258
235L	3.09	12.5	2110	189
239R	11.8	14.2	5950	401
239L	16.3	21.9	6620	348
243R	19.2	33.8	6070	621
243L	15.0	36.4	6270	625
247R	37.3	61.9	15500	1460
247L	38.6	69.5	12900	1220
248	195	98.9	16900	452
249	230	117	20100	631
253R	11.4	19.2	4500	426
253L	11.4	23.8	4880	402
259R	15.2	26.9	7630	513
259L	11.4	21.8	6530	419
265R	23.6	39.4	7800	625
265L	15.8	25.8	8310	677.
271R	32.1	55.7	16000	1370
271L	17.8	63.7	11800	692
273R	32.1	55.8	16000	1370
273L	22.0	78.1	16600	888
277R	34.7	39.7	4710	411.
277L	20.2	31.2	4690	358
279R	30.0	40.3	7440	527
279L	34.9	39.3	6980	466
281R	44.4	58.9	12000	827

Table 2 (cont.). RESULTS OF METAL ANALYSIS OF WATER

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
281L	40.1	49.3	14500	974
283R	43.2	58.4	11500	782
283L	50.7	58.8	12500	870
285R	46.6	65.4	12900	897
285L	37.6	56.9	10200	718
287R	51.0	78.0	13700	1340
287L	72.6	79.5	16400	1580
289R	52.0	79.2	20200	2000
289L	43.2	64.9	19800	2050
291R	76.1	167	23600	2950
294R	66.2	143	22700	2770
294L	103	156	20400	2450
299R	60.6	104	18500	1630
299L	74.3	118	22300	2130
301R	62.8	110	27100	2810
301L	63.3	112	24200	2360
LF01	1290	253	17500	7780
LF02	595	558	54800	7790
LF03	516	1530	86800	13400
LF04	365	10500	133000	15800

Table 3. RESULTS OF METAL ANALYSIS OF EP TOX LEACHATE

Concentrations as ug/ml (ppm)

Element

Sample No.	Zn	Fe	Cd	Ni	Mg	Cu	Pb	Ca
Det. Limit	.027	.048	.021	.10	.018	.009	.105	.174
001	.525	BDL	BDL	BDL	7.73	BDL	63.5	83.2
002	.721	.505	0.0100	BDL	5.95	.0430	65.5	53.4
003	.234	.180	BDL	BDL	2.25	.0800	25.3	25.7
18	BDL	.113	BDL	BDL	2.53	.0610	7.14	6.40
19	.146	BDL	.0310	.196	4.53	.240	12.4	23.2
21	.270	BDL	.0270	.130	4.93	0.0700	41.3	36.1
22	BDL	BDL	BDL	BDL	1.57	BDL	9.71	23.6
27	.360	.360	.0200	.100	7.34	.130	5.30	60.9
29	.260	BDL	.0300	.160	5.22	.0700	43.0	33.4
36L	BDL	17.5	BDL	BDL	29.2	BDL	206	132

Table 3 (cont.). RESULTS OF METAL ANALYSIS OF EP TOX LEACHATE

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
46R	16.5	5.17	74.8	17.8
46L	12.0	5.4	71.5	21.4
59	BDL	1.62	13.9	16.5
82	1.85	6.62	2.82	44.3
83	.81	2.78	21.8	76.3
101R	2.62	3.27	4.61	7.50
101L	1.58	2.02	3.32	8.48
102	1.67	2.01	8.32	17.6
102R	4.86	2.35	11.5	6.54
102L	3.87	2.28	5.81	8.9
121R	.69	4.35	1.88	22.4
121L	.47	2.31	BDL	23.2
124	1.65	1.54	64.5	27.6
140R	2.01	5.24	11.8	44.2
140L*	.62	2.63	34.3	51.9
144R*	.41	5.00	15.4	32.9
144L*	BDL	1.68	50.1	43.5
147L	.55	2.97	36.6	46.8
163R	.57	5.67	3.88	36.9
163L*	BDL	8.74	1.19	43.7
167R	.71	6.09	3.39	30.4
167L*	BDL	14.4	5.30	51.5
168S	.323	3.04	6.54	68.9
185	BDL	1.09	14.2	17.5
186	.16	1.91	20.0	6.34
187	BDL	1.29	47.9	16.9
188	BDL	.38	4.07	5.06
189	BDL	.53	7.52	16.4
190	.23	1.57	10.4	10.6
191	BDL	.92	6.33	13.5
192	1.49	1.12	9.51	3.44
193	.16	.69	14.4	6.41
194	BDL	.54	6.64	21.7
203	.266	2.46	14.4	77.5
250	1.30	3.46	2.66	58.3
251	2.78	20.1	482	151
252	BDL	3.22	BDL	90.2
258R	.32	4.81	3.66	44.4

Table 3 (cont.). RESULTS OF METAL ANALYSIS OF EP TOX LEACHATE

Concentrations as ug/ml (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	.048	.018	.105	.174
258L	.083	2.90	4.69	43.4
264R	.28	3.36	3.13	43.4
264L	.10	3.49	2.66	50.0
270R	2.41	3.62	4.20	43.8
270L	2.54	4.48	2.28	32.1
272R	1.42	3.37	3.91	36.2
272L	3.12	5.61	3.20	41.5
274R*	BDL	4.02	3.45	35.9
274L*	2.79	2.98	4.06	37.6
278R	.515	4.57	5.60	51.5
278L	.21	3.70	14.6	61.1
280R	.24	4.19	5.71	61.3
280L	BDL	3.39	5.78	78.4
282R	BDL	3.67	5.31	92.6
282L	.38	5.40	6.27	74.5
284R	.11	2.66	5.22	6.59
284L	.20	2.49	6.10	68.9
286R	.61	6.92	19.4	73.4
286L	BDL	3.04	3.22	69.5
288R	2.40	1.97	10.8	68.0
288L	1.78	2.45	8.72	66.2
290R	3.22	3.46	2.29	65.4
290L	1.61	2.40	5.96	70.3
292	BDL	3.06	BDL	103
292R	BDL	2.68	6.20	64.0
292L	.44	2.88	1.34	72.2
295R	BDL	2.20	1.92	58.0
295L	BDL	1.68	9.87	63.7
296	BDL	2.87	BDL	74.2
297	BDL	3.00	25.4	90.1
298	.089	4.35	BDL	17.2
300R	BDL	2.79	5.44	85.2
300L	BDL	2.87	2.54	82.1
302R	1.30	4.40	6.68	88.9
302L	BDL	3.41	2.73	94.9
303	BDL	3.27	2.47	82.8

* Repeated analysis, Refer to Section 3

Table 4. RESULTS OF METAL ANALYSIS OF SOILS

Concentrations as ug/g (ppm)

Element

Sample No.	Zn	Fe	Cd	Ni	Mg	Cu	Pb	Ca
Det. Limit	1.35	2.40	1.05	5.1	0.9	0.45	5.25	8.7
01	141	25100	7.89	18.5	3710	102	48700	8960
02	98.4	13500	2.88	25.6	3340	54.0	30200	5410
06	31.7	13500	1.72	15.6	1800	32.0	10600	52700
012	32.3	12700	2.12	12.0	2060	18.7	4810	4740
014	55.5	14100	2.46	17.6	3650	37.4	28100	8755
21	--	33600	--	--	4800	--	48000	10900
23	52.7	33700	4.82	18.5	3640	28.7	29300	10800
27	41.4	29000	6.71	21.7	9490	19.2	1080	14600
29	83.2	34000	2.33	17.5	5370	43.3	46700	10700
36R	--	21100	--	--	2420	--	4810	3300
36L	46.0	12900	1.30	10.1	2227	21.8	3575	2961

Table 4 (cont.). RESULTS OF METAL ANALYSIS OF SOILS

Concentrations as ug/g (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	2.40	.90	5.25	8.7
37	30600	2650	41100	10610
46L	27000	2270	2290	13900
82	16600	1030	736	3790
101R	15800	835	656	1175
101L	13000	1000	1080	2230
102R	14100	1480	1170	9710
102	19900	1230	24300	7780
102L	10500	895	281	2750
121R*	11600	1320	1650	1670
121L*	13100	1770	30500	2420
124	12100	979	20400	2140
140R*	16700	1830	2670	4260
140L	27000	1540	23600	3700
144R*	16400	1560	4730	1850
144L	17900	1310	21600	4190
147	14800	1190	24100	2130
163R	27600	1370	25000	1920
163L	13600	1900	900	3390
167R	45400	1610	774	2170
167L	20000	2690	8120	3920
168S	33000	4250	12500	11600
196	66000	4400	83900	5450
197	63000	5000	76900	7000
198	95400	4270	54000	4100
199	22800	1390	17500	2520
203	15800	1220	8950	3360
221	15100	2860	13400	6630

* Repeated analysis, Refer to Section 3

Table 4 (cont.). RESULTS OF METAL ANALYSIS OF SOILS

Concentrations as ug/g (ppm)

Element

Sample No.	Zn	Fe	Cd	Ni	Mg	Cu	Pb	Ca
Det. Limit	1.35	2.40	1.05	5.1	.9	.45	5.25	8.7
250	40.3	7200	BDL	10.1	2100	15.7	6740	4860
251	216	34800	BDL	33.9	6324	118	81800	9750
252	51.3	8480	5.72	8.48	1960	21.7	11600	7450
258R*	23.3	6670	BDL	6.13	1610	81.9	9150	2460
258L	45.6	10700	BDL	17.1	2260	12.6	594	2470
264R	30.8	11800	BDL	20.4	2590	42.9	713	2430
264L	26.9	7600	BDL	7.41	2010	12.0	1030	2580
270R	61.1	7950	BDL	BDL	1760	17.0	2440	21800
270L	45.2	8120	BDL	9.55	1980	19.1	3500	15400
272R*	26.5	6800	3.67	8.45	3470	19.30	29200	10100
272L*	25.5	6260	BDL	7.54	1520	8.45	14500	2860
274R	26.7	8300	BDL	8.65	1930	27.7	3310	3160
274L	38.8	13800	BDL	13.8	8330	25.5	1000	10600

* Repeated analysis, Refer to Section 3

Table 4 (cont.). RESULTS OF METAL ANALYSIS OF SOILS

Concentrations as ug/g (ppm)

	Element			
Sample No.	Fe	Mg	Pb	Ca
Det. Limit	2.40	0.9	5.25	8.7
278R	16900	2690	2570	40700
278L	14500	2910	1100	7430
280R	12000	2690	933	65000
280L	17500	3200	719	31700
282R	15300	1990	1270	3890
282L	16200	2370	1220	5250
284R	16800	2750	4880	16800
284L	13800	2580	2200	51700
286R	23800	3220	5790	6500
286L	23000	4600	1820	8540
288R	12100	2020	4410	3670
288L	12500	2170	5990	6140
290R	18100	2760	2510	12900
290L	26600	2310	10200	13800
292	23800	5110	14600	20200
292R	24600	2390	3470	8570
292L	18200	2230	7490	9370
295R	15000	1890	655	26000
295L	52800	6410	6360	15800
296	22000	3000	9250	34800
297	12900	3130	8240	5600
298	16900	4510	8200	10700
300R	12700	2000	1790	4070
300L	25300	1980	4060	3960
302R	14400	1880	6640	16900
302L	16200	2230	3300	4280
303	16500	2040	14900	5070
P01	75000	1660	9480	1540
P02	14200	2930	753	2810
P03	6620	1840	3960	46600
P04	13400	6540	6660	18600
P05	11470	3320	4500	7700
P06	8870	1580	11100	4020
P07	8347	1570	10580	3090
P08	13800	5670	23500	7780
P09	20400	10100	37600	14900
P010	21900	11600	37600	16200
P011	19500	11200	65000	15500

Table 4 (cont.). RESULTS OF METAL ANALYSIS OF SOILS

Concentrations as ug/g (ppm)

Element

Sample No.	Fe	Mg	Pb	Ca
Det. Limit	2.40	0.9	5.25	8.7
P012	20600	9430	77200	13100
P018	1180	161	184	444
P019	13700	1130	13400	8620
P020	8110	7190	2360	20000
P021	8500	2860	3410	13800
P022	10700	1970	7740	6200
P023	4400	940	4021	1930
P024	9270	4490	32900	6700
P025	12100	7300	60100	11000
P026	14700	8910	75000	13400
P027	BDL	BDL	104000	BDL
P028	34000	6530	139000	9800

Table 5. RESULTS OF PER CENT MOISTURE ANALYSIS

Sample Number	% Moisture
01	12.5
02	12.1
03	12.6
23	14.1
27	12.2
29	12.0
36R	11.1
36L	24.8
37	11.4
46R	16.5
46L	15.2
58	7.3
59	2.7
60	7.7
82	17.5
101R	14.9
101L	14.5
102	16.0
102R	17.6
102L	12.3
121R	14.5
121L	13.3
124	24.5
140L	11.5
140R	15.0
144R	14.6
1441	15.2
147	17.0
163R	15.5
163L	13.7
167R	12.1
167L	15.6
168S	17.9
195	99.0
196	85.0
197	31.8
198	46.3
199	13.9
221	14.1
250	10.5
252	15.3

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Table 6. RESULTS OF EDTA ANALYSIS

Sample Number	Result Percent
24	13.1
25	2.94
35L	6.39
35R	.863
42L	11.4
42R	7.57
45L	1.92
45R	2.49
56	22.3
57	2.00
63	16.3
64	2.20
69	14.8
88L	11.6
88R	3.46
102E	34.3
103L	13.9
103R	9.58
107L	11.4
107R	11.7
122	15.4
123	7.87
129L	ND
133L	ND
133R	4.67
145	22.5
146	5.44
152L	14.3
152R	14.0
156R	.529
168E	22.5
169L	18.4
169R	19.3
170L	15.6
170R	15.4
171L	11.8
171R	15.6
173L	19.6
173R	19.6
174L	12.9
174R	12.6

Table 6 (cont.).

Sample Number	Result Percent
175L	12.2
175R	12.1
176L	12.2
176R	12.0
177L	13.9
177R	15.4
178L	8.40
178R	9.96
179L	9.85
179R	9.20
180L	9.20
180R	9.35
181L	11.9
181R	12.3
182L	6.73
182R	6.69
183L	6.50
183R	6.62
184L	6.01
184R	5.48
201	9.16
202	22.8
206L	15.4
206R	15.4
210L	12.5
210R	13.4
214L	11.2
214R	10.6
218L	9.62
218R	7.22
220	22.9
222L	18.3
222R	21.1
223L	13.4
223R	13.7
224L	12.9
224R	12.1
225L	11.9
225R	13.6
226L	10.3
226R	12.2
227L	9.73
227R	12.1
228L	8.94
228R	9.54
229L	8.67
229R	9.58

Table 6 (cont.).

Sample Number	Result Percent
231	23.4
235L	8.48
235R	13.0
239L	8.56
239R	8.48
243L	6.58
243R	5.86
247L	4.98
247R	3.65
248	12.1
249	11.0
252E	22.7
253L	18.9
253R	9.62
259L	13.6
259R	14.2
265L	10.3
265R	14.8
271L	12.8
271R	13.5
273L	11.3
273R	10.8
277L	18.1
277R	19.8
279L	11.9
279R	13.7
281L	14.5
281R	14.5
283L	11.3
283R	12.1
285L	8.67
285R	10.6
287L	10.6
287R	11.0
289L	8.40
289R	8.63
291	22.7
291L	9.54
291R	8.48
294L	7.34
294R	7.53
299L	7.68
299R	7.22
301L	4.22
301R	6.35

Table 7. RESULTS OF TOTAL SOLIDS ANALYSIS

Concentrations are in ug/ml (ppm)

Sample #	Result
04	3,500
05	860
07	82,700
08	8,900
09	116,700
10	3,400
11	1,300
15	3,000
16	134,300
17	660
20	50,600

SECTION II

QA/QC PROCEDURES AND RESULTS

QA/QC PROCEDURES

Metals Analysis

The QA/QC data for soil samples contains duplicates, matrix spikes, and an NBS standard.

Results of duplicate soil analyses are summarized in table (8). In some cases, poor lead reproducability was obtained. This was due to non-uniform distribution of the lead contamination and non-uniform sample particle size. This is confirmed by the constant levels of other metals in the background matrix, especially magnesium and iron.

The spiked samples gave good recovery in most cases. Poor recovery both high and low can again be attributed to non-homogenous lead distribution. The results are summarized in table (9).

EP Tox samples were analyzed in duplicate. In all cases good agreement was obtained. The results are summarized in table (10).

Water samples were analyzed in duplicate. The results are summarized in table (11). The analytical precision was acceptable in all cases.

Spiked water samples could not be run initially since in most samples the lead concentration was greater than the concentration of the spiking standards available. Several samples were spiked after dilution. These results are discussed in the section on repeated analysis.

To determine whether the high level of EDTA was an interferent, 5 point calibration ranges were done using a background EDTA concentration of 0.2 and 0.02 per cent. This corresponded to the EDTA level in the water samples after a 1/1000 or 1/100 sample dilution prior to analysis. No significant interferences were found. The results are summmarized in table (12).

In all cases the analyzed metal concentration is corrected for blank subtraction and interfering metals. The experimentally determined interelement corrections are automatically included in the result.

An instrument variation of up to ±20% is not uncommon between samples or from day to day.

Running a daily EMSL standard was the method used to determine this fluctuation. The results of the EMSL analysis are summarized in table (13). All EMSL results are within the 95% confidence interval, with the exception of concentration 2 EP 283. This was not discovered until after all analyses had been completed. This was a two month study, and the result in question occurred on the next to the last day (7/11/86), and represent only six samples. Subsequently, analyses performed on the next day (7/12/86) was validated by a new preparation of concentration 1 WP 283 using the same standards from July 11. The result for July 12 was within the 95% confidence interval.

EDTA Analysis

Upon standardization of the calcium chloride solution, an average was taken of 4 nearly identical titrations according to the method in Section I. The results of the standardization are given in Table (14).

Approximately 10% of the samples were analyzed in duplicate. Results are calculated using the following formula and are summarized in Table (15). In all cases, satisfactory QA/QC results were achieved.

$$\text{RPD} = \text{Relative Percent Difference} = \frac{\text{Trial 1} - \text{Trial 2}}{\text{Average}} \times 100\%$$

All duplicate results show a Relative Percent Difference of less than 10% which was considered acceptable.

The highest RPD was 223L, possibly due to the color of the sample being tan, making the endpoint being more difficult to determine.

Certain samples, due to their dark color, were diluted with distilled water and more than 10 drops of Erichrome Black T indicator were added. This was done to lighten the solution color. This would not effect the result since total moles were being titrated.

A blank consisting of 100 ml of distilled water was analyzed with each standard calcium chloride solution and buffer solution. It was found that one drop of the calcium chloride titrant gave an immediate titration end point in the blank. This demonstrated that adding distilled water to a sample did not change the amount of titrant consumed.

Table 8. RESULTS OF DUPLICATE ANALYSIS FOR METALS - SOILS

All concentrations in ug/g (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	%RD
01	Zn	141	108	33.0	26
	Fe	25100	22700	2400	10
	Cd	7.89	6.53	1.36	19
	Ni	18.5	19.6	1.1	5.8
	Mg	3710	3490	220	6.1
	Cu	102	61.0	41.0	50
	Pb	48700	45100	3600	7.7
	Ca	8960	8270	690	8.0
02	Zn	98	120	22.0	20
	Fe	13500	12500	1000	7.7
	Cd	2.88	2.87	0.01	0.3
	Ni	25.9	23.2	2.70	11
	Mg	3340	3450	110	3.2
	Cu	54.1	64.8	10.7	18
	Pb	30200	89700	59500	99
	Ca	5400	5520	120	2.2
27	Zn	41.4	29.2	12.2	34
	Fe	28900	14700	14200	33
	Cd	6.70	2.11	4.59	104
	Ni	21.7	10.7	11	68
	Mg	9490	1540	7950	144
	Cu	19.2	41.0	21.8	72
	Pb	1080	44200	43000	95
	Ca	14600	41.0	14600	200
102	Fe	19900	19000	9000	4.6
	Mg	1230	1650	420	29
	Pb	24300	13300	11000	59
	Ca	7780	5050	2730	42
197	Fe	63000	49000	14000	25
	Mg	5000	4200	800	17
	Pb	76900	10000	66900	153
	Ca	7000	5960	1040	16
221	Fe	15100	13200	1900	13
	Mg	2850	2170	680	27
	Pb	13400	23200	9800	54
	Ca	6630	4990	1640	28

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Table 8. DUPLICATE ANALYSIS FOR METALS - SOILS (Cont'd)

All concentrations in ug/g (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	%RD
251	Zn	216	222	6.00	2.7
	Fe	34800	38700	3900	11
	Cd	BDL	BDL	0	0
	Ni	33.8	37.0	3.20	9.0
	Mg	6320	7340	1020	15
	Cu	118	123	5.00	4
	Pb	81800	96500	14700	11
	Ca	9750	11500	1750	16
282R	Fe	15300	13400	1900	13
	Mg	1990	1630	360	20
	Pb	1270	5890	4620	129
	Ca	3900	5760	1860	38
288R	Fe	12100	18900	6800	44
	Mg	2020	3030	1010	40
	Pb	4400	4900	500	11
	Ca	3700	5560	1860	40
296	Fe	22000	13600	8400	47
	Mg	3000	2070	930	37
	Pb	9250	6700	2550	32
	Ca	34700	6370	28330	138
303	Fe	16500	15600	900	5.6
	Mg	2040	2110	70	3.3
	Pb	14900	12500	2400	17
	Ca	5070	9700	4630	63
P005	Fe	11500	11400	100	0.8
	Mg	3320	3900	580	16
	Pb	4500	2950	1550	41
	Ca	7700	12700	5000	49

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Table 9. RESULTS OF MATRIX SPIKE ANALYSIS LEAD IN SOIL

(Results in total ug)

Sample No.	Total Amount	Sample Amount	Amount Added	Amount Recovered	% Recovery
01	34750	27400	5000	7350	147
06	8950	7200	2000	1750	87.5
23	13400	16800	1000	0	0
46L	20500	1150	20000	19400	96.8
124	26500	10200	20000	16300	81.5
221	25300	6720	20000	18600	92.9
284L	19400	2390	20000	17000	85.0
288L	25500	3000	20000	22500	113
298	14300	5420	20000	8880	44.4
302L	19100	1680	20000	17420	87.1
P012	64500	35500	20000	29000	145
P026	53500	37600	20000	15900	79.5

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Table 10. RESULTS OF DUPLICATE ANALYSIS FOR METALS - EP TOX

All concentrations in ug/ml (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	%RD
01	Zn	0.525	.512	.013	2.5
	Fe	BDL	BDL	0	0
	Cd	BDL	0.04		
	Ni	BDL	BDL	0	0
	Mg	7.73	6.86	0.87	12
	Cu	BDL	0.01		
	Pb	63.5	68.7	5.20	4.8
	Ca	83.2	80.0	3.20	3.9
82	Fe	1.85	1.62	0.23	13
	Mg	6.62	6.18	0.44	6.9
	Pb	2.82	2.77	0.05	1.7
	Ca	44.3	42.7	1.60	3.7
140R	Fe	2.01	2.34	0.33	15
	Mg	5.24	5.18	0.06	1.1
	Pb	11.8	12.2	0.40	3.3
	Ca	44.2	44.2	0	0
167R	Fe	0.71	0.40	0.31	56
	Mg	6.08	5.98	0.10	1.7
	Pb	3.39	3.27	0.12	3.6
	Ca	30.4	30.1	0.30	1.0
203	Fe	0.26	0.29	0.03	11
	Mg	2.46	2.52	0.06	2.4
	Pb	14.4	14.6	0.20	1.4
	Ca	77.5	77.6	0.1	0.1
252	Fe	BDL	BDL	0	0
	Mg	3.22	2.17	1.05	39
	Pb	BDL	3.0		
	Ca	90.2	48.0	42.2	26
270R	Zn	BDL	0.11		
	Fe	2.41	2.43	0.02	0.8
	Cd	BDL	0.04		
	Ni	BDL	BDL	0	0
	Mg	3.62	3.18	0.44	13
	Cu	BDL	BDL	0	0
	Pb	4.20	3.79	0.41	10
	Ca	43.7	39.5	4.20	10

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Table 10. DUPLICATE ANALYSIS FOR METALS - EP TOX (Cont'd)

All concentrations in ug/ml (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	%RD
280R	Fe	0.24	0.23	0.01	4.2
	Mg	4.19	3.90	0.29	7.2
	Pb	5.71	6.28	0.57	9.5
	Ca	61.3	62.1	0.8	1.3
290L	Fe	1.61	1.63	0.02	1.2
	Mg	2.40	2.41	0.01	0.4
	Pb	5.96	5.94	0.02	0.3
	Ca	70.3	70.3	0	0
302L	Fe	BDL	BDL	0	0
	Mg	3.41	3.43	0.02	0.6
	Pb	2.73	2.73	0	0
	Ca	94.9	94.9	0	0

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Table 11. RESULTS OF DUPLICATE ANALYSIS FOR METALS - WATERS

All concentrations in ug/ml (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	% RD
*24	Fe	7.64	3.64	4.00	71.0
	Mg	14.5	11.6	2.90	22.0
	Pb	4780	5000	220	4.5
	Ca	308	220	88.0	33.0
*92R	Fe	33.9	21.6	12.3	44.0
	Mg	3.40	5.23	2.23	51.0
	Pb	454	418	36.0	8.3
	Ca	149	186	37.0	22.0
*94R	Fe	65.0	41.3	23.7	44.0
	Mg	5.67	8.90	3.23	44.0
	Pb	515	439	76.0	16.0
	Ca	185	250	65.0	30.0
*110L	Fe	38.5	24.5	14.0	44.0
	Mg	17.5	20.2	2.7	14.0
	Pb	3400	4920	1520	36.0
	Ca	699	699	0	0.0
*116L	Fe	12.9	20.5	7.60	23.0
	Mg	1.24	1.29	0.05	3.9
	Pb	122	78.6	43.4	43.0
	Ca	19.4	22.8	3.40	16.0
*123	Fe	1.69	0.64	1.05	90.0
	Mg	2.00	1.32	0.68	41.0
	Pb	BDL	6.54		
	Ca	45.9	38.0	17.9	43.0
*156R	Fe	22.7	52.9	30.2	80.0
	Mg	10.7	12.0	1.30	11.0
	Pb	782	790	8.00	1.0
	Ca	235	309	74.0	27.0
*173L	Fe	43.2	99.5	56.3	78.0
	Mg	25.0	35.5	10.5	35.0
	Pb	6230	7850	1620	23.0
	Ca	531	798	267	40.0
220	Fe	4.00	5.84	1.84	37.0
	Mg	3.04	3.70	0.66	19.0
	Pb	412	475	63.0	14.0
	Ca	83.6	102	18.4	19.0

*Duplicate analysis performed on different days.

Table 11.
RESULTS OF DUPLICATE ANALYSIS FOR METALS - WATERS (Cont'd)

All concentrations in ug/ml (ppm)

Sample No.	Parameter	Run #1	Run #2	Dif.	% RD
229R	Fe	56.8	53.4	3.40	6.2
	Mg	37.2	35.2	2.00	5.5
	Pb	7000	6080	920	14.0
	Ca	402	359	43	7.4
235L	Fe	3.09	3.01	0.08	2.6
	Mg	12.5	11.9	0.60	4.9
	Pb	2110	2000	110	5.4
	Ca	189	181	8.00	4.3
247L	Fe	38.6	34.6	4.00	11.0
	Mg	69.5	66.6	2.90	4.3
	Pb	12900	13000	100	0.7
	Ca	1220	1210	10.0	0.8
253R	Fe	11.4	12.2	0.80	6.8
	Mg	19.2	19.8	0.60	3.1
	Pb	4500	3900	600	14.0
	Ca	426	431	5.00	1.2
285L	Fe	37.6	36.6	1.00	2.6
	Mg	56.9	55.4	1.50	2.6
	Pb	10200	9870	330	3.3
	Ca	718	698	20.0	2.8
289L	Fe	43.2	44.2	1.00	2.3
	Mg	64.9	67.1	2.20	3.3
	Pb	19800	19600	200	1.0
	Ca	2050	2020	30.0	1.5
294L	Fe	103	103	0	0
	Mg	156	155	1.00	0.6
	Pb	20400	20900	500	2.4
	Ca	2450	2520	70.0	2.8
301L	Fe	63.3	64.3	1.00	1.6
	Mg	112	114	2.00	1.8
	Pb	24200	23600	600	2.5
	Ca	2360	2330	30.0	1.2
LF01	Fe	1290	1270	20.0	1.6
	Mg	253	253	0	0
	Pb	17500	17600	100	0.6
	Ca	7780	7630	150	1.9

Table 12.

EFFECT OF EDTA CONCENTRATION ON THE CALIBRATION RANGE FOR LEAD

Standard concentrations are in ug/ml (ppm)

% Concentration of EDTA	0 ppm	10 ppm	50 ppm	100 ppm	150 ppm
0.02	0.25	11.5	54.8	114	157
0.20	0.05	13.5	52.0	120	156

% EDTA	Correlations	Slope	Intercept
0.02	.998	1.06	1.61
0.20	.995	1.07	2.05

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Table 13.
RESULTS OF ANALYSIS FOR ENVIRONMENTAL MONITORING SURVEILLANCE LABORATORY SAMPLE

All concentrations in ug/ml

Metals EP Concentration 1 WP 283 for Lead

Date	Analysis	True Value	95% Confidence Range	Difference	%RE
5/13/86	10.0	10.0	7.89 - 12.9	0.	0.
5/21/86	10.6	10.0	7.89 - 12.9	.6	6.0
5/26/86	9.66	10.0	7.89 - 12.9	.34	3.4
5/31/86	8.91	10.0	7.89 - 12.9	1.09	11.0
6/2/86	8.97	10.0	7.89 - 12.9	1.03	10.0
6/3/86	9.29	10.0	7.89 - 12.9	.71	7.0
6/4/86	9.95	10.0	7.89 - 12.9	.05	0.5
6/11/86	10.2	10.0	7.89 - 12.9	.20	2.0
6/12/86	10.8	10.0	7.89 - 12.9	.80	8.0
6/13/86	9.15	10.0	7.89 - 12.9	.85	8.5
6/17/86	11.3	10.0	7.89 - 12.9	1.30	13.0
6/23/86	8.85	10.0	7.89 - 12.9	1.15	12.0
6/25/86	10.2	10.0	7.89 - 12.9	.20	2.0
6/26/86	10.2	10.0	7.89 - 12.9	.20	2.0
6/27/86	10.7	10.0	7.89 - 12.9	.70	7.0
6/30/86	10.5	10.0	7.89 - 12.9	.50	5.0
7/3/86	8.48	10.0	7.89 - 12.9	1.52	15.0
7/8/86	12.1	10.0	7.89 - 12.9	2.10	21.0
7/10/86	10.6	10.0	7.89 - 12.9	.60	6.0
7/12/86	9.59	10.0	7.89 - 12.9	.41	4.1

Metals EP Concentration 2 WP 283 for Lead

Date	Analysis	True Value	95% Confidence Range	Difference	%RE
7/11/86	18.1	16.0	14.3 - 17.9	2.1	13.0

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Table 14. RESULTS OF CALCIUM CHLORIDE STANDARDIZATION

EDTA Mass	Volume-calcium Chloride	Experimental Molarity
Standard Solution 1		
2.683	14.25	.5057
2.754	14.70	.5032
2.695	14.35	.5044
2.710	14.40	.5055
$\bar{X}$ = .5047	S = .001152	% RSD = .228
Standard Solution 2		
2.61655	13.90	.5057
2.65424	14.00	.5093
2.91942	15.45	.5076
2.92816	15.55	.5059
$\bar{X}$ = .5071	S = .001682	% RSD = .3317
Standard Solution 3		
2.85706	14.95	.5135
2.69640	14.05	.5157
2.69635	14.15	.5120
2.69254	14.00	.5168
$\bar{X}$ = .5145	S = .002158	% RSD = .4196

All of the above had a Percent Relative Standard Deviation of less than half a percent which was considered acceptable.

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Table 15.
RESULTS OF DUPLICATE ANALYSIS FOR EDTA - WATERS

Sample Number	Trial 1	Trial 2	AVG	% RPD
24	13.1	13.	13.5	.760
145	22.5	22.5	22.5	0
146	5.44	5.51	5.48	1.28
169R	19.3	19.4	9.35	.517
170R	15.4	15.5	15.45	.647
178L	8.40	8.48	8.44	.948
182L	6.73	6.73	6.73	0
223L	13.4	14.6	14.0	8.57
223R	12.5	12.9	12.7	3.15
235R	13.0	12.6	12.8	3.13
252E	22.7	21.5	22.1	5.43
273R	10.8	10.4	10.6	3.77
279L	11.9	11.8	11.85	.844
291	22.7	22.6	22.65	.442
301	6.35	6.27	6.31	1.27

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SECTION III

REPEATED ANALYSES

Repeated Analysis

On 6/24/86 repeat metal analysis was requested for 7 soil samples, 15 water samples, and 7 samples for EP Tox extraction and lead analysis of the leachate.

Four of the water samples were not available due to either being previously completely used for analysis or being missing from the sample storage area. The remainder were analyzed as described in Section I. The results of this analysis are summarized in Table (16).

Results that exceeded more than three standard deviations from the mean were discarded. These samples are designated by an asterisk.

It was not possible to obtain reliable results for 3 of the water samples. This was possibly due to some solution instability which caused the measurable lead concentration to fluctuate. Results are summarized in Table (17).

These three samples were appropriately diluted, analyzed, spiked and reanalyzed. In all three cases, excellent spike recoveries were obtained. However, there is no reason to believe that the results of this final analysis was any more valid than the preceeding ones. The results of this analysis were summarized in Table (18).

There was an insufficient sample mass remaining for a full scale EP Tox extraction. The procedure was modified as follows. Twenty grams of sample was placed in an 8 oz sample jar. To this was added sixteen times the sample weight in deionized water along with sufficient acetic acid to maintain the pH at 5.0 ± 0.2 pH unit. The sample was agitated for 24 hours on a shaker table. After this additional deionized water was added according to the formula in section one.

The results of this replicate analysis are summarized in Table (19).

Soil samples were redigested according to the procedure described in Section 1. The results are summarized in Table (20). The results of 2 lead analyses was later shown to be the result of instrument error. These results are marked with an asterisk. The precision of this analysis is given in Table (21). This table gives further evidence of poor sample homogeneity.

Samples 121R-1 was spiked with 20000 ug lead and sample 121L-1 was run in duplicate. The results of these analyses are shown in Tables (22) and (23). In both cases, suitable QA/QC results were obtained.

For samples where the replicate analysis is significantly different than the original result, there apparently was an error either in the analysis or in the subsequent data processing.

Comments

Sample numbers are followed by a digit. This digit represents the number of the reanalysis i.e., 121R-1 is a redigestion and analysis of the sample, 121R-1A is a reanalysis of the sample solution resulting from the 121R-1 digestion.

Table 16. RESULTS OF REPEATED ANALYSIS - WATER

Concentrations in ug/ml (ppm)

Sample No.	Fe	Mg	Pb	Ca
*65	45.1	43.9	68000	409
65-1	88.2	61.9	30700	794
65-2	81.9	80.8	32900	143
	Pb = 31800	n = 2	% RSD = 7	
67	85.6	47.9	84600	543
67-1	89.6	54.7	86500	1080
*67-2	121	83	29100	1430
67-3	81.6	68.9	90800	1350
	Pb = 87300	n = 3	% RSD = 4	
*84R	49.2	5.6	1750	78.9
84R-1	66.1	48.6	20800	626
84R-2	96.8	78.4	35200	1160
84R-3	43.9	55.4	19300	563
	Pb = 25100	n = 3	% RSD = 35	
84L	134	35.2	15500	284
84L-1	313	75.7	21700	1100
84L-2	306	91.1	18200	1020
84L-3	54.4	57.3	19700	1090
	Pb = 18800	n = 4	% RSD = 14	
*89R	BDL	BDL	8200	420
89R-1	34.4	9.65	3170	424
89R-2	23.1	10.8	3340	482
89R-3	BDL	10.0	3320	436
	Pb = 3280	n = 3	% RSD = 3	
89L	17.2	7.18	1530	298
89L-1	47.2	10.1	1900	498
89L-2	12.7	9.73	2420	609
89L-3	BDL	7.76	1800	641
	Pb = 1910	n = 4	% RSD = 20	

*Data rejected

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Table 16. RESULTS OF REPEATED ANALYSIS - WATER (CONT'D)

Concentrations in ug/ml (ppm)

Sample No.	Fe	Mg	Pb	Ca
*125R	58.2	88.1	67600	614
125R-1	65.4	74.5	19000	746
125R-2	61.8	107	27700	1340
125R-3	28.6	72.6	17900	746
	Pb = 21600	n = 3	% RSD = 25	
157R	12.6	4.59	231	72.7
*157R-1	14.8	3.07	616	154
157R-2	9.51	3.32	285	153
157R-3	BDL	1.14	114	208
	Pb = 210	n = 3	% RSD = 16	

*Data rejected

Table 17. ANALYSIS THAT FAIL TO MEET QA/QC STANDARDS

Results in ug/ml (ppm)

Sample No.	Fe	Mg	Pb	Ca
103-L	41.7	44.4	99700	340
103-L1	108	92.3	40600	4590
103-L2	132	128	26700	3700
103-L3	89.4	107	82200	2920
103-L4	97.9	100	66100	3500
107-L	151	79.6	37500	912
107-L1	150	97.5	144000	2170
107-L2	169	121	86800	2370
107-L3	99.7	103	181000	2350
107-L4	116	103	98200	1710
127-R	91.8	87.1	87600	951
127-R1	76.8	59.6	17500	924
127-R2	80.6	86.6	28400	1940
127-R3	49.2	67.0	175000	1330
127-R4	54.8	61.2	36300	1350

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Table 18.
RESULTS OF SPIKED SAMPLES FOR REPEATED ANALYSIS - WATER

Results in concentrations ug/ml (ppm Lead)

Sample No.	Dilution	Conc.	Conc. Added	Conc. Recovered	% Rec.
103-L5	1/1000	21.0	40.0	45.7	114
107-L5	1/1000	27.6	40.0	41.1	103
127-R5	1/1000	17.0	40.0	43.6	109

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Table 19. RESULTS OF REPEATED ANALYSIS - E.P. TOX

Concentrations in ug/ml (ppm)

Sample No.	Fe	Mg	Pb	Ca
140L	0.62	2.63	34.3	51.2
140L-1	BDL	4.47	4.28	125
144R	0.41	5.00	15.4	32.9
144R-1	BDL	3.83	5.3	63.9
144L	BDL	1.68	50.0	43.5
144L-1	BDL	2.91	34.9	55.1
1631	BDL	8.74	1.19	43.7
163L-1	0.48	4.66	4.03	79.1
167L	BDL	14.4	5.28	51.5
167L-1	BDL	12.1	4.76	50.9
274R	BDL	4.02	3.45	35.9
274R-1	BDL	3.44	1.70	75.3
274L	2.78	2.98	4.06	37.6
274L-1	0.15	2.96	2.58	76.7
274L-1 Dup.	0.29	2.84	2.94	77.1

Table 20. RESULTS OF REPEATED ANALYSIS - SOILS

Concentrations in ug/g (ppm)

	Sample No.	Fe	Mg	Pb	Ca
Original	121R	11600	1320	1650	1666
Re-analysis	121R-A	14400	2500	1320	4740
New Digestion	121R-1	10100	2080	3410	4160
Re-analysis	121R-1A	10300	2500	3040	4210
	121L	13100	1780	30500	2420
	121L-A	10700	2430	25800	4390
	121L-1	13000	2710	1000	4090
	121L-1A	13700	2540	1020	4130
	140R	16700	1830	2670	4260
	140R-1	20200	2950	2510	7670
	144R	16400	1560	4700	1850
	144R-A	16600	2880	5800	5150
	144R-1	8120	2140	1980	14700
	144R-1A	6950	1790	1520	12800
	258R	6660	1610	9150	2460
	258R-A	5440	1360	8060	2520
	258R-1	15900	2340	2971	10500
	258R-1A	14200	2090	2860	10400
	272R	6800	3470	29200*	10100
	272R-A	6500	3150	2820	11300
	272R-1	17400	2450	1480	6540
	272R-1A	12800	1860	1410	5290
	272L	6260	1520	14500*	2860
	272L-A	5650	1540	1290	3070
	272L-1	22500	2750	1120	9560
	272L-1A	16400	2070	1050	7390

*Results were later shown to be instrument error.

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Table 21. RESULTS COMPARISON FOR REPEATED SAMPLES - SOILS

Sample Number	First Digestion Average	Second Digestion Average	%RD
121R	1490	3230	74
121L	28200	1010	186
140R	2670	2510	6.2
144R	5250	1750	100
258R	8605	2920	99
272R	2820	1450	64
272L	1290	1090	17

Table 22. MATRIX SPIKES FOR REPEATED SAMPLES - SOILS

Results as Total ug Lead

Sample No.	Total	Sample Amount	Recovered Amount	Added Amount	% Recovered
121R-1	20200	1700	18500	20000	92.5

Table 23.
RESULTS OF DUPLICATE ANALYSIS FOR REPEATED SAMPLES - SOILS

Concentrations as ug/g (ppm Lead)

Sample No.	Parameter	Run #1	Run #2	Difference	% RD
121L-1	Fe	13000	14000	1000	7.4
	Mg	2710	2420	290	11.3
	Pb	1000	1020	20	2.0
	Ca	4090	4380	290	6.8

SECTION IV

EDTA ANALYSES

EDTA ANALYSIS DATA

Sample Number	Sample Size	Mca	Vca	M_{EDTA}	Result Percent
24	50	.5047	34.20	.345	13.1
24 Dup	50	.5047	34.30	.346	13.2
25	50	.5047	7.65	.0772	2.94
35L	3.90[a]	.5047	1.30	.168	6.39
35R	20	.5047	.90	.0227	.863
42L	50	.5047	29.75	.300	11.4
42R	16	.5047	6.30	.199	7.57
45L	10[a]	.5047	1.00	.0505	1.92
45R	10[a]	.5047	1.30	.0656	2.49
56	14.65	.5047	17.00	.586	22.3
57	35	.5047	3.65	.0526	2.00
63	50	.5047	40.35	.407	16.3
64	50	.5047	5.45	.055	2.20
69	25	.5047	19.20	.388	14.8
88L	10	.5047	6.05	.305	11.6
88R	15	.5047	2.70	.091	3.46
102E	25	.5047	44.75	.903	34.3
103L	25	.5047	18.10	.365	13.9
103R	25	.5047	12.50	.252	9.58
107L	25	.5047	14.80	.299	11.4
107R	25	.5047	15.25	.308	11.7
122	50	.5047	40.20	.406	15.4
123	50	.5047	20.5	.207	7.87
129L	50	.5047	-0-	ND	ND
129R	25	.5047	15.15	.306	11.6
133L	50	.5047	-0-	ND	ND
133R	25	.5047	6.10	.123	4.67
145	25	.5071	29.20	.592	22.5
145 Dup	25	.5071	29.20	.592	22.5
146	25	.5071	7.05	.143	5.44
146 Dup	25	.5071	7.15	.145	5.51
152L	20	.5047	14.85	.375	14.3
152R	20	.5047	14.60	.368	14.0
156R	20	.5047	.55	.0139	.529
168E	15	.5071	17.50	.592	22.5
169L	20	.5071	19.10	.484	18.4
169R	NOTE b	.5071	10.00	.507	19.3
169R Dup	NOTE b	.5071	10.05	.510	19.4
170L	25	.5071	20.20	.410	15.6
170R	10	.5071	8.00	.406	15.4
170R Dup	10	.5071	8.05	.408	15.5
171L	25	.5071	15.40	.312	11.8
171R	25	.5071	20.25	.411	15.6
173L	20	.5071	20.35	.516	19.6

Sample Number	Sample Size	Mca	Vca	M_{EDTA}	Result Percent
173R	25	.5071	25.40	.515	19.6
174L	25	.5071	16.70	.339	12.9
174R	20	.5071	13.10	.332	12.6
175L	25	.5071	15.80	.320	12.2
175R	20	.5071	12.55	.318	12.1
176L	25	.5071	15.80	.320	12.2
176R	25	.5071	15.60	.316	12.0
177L	20	.5071	14.40	.365	13.9
177R	15	.5071	11.95	.404	15.4
178L	10^{a}	.5071	4.35	.221	8.40
178L Dup	10^{a}	.5071	4.40	.223	8.48
178R	25	.5071	12.90	.262	9.96
179L	20	.5071	10.20	.259	9.85
179R	20	.5071	9.55	.242	9.20
180L	20	.5071	9.55	.242	9.20
180R	20	.5071	9.70	.246	9.35
181L	25	.5071	15.40	.312	11.9
181R	25	.5071	15.70	.323	12.3
182L	10^{a}	.5071	3.50	.177	6.73
182L Dup	10^{a}	.5071	3.50	.177	6.73
182R	15	.5071	5.20	.176	6.69
183L	25	.5071	8.45	.171	6.50
183R	25	.5071	8.60	.174	6.62
184L	20	.5071	6.25	.158	6.01
184R	25	.5071	7.10	.144	5.48
201	50	.5071	23.80	.241	9.16
202	3.8^{c}	.5145	36.25	.598	22.8
206L	20	.5145	15.70	.404	15.4
206R	20	.5145	15.75	.405	15.4
210L	15	.5145	9.55	.328	12.5
210R	10^{a}	.5145	13.70	.352	13.4
214L	15	.5145	8.60	.295	11.2
214R	15	.5145	8.15	.280	10.6
218L	20	.5145	9.85	.253	9.62
218R	20	.5145	7.40	.190	7.22
220	15	.5071	17.85	.603	22.9
222L	10^{a}	.5071	9.50	.482	18.3
222R	10^{a}	.5071	10.95	.555	21.1
223L	15	.5071	10.40	.352	13.4
223L Dup	15	.5071	11.35	.383	14.6
223R	15	.5071	10.65	.360	13.7
223R Dup	15	.5071	9.70	.328	12.5
224L	25	.5071	16.65	.338	12.
224R	25	.5071	15.70	.318	12.1
225L	25	.5071	15.45	.313	11.9
225R	25	.5071	17.65	.358	13.6

Sample Number	Sample Size	Mca	Vca	M_{EDTA}	Result Percent
226L	25	.5071	13.30	.270	10.3
226R	25	.5071	15.80	.320	12.2
227L	25	.5071	12.60	.256	9.73
227R	25	.5071	15.70	.318	12.1
228L	25	.5071	11.60	.235	8.94
228R	25	.5071	12.35	.251	9.54
229L	25	.5071	11.25	.228	8.67
229R	25	.5071	12.40	.252	9.58
231	20	.5071	24.25	.615	23.4
235L	20	.5071	8.80	.223	8.48
235R	15	.5071	10.10	.341	13.0
235R Dup	15	.5071	9.80	.331	12.6
239L	25	.5071	11.10	.225	8.56
239R	25	.5071	11.00	.223	8.48
243L	25	.5071	8.55	.173	6.58
243R	15	.5071	4.55	.154	5.86
247L	20	.5071	5.15	.131	4.98
247R	15	.5071	2.85	.096	3.65
248	10[a]	.5071	6.30	.319	12.1
249	15	.5071	8.55	.289	11.0
252E	25	.5145	29.05	.598	22.7
252E Dup	25	.5145	27.50	.566	21.5
253L	15	.5145	14.55	.499	18.9
253R	25	.5145	12.30	.253	9.62
259L	20	.5145	13.65	.351	13.6
259R	25	.5145	18.15	.374	14.2
265L	25	.5145	13.20	.272	10.3
265R	20	.5145	15.10	.388	14.8
271L	15	.5145	9.80	.336	12.8
271R	25	.5145	17.20	.354	13.5
273L	15	.5145	8.65	.297	11.34
273R	15	.5145	8.30	.285	10.8
273R Dup	15	.5145	8.00	.274	10.4
277L	20	.5145	18.55	.477	18.1
277R	20	.5145	20.30	.522	19.8
279L	15	.5145	9.10	.312	11.9
279L Dup	10[a]	.5145	6.05	.311	11.8
279R	20	.5145	13.95	.359	13.7
281L	20	.5145	14.80	.381	14.5
281R	20	.5145	14.80	.381	14.5
283L	20	.5145	11.60	.298	11.3
283R	25	.5145	15.50	.319	12.1
285L	25	.5145	11.10	.228	8.67
285R	20	.5145	10.85	.279	10.6
287L	20	.5145	10.90	.280	10.6

Sample Number	Sample Size	Mca	Vca	M_{EDTA}	Result Percent
287R	20	.5145	11.20	.288	11.0
289L	20	.5145	8.60	.221	8.40
289R	20	.5145	8.85	.227	8.63
291	25[d]	.5145	28.55	.598	22.7
291 Dup	25[d]	.5145	28.45	.596	22.6
291L	25	.5145	12.20	.251	9.54
291R	20	.5145	8.65	.223	8.48
294L	20	.5145	7.50	.193	7.34
294R	15	.5145	5.80	.198	7.53
299L	15	.5145	15.90	.202	7.68
299R	15	.5145	5.55	.190	7.22
301L	20	.5145	4.30	.111	4.22
301R	10[a]	.5145	3.25	.167	6.35
301R Dup	10[a]	.5145	3.20	.165	6.27

a - Denotes low sample size, may affect reproducability of result

b - 20 ml of this sample was put into a 50 ml volumetric flask and diluted to volume with distilled water. Then 25 ml was taken for each analysis for an effective sample size of 10 ml

c - Sample 202 had a precipitate (EDTA) in it. It became necessary to add .68 ml of 50% NaOH to make the ppt soluble in sample. So the effective sample size was 31.12 mls.

d - Sample 291 had a precipitate (EDTA), 1.7 ml of 50% NaOH to make it soluble in solution. The total volume of the jar after addition was 101 ml. Therefore, the dilution factor is 101-1.7/101 or .983.

Mca - Molarity of Calcium Chloride Solution as is outlined in procedures and given by equation (4)

Vca - Volume of Calcium Chloride used

M_{EDTA} - Molarity of EDTA as is given by equation (1)

Result Percent - Percent EDTA as tetrasodium salt given by equation (2) or (3)

pt/6262D:0268D

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
LOCATION WOODVILLE, WISCONSIN
SUBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 1 OF
PREPARED BY RHI

ITEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
R-101	SCREEN FEED CONVEYOR INCLUDES: TK-101 FD-101 PORTABLE UNIT W/DISCH. CHUTE	20 STPH	18"W x 50'-OL	28100	7½
CR-102	RECYCLE CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 40'-OL	14000	7½
CR-103	REACTOR FEED CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 50'-OL	15000	7½
R-104	CLAY/SILT CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 50'-OL	15000	7½
CR-105	FINES REACTOR DISCH. CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 40'-OL	14000	7½
CR-106	FIRST RINSE DISCH. CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 40'-OL	14000	7½
R-107	SECOND RINSE DISCH. CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18"W x 40'-OL	14000	7½
R-108	THIRD RINSE DISCH. CONVEYOR INCLUDES: RECEIVING HOPPER DISCH. CHUTE PORTABLE UNIT	20 STPH	18" x 40'-OL	14000	7½

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
ATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 2 OF
PREPARED BY RHL

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
R-109	FOURTH RINSE DISCH. CONVEYOR	20 STPH	18" W x	14000	7½
	INCLUDES: RECEIVING HOPPER		40'-0 L		
	DISCH. CHUTE				
	PORTABLE UNIT				
CR-110	CRUSHER FEED CONVEYOR	20 STPH	18" W x	15000	7½
	INCLUDES: RECEIVING HOPPER		50'-0 L		
	DISCH. CHUTE				
	PORTABLE UNIT				

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/85
SHEET No. 3 OF
PREPARED BY RH

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
D-101	SOIL FEEDER INCLUDED WITH CR-101 RECIPROCATING REXNORD SYNTRON	20 STPH			2

Form No 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
LOCATION WOODVILLE, WISCONSIN
SUBJECT EQUIPMENT PRICING
No.
DATE 6/27/86
SHEET No. 4 OF
PREPARED BY RHI

ITEM		DESCRIPTION	SIZE	PRICE	HP
M-101		FINES EDTA MIXER LIGHTNIN XJQ-65	13" φ	1500	1
M-102	A/B	REACTION TANK MIXER NETTCO MODEL T100 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 54" φ TURBINE (E464)	46,078 (TOTAL)	120 (TOTAL)
M-103		FINES REACTOR MIXER NETTCO MODEL T100 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 54" φ TURBINE	23 039	60
M-104		FIRST FINES RINSE MIXER NETTCO MODEL WT60 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 36" φ TURBINE	8558	10
M-105		SECOND FINES RINSE MIXER NETTCO MODEL WT60 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 36" φ TURBINE	8558	10
M-106		THIRD FINES RINSE MIXER NETTCO MODEL WT60 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 36" φ TURBINE	8558	10
M-107		FOURTH FINES RINSE MIXER NETTCO MODEL WT60 PITCH BLADE AXIAL FLOW TURBINE 304 SS CONSTRUCTION 88 RPM	(2) 36" φ TURBINE	8558	10
M-108		EDTA SURGE TANK MIXER LIGHTNIN XJQ-65	13" φ	1500	1
M-109		EDTA MAKE-UP MIXER LIGHTNIN XJQ-65	13" φ	1500	1

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 5 OF
PREPARED BY RHH

TEM		DESCRIPTION	CAPACITY		PRICE	HP
-101	A/B	SCREEN UNDERS PUMP	300 GPM		3800	10
		WORTHINGTON	40 FT		3800	
		RUBBER LINED			7600	
			10% SLURRY		(TOT)	
P-102		CENTRIFUGE FEED PUMP	600 GPM		5400	20
		WORTHINGTON	40 FT			
		RUBBER LINED				
			4% SLURRY			
-103		RECYCLE WATER PUMP	600 GPM		3500	50
		WORTHINGTON	200 FT			
		CAST IRON				
			MIN. FINES			
P-105		REACTION TANK PUMP	300 GPM		3750	5
		WORTHINGTON	20 FT			
		RUBBER LINED				
			25% SLURRY			
P-106		REACTOR DEWATERER PUMP	250 GPM		3750	5
		WORTHINGTON	20 FT			
		RUBBER LINED				
			MIN. FINES			
-107		FIRST RINSE PUMP	250 GPM		3750	5
		WORTHINGTON	20 FT.			
		RUBBER LINED				
			MIN. FINES			
P-108		SECOND RINSE PUMP	250 GPM		3750	5
		WORTHINGTON	20 FT			
		RUBBER LINED				
			MIN. FINES			

Form No 130-3 25M

ESTIMATE

CUSTOMER ERT/US EPA
No.
CATION WOODVILLE, WISCONSIN
DATE 6/27/86
SUBJECT EQUIPMENT PRICING
SHEET No. 6 OF
PREPARED BY RHU

ITEM	DESCRIPTION	CAPACITY		PRICE	HP	
P-109	THIRD RINSE PUMP WORTHINGTON RUBBER LINED	250 gpm 20 FT MIN. FINES		3750	5	
P-110	FOURTH RINSE PUMP WORTHINGTON RUBBER LINED	250 gpm 20 FT MIN. FINES		3750	5	
-112	FINES EDTA MAKE-UP PUMP BRAN & LUEBBE MODEL ND-31 316 SS, 56 mm ϕ	230 gph		3500	1 1/2	
P-113	MAKE-UP WATER PUMP WORTHINGTON RUBBER LINED	250 GPM 30 FT MIN. FINES		3750	5	
P-114	EDTA REACTION METERING PUMP BRAN & LUEBBE MODEL ND-31 316 SS, 125 mm ϕ	1400 GPH		3000	5	
P-115	FINES EDTA METERING PUMP BRAN & LUEBBE MODEL ND-31 316 SS, 125 mm ϕ	1400 GPH		3000	5	
P-116	EDTA MAKE-UP PUMP BRAN & LUEBBE MODEL ND-31 316 SS, 56 mm ϕ	250 GPH		3500	1 1/2	

Form No 130-3 25M

ESTIMATE

USTOMER ERT/U.S. EPA
ATION WOODVILLE, WISCONSIN
JBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 7 OF
PREPARED BY RH

TEM	DESCRIPTION	CAPACITY	PRICE	HP
-117	FINES REACTOR PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT 25% SLURRY	3650	3
P-118	FIRST FINES RINSE PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT 25% SLURRY	3650	3
-119	SECOND FINES RINSE PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT 25% SLURRY	3650	3
120	THIRD FINES RINSE PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT 25% SLURRY	3650	3
P-121	FOURTH FINES RINSE PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT 25% SLURRY	3650	3
-122	FINES EDTA RECYCLE PUMP WORTHINGTON RUBBER LINED	60 GPM 30 FT MIN. FINES	3650	3
-123	FIRST FINES SUMP PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT MIN. FINES	3650	3
P-124	SECOND FINES SUMP PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT MIN. FINES	3650	3

Form No. 130-3 25M

ESTIMATE

STOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 8 OF
PREPARED BY RHL

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
-125	THIRD FINES SUMP PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT. MIN. FINES		3650	3
P-126	FOURTH FINES SUMP PUMP WORTHINGTON RUBBER LINED	60 GPM 20 FT MIN. FINES		3650	3

Form No 130-3 25M

ESTIMATE

USTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
SUBJECT EQUIPMENT PRICING
No.
DATE 6/27/86
SHEET No. 9 OF
PREPARED BY RHI

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
-101	SOIL SCREEN EDW. RENNEBURG & SONS WET TROMMEL CARBON STEEL CONSTR., REMOVEABLE DECKS, LIFTING BARS, 10-15 RPM 1 PIECE BASE, HOPPERS, SPRAYS, DRIVE	20 STPH	4'-0"ϕ x 14'-0"L	80 000	15
S-102	SOIL CLASSIFIER EAGLE IRON WORKS, INCLUDES BASIC CONTROLS AND DEWATERING SCREENS S-103 A/B - PORTABLE UNIT	600 GPM	32' x 8' 36"ϕ SCREWS	$152 000	30 (TOTAL)
S-103 A/B	DEWATERING SCREEN EAGLE, INCLUDED WITH S-102				
04	REACTOR DEWATERER EAGLE DEWATERING SCREEN -304 SS SCREEN W/URETHANE SHOES, EPOXY LINED TROUGH, 304 SS INLET PLATE	20 STPH	36"ϕ x 25'L	47690	15
-105	FIRST RINSE SAME AS S-104	20 STPH	36"ϕ x 25'L	47690	15
S-106	SECOND RINSE SAME AS S-104	20 STPH	36"ϕ x 25'L	47690	15
-107	THIRD RINSE SAME AS S-104	20 STPH	36"ϕ x 25'L	47690	15
-108	FOURTH RINSE SAME AS S-104	20 STPH	36"ϕ x 25'L	47690	15

Form No 130-3 25M

ESTIMATE

USTOMER ERT / U.S. EPA
CATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 10 OF
PREPARED BY RHL

ITEM		DESCRIPTION	CAPACITY	SIZE	PRICE	HP
S-109	A/B	CLAY/SILT CENTRIFUGE BIRD MODEL 4900	300 GPM EA.	36"x96"	640 000 (TOTAL FOR TWO)	250 (TOTAL)
S-110		FINES REACTOR CENTRIFUGE BIRD	60 GPM	24" x 60"	189 000	75
-111		FIRST RINSE CENTRIFUGE BIRD	60 GPM	24" x 60"	189 000	75
112		SECOND RINSE CENTRIFUGE BIRD	60 GPM	24 x 60"	189 000	75
S-113		THIRD RINSE CENTRIFUGE BIRD	60 GPM	24"x60"	189 000	75
-114		FOURTH RINSE CENTRIFUGE BIRD	60 GPM	24" x 60"	189 000	75
-115		MAGNETIC SEPARATOR SUSPENDED, SELF CLEANING			9000	2

Form No. 130-3 25M

ESTIMATE

USTOMER ERT/U.S. EPA

CATION WOODVILLE, WISCONSIN

UBJECT EQUIPMENT PRICING

No.

DATE 6/27/86

SHEET No. 11 OF

PREPARED BY RHL

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE	HP
R-101	SCREEN OVERS CRUSHER JEFFREY MINI MILL	5 STPH	20x12	13500	2

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
JBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 12 OF
PREPARED BY RHU

ITEM		DESCRIPTION	CAPACITY	SIZE	PRICE
TK-101		SOIL FEED HOPPER INCLUDED WITH CR-101 4"x4" GRIZZLY ONE WAY SLOPE	6 YD^3	8'-0x10'-0	
K-103		CLAY/SILT SUMP CS CONSTR.	1200 GAL	6'-6"ϕx5'-0H	5400
TK-105		RECYCLE WATER TANK CS CONSTR.	2100 GAL	8'-6"ϕx5'-0H	5800
K-106	A/B	EDTA REACTION TANK 304SS W/CS TOF MIXER SUPPORTS	3600 GAL	8'-6"ϕx8'-6"H	14 000 14 000 28 000

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
JBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 13 OF
PREPARED BY RHJ

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE
[illegible]-112	EDTA SURGE TANK 304 SS w/C.S. TOP MIXER SUPPORTS	1400 GAL	6'-0"φx6'-6"H	7400
TK-113	EDTA MAKE-UP TANK 304 SS w/C.S. TOP MIXER SUPPORTS	2240 GAL	6'-0φ, 11'-0H	11 500
TK-114	FINES EDTA SURGE TANK 304 SS w/CS TOP MIXER SUPPORTS	1400 GAL	[illegible]	7400
K-115	WATER MAKE-UP TANK 304 SS w/C.S. TOP	3600 GAL	8'-6"φx8'-6"H	14000
TK-116	FINES REACTOR	3600 GAL.	8'-6"φx8'-6"H	14 000

Form No. 130-3 25M

ESTIMATE

USTOMER ERT/U.S. EPA
CATION WOODVILLE, WISCONSIN
UBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 14 OF
PREPARED BY RWW

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE
K-117	FINES EDTA RECYCLE TANK	300 GAL	6'-0ϕ x 5'-0H	8500
TK-118	FIRST RINSE TANK 304 SS SIDES & BOTTOM, CS TOP W/MIXER SUPPORT	870 GAL	5'-0ϕ x 7'-6"H	6700
K-119	FIRST FINES SUMP	300 GAL	6'-0ϕ x 5'-0H	6000
-120	SECOND RINSE TANK 304 SS SIDES & BOTTOM, CS TOP W/MIXER SUPPORT	870 GAL	5'-0ϕ x 7'-6"H	6700
TK-121	SECOND FINES SUMP	300 GAL	6'-0ϕ x 5'-0H	6000
TK-122	THIRD RINSE TANK 304 SS SIDES & BOTTOM CS TOP W/MIXER SUPPORT	870 GAL.	5'-0ϕ x 7'-6"H	6700
K-123	THIRD FINES SUMP	300 GAL	6'-0ϕ x 5'-0H	6000
TK-124	FOURTH RINSE TANK 304 SS SIDES & BOTTOM CS TOP W/MIXER SUPPORT	870 GAL.	5'-0ϕ x 7'-6"H	6700

Form No. 130-3 25M

ESTIMATE

CUSTOMER ERT/U.S. EPA
OCATION WOODVILLE, WISCONSIN
SUBJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 15 OF
PREPARED BY RHM

ITEM	DESCRIPTION	CAPACITY	SIZE	PRICE		
K-125	FOURTH FINES SUMP	300 GAL	6'-0Ø x 5'-0H	6000		

Form No 130-3 25M

ESTIMATE

USTOMER ERT/U.S. EPA
ATION WOODVILLE, WISCONSIN
BJECT EQUIPMENT PRICING

No.
DATE 6/27/86
SHEET No. 16 OF
PREPARED BY RHA

TEM	DESCRIPTION	CAPACITY	SIZE	PRICE
S-101	SOIL FEED SCALE MERRICK 465 WEIGHTOMETER W/ MICROPROCESSOR FOR - RATE - TOTAL	20 STPH	18"W	7000
WS-102	REACTOR FEED SCALE SAME AS WS-101	20 STPH	18"W	7000
S-103	FINES FEED SCALE SAME AS WS-101	20 STPH	18"W	7000

Form No. 130-3 25M

ESTIMATE

STOMER ERT / US EPA
CATION WOODVILLE, WISC.
SUBJECT SOIL PREPARATION SUMMARY

NO. 60-00510098
DATE 6/25/86
SHEET NO. 1 OF 1
PREPARED BY JD

	QTY	MAT'L COST	MH'S	LABOR COST @$32/MH
CONVEYORS	5	90,500	200	7,000
PUMPS	4	17,400	100	4,000
CLASSIFICATION / SEPARATION	6	937,700	700	22,000
TANKS	2	13,800	50	1,000
SCALES	3	22,200	50	1,000
ST EQUIPMENT	20	1,081,600	1,100	35,000
PIPING		15,000	400	13,000
INSTRUMENTATION		10,000	300	10,000
ELECTRICAL		20,000	1,000	32,000
S.T. BULKS		45,000	1,700	55,000
SOIL PREPARATION TOTAL		1,126,600	2,800	90,000

Form No. 130-3 25M

ESTIMATE

STOMER ERT / US EPA
OCATION Woodville, Wisc.
SUBJECT Soils Extraction and Rinsing Summary

NO. 60-00510098
DATE 6/30/86
SHEET NO. ______ OF ______
PREPARED BY MO

	QTY	MAT'L COST	MH'S	LABOR COST @$32/MH
MIXERS	6	51,600	200	6,000
PUMPS	10	43,800	300	10,000
CLASSIFICATION / SEPARATION	5	250,500	300	10,000
TANKS	5	64,000	100	3,000
SUBTOTAL EQUIPMENT	26	409,900	900	29,000
PIPING		25,000	700	22,000
INSTRUMENTS		10,000	600	19,000
ELECTRICAL		20,000	1200	38,000
SUBTOTAL BULKS		55,000	2,500	79,000
SOILS EXTRACTION ; RINSING TOTAL	D-18	464,900	3,400	108,000

Form No. 130-3 25M

ESTIMATE

STOMER ERT / US EPA
OCATION Woodville, Wisc.
SUBJECT Fines Extraction and Rinsing Summary

NO. 60-00510098
DATE 6/30/86
SHEET NO. ______ OF ______
PREPARED BY MD

	Qty	Mat'l Cost	MH's	Labor Cost
Conveyors	5	73,500	200	6,000
Mixers	11	61,800	300	10,000
Pumps	11	47,400	200	6,000
Classification/Separation	5	992,500	400	13,000
Tanks	11	84,600	200	6,000
Subtotal Equipment	43	1,259,800	1,300	41,000
Piping		30,000	800	26,000
Instruments		10,000	500	16,000
Electrical		30,000	2,000	64,000
Subtotal Bulks		70,000	3,300	106,000
Fines Extraction ; Rinsing Total	D-19	1,329,800	4,600	147,000

Form No. 130-3 25M

ESTIMATE

USTOMER ERT / US EPA

OCATION Woodville, Wisconsin

SUBJECT General Requirements

NO. 60.00510098

DATE 6/27/86

SHEET NO. ______ OF ______

PREPARED BY MO

1.	AREA LEVELING ; GRADING					
	300'×120'	36000 SF				
	EXCAVATION					
	SAY	200 CY	MEANS	- DOZER	300' HAUL	1,000
	FINE GRADING	4000 SY	MEANS	GRADER +	ROLLER	3,000
	TOTAL					4,000
2.	AREA PAVING					
	GRAVEL - ONSITE					
	VOLUME 300'×120'×2"	(220 CY × 1.10 waste)				
	EXCAVATION	240 CY	$10/CY			2,000
	SURFACING	240 CY				
3.	MISC. WOOD FOR LEVELING, ETC.					1,000
5.	WELL FOR WATER	ALLOW	- MEANS			30,000
6.	TRAILER FACILITIES FOR OPERATORS -					
	SAY 8'×20'	4 MOS	× $200	MO		2,000
	HOOK-UPS					5,000
						7,000
7.	AREA LIGHTING	36,000	× $1.00	SF		36,

Form No. 130-3 25M

[illegible] 80 ea - Valves

ESTIMATE

CUSTOMER ERT/US EPA
LOCATION WOODVILLE, WISC
SUBJECT GENERAL REQUIREMENTS

NO. 60-00510098
DATE 6/30/86
SHEET NO. ____ OF ____
PREPARED BY MD

8.	FLAT BED FOR TANKS 8'×40'	8 MO	350			3,000
	SITE DEVELOPMENT TOTAL					83

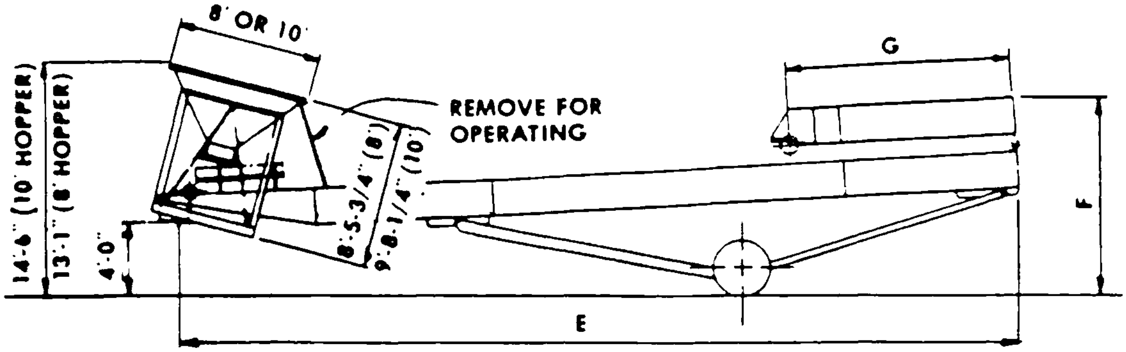
① CR-102
CR-105
CR-106
CR-107
CR-108
CR-108

② CR-101
CR-103
CR-104
CR-105

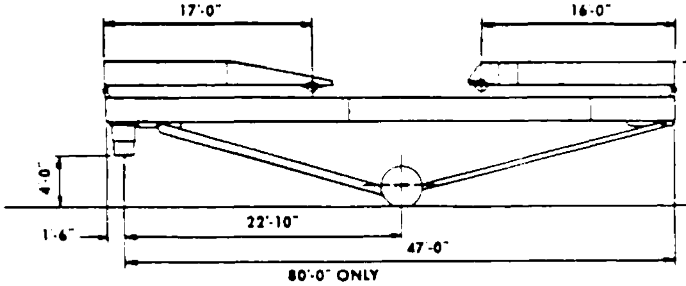
dimensions

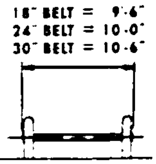
NORDBERG MODEL 130 WITH SCREEN TRAP AND HOPPER FEEDER

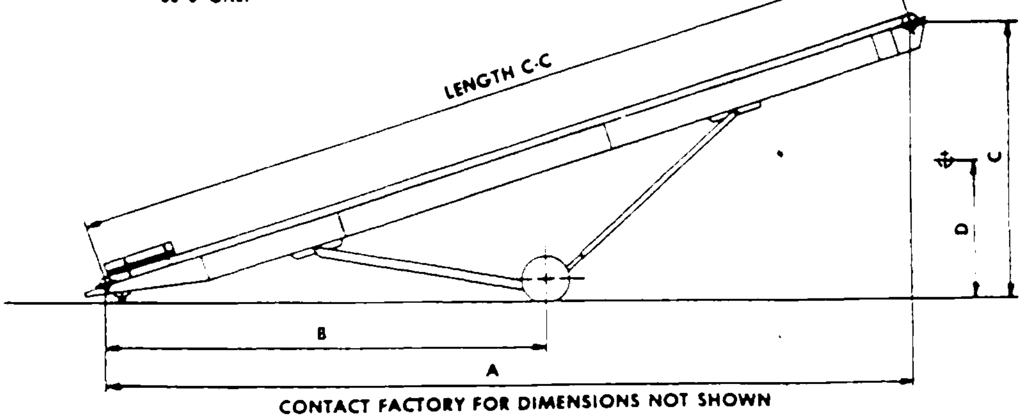
LENGTH C-C	A	B	C	D	E	F	G
40'-0"	38'-0-1/2"	23'- 7-3/4"	13'- 9-3/4"	8-11-1/2"	-	-	- ①
50'-0"	47'-6-5/8"	28'- 7-3/4"	16'-10-1/2'	10'- 1-1/2"	-	-	②
60'-0"	57'-0-3/4"	30'-11-3/4"	20'- 0"	10'- 5-1/2"	47'-9"	11'-8"	13'-0"
70'-0"	66'-6-7/8"	35'-3"	23'- 0-1/2"	14'- 3"	54'-5"	14'-0"	16'-0"
80'-0"	76'-0-7/8"	41'- 1-3/4"	26'- 3"	15'- 3"	64'-5"	14'-0"	16'-0"



HOPPERS WITH DUPLEX GATE







CONTACT FACTORY FOR DIMENSIONS NOT SHOWN

S-104
S-105
S-106
S-107
S-108

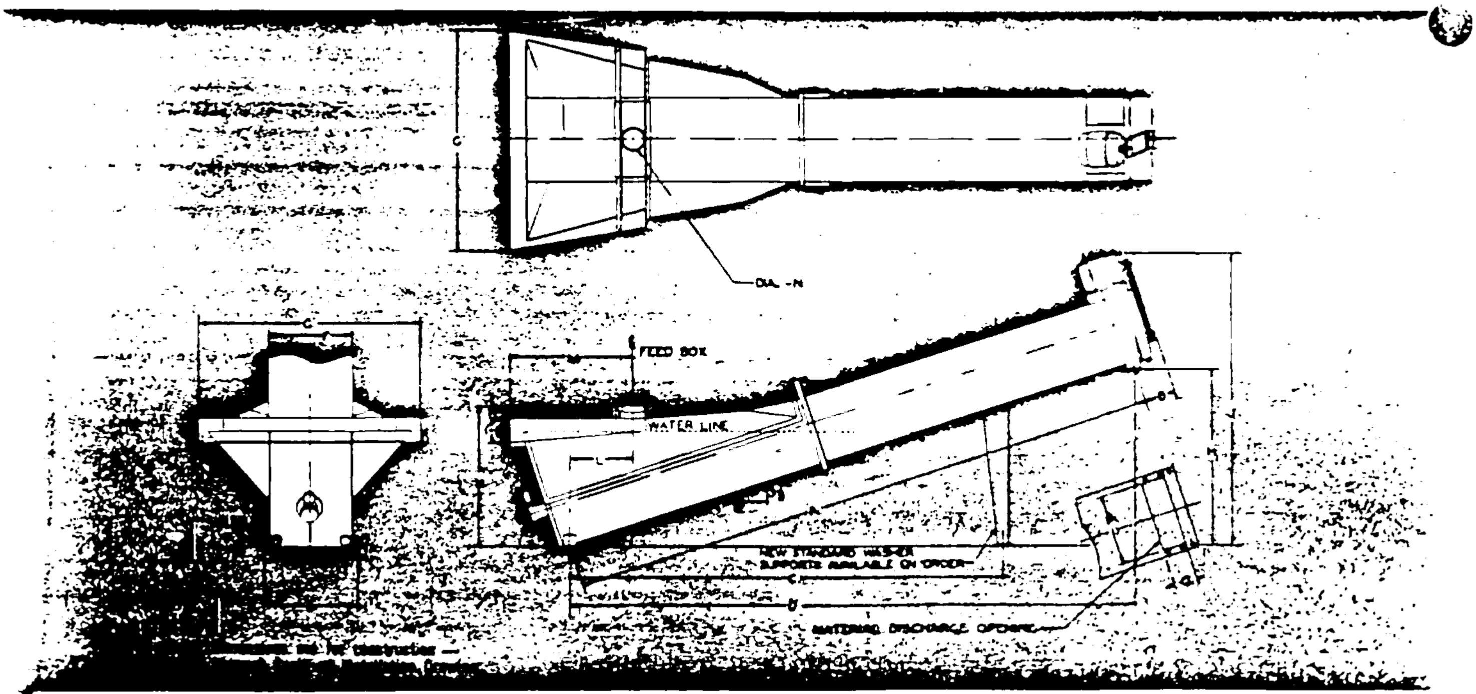
SINGLE SCREW WASHER SPECIFICATIONS

General Specifications — Single Screw Washers

Screw Diameter	20"	24"	30"	36"	44"	54"	66"	72"
Tub Length — Feet	22	22	25	25	32	34	35	38
Capacity* — Tons per hour	30	50	75	100	175	275	400	475
Maximum Material Size	3/8"	3/8"	3/8"	3/8"	3/8"	3/8"	3/8"	3/8"
Horsepower Req. (Electric) at normal speed	5	7-1/2	15	15	25	40	60	75
Water Required (G.P.M. at 25 P.S.I.)	30—195	30—235	40—275	40—360	60—740	60—950	60—1150	60—1250
Screw Speed R.P.M. (Normal)	38	32	26	21	17	14	11	11
Weight of Washer—Pounds	5500	6100	9000	10.400	17 900	28.450	40.200	49.220
Loaded Weight—Pounds	16.850	17 850	24 900	29 800	69 900	86 500	131 000	173.270

*Capacity ratings are stockpiled materials and are to be used as a guide only

specifications subject to change without notice.



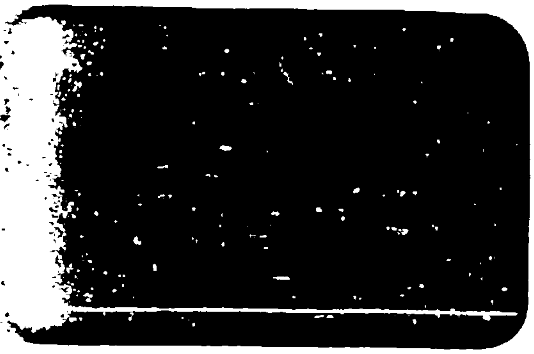
Flight Dia.	Washer Length	H.P. Req.	A	B	C	D	E	F	G	H	J	K	L	M	Dia. of N	P	Q	R
20"	22'0"	5	21'7"	10 7/8"	18'0"	20'8 3/8"	2'5 3/8"	2'0 3/8"	7'8 5/8"	6'1 3/4"	10'2"	5'0 1/4"	2'1"	5'1 1/2"	10"	1'6"	[illegible]	[illegible]
24"	22'0"	7 1/2	21'7"	10 7/8"	18'0"	20'7 5/8"	2'10 3/8"	2'5 3/8"	8'2 1/4"	6'4 1/8"	10'4 3/8"	5'0 1/4"	2'1"	5'1 1/2"	10"	1'0"	[illegible]	[illegible]
30"	25'0"	15	24'10"	1'4 1/2"	18'0"	23'10 1/4"	3'5 3/8"	3'0 3/8"	8'8-3/8"	6'11 5/8"	12'0 5/8"	5'4 1/2"	2'10 3/8"	5'1 1/2"	10"	2'6"	12"	5"
36"	25'0"	15	24'10"	1'4-1/2"	18'0"	23'9 1/8"	3'11 3/8"	3'6 3/8"	9'2 5/8"	7'2 3/4"	12'4 5/8"	5'10"	2'7 5/8"	5'1 3/8"	10"	3'0"	12"	5"
44"	32'0"	25	31'6"	1'9-3/8"	24'0"	30'0 3/4"	4'7 1/2"	4'2 1/2"	12'11 3/4"	9'4 7/8"	15'1 1/2"	3'1/4"	3'11"	7'3 1/4"	13 1/2"	3'8"	[illegible]	[illegible]
54"	34'0"	40	33'2 3/4"	2'2 1/2"	25'3"	31'9 1/8"	5'5 1/2"	5'0 1/2"	13'9-3/4"	9'9 1/8"	17'5 1/2"	4'6 1/2"	3'3 1/2"	7'3 1/4"	13 1/2"	4'7"	2"	[illegible]
66"	35'0"	60	34'6 5/8"	2'5 1/2"	25'3"	33'0 3/8"	6'7 3/4"	6'4"	15'0 1/4"	10'2"	18'3 3/4"	3'10 5/8"	2'11 3/8"	7'3 15/16"	18"	5'0"	16"	
72"	38'0"	75	37'9 1/4"	2'7 1/8"	27'0"	36'1 1/8"	7'2 3/4"	6'10"	15'7 1/4"	11'1 3/4"	20'1 1/2"	3'8 3/4"	2'8"	7'1 1/8"	18"	5'0"	15"	

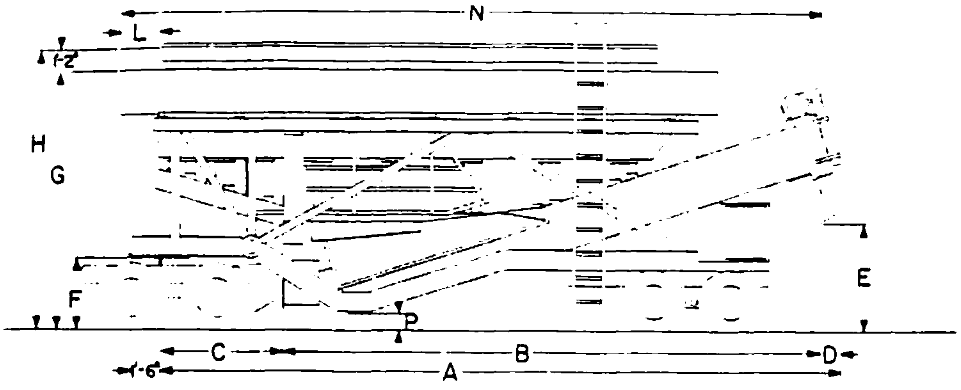
S-102

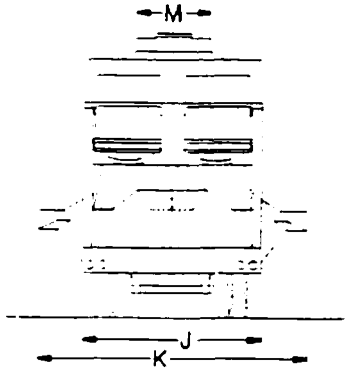
EAGLE IRON WORKS
WATER SCALPING - CLASSIFYING
TANK

S-103 A/B

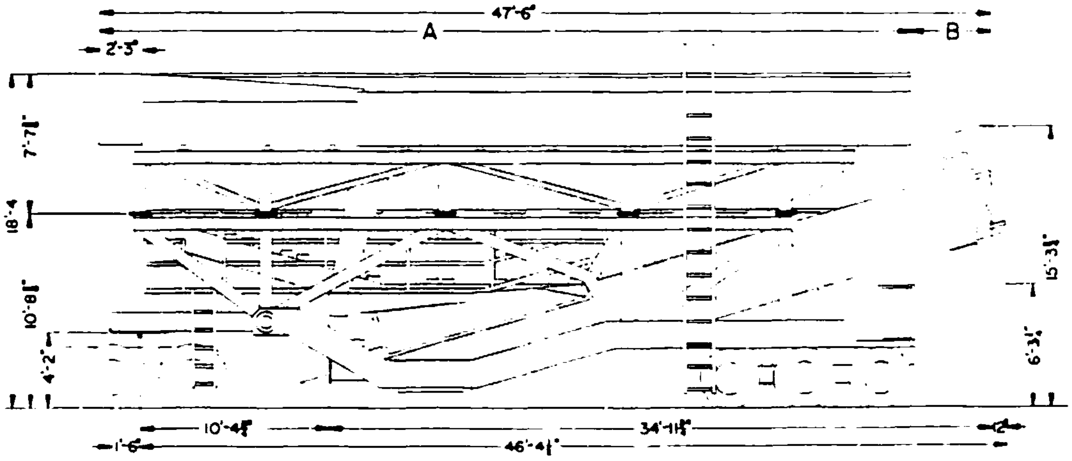
INCLUDED WITH UNIT







DBL 36" Dia x 25	200	24 x 8	35'0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DBL 36" Dia x 25	200	28 x 8	35'0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
⇒DBL 36" Dia x 25	200	32 x 8	35'0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] ⇐
DBL 44 Dia x 32	350	32 x 8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



DBL 44" Dia x 32'	350	32 x 10	35'10-1/8"	11'7-7/8"
DBL 44" Dia x 32'	350	36 x 10	43'10-1/8"	7'7-7/8"
DBL 44" Dia x 32'	350	40 x 10	43'10-1/8"	3'7-7/8"

Dimensions for general planning only, not for construction.
Dimensions and specifications subject to change without notice.

The Bird "H" Series Low Speed Centrifuge also achieves greater economy:

By reducing chemical costs. Shearing and resuspension of flocculant solids are greatly reduced.

By reducing capital investment. Less space, smaller structural requirements, a less costly electrical system, fewer accessories, and elimination of expensive sound suppression systems are all benefits of low speed operation.

By cutting power costs. Operating power can be as little as ¼ of that required by high speed centrifuges and connected horsepower can be ⅓ the usual high speed requirements.

By cutting maintenance costs. Field-replaceable ceramic conveyor blade tips and ceramic feed ports, standard on "H" Series Centrifuges, make screw conveyor and ports last up to ten times longer. In addition, low speed operation means longer bearing life, longer gear life, less operator attention, and less downtime for maintenance or repair.

LOW NOISE LEVEL

While high speed creates noise problems, the Bird "H" Series low speed, low decibel centrifuge operates at a comfortable 80-85DBa sound level.

Bird Waste Treatment Capability can be measured by these notable accomplishments

1934 – Bird developed the first practical continuous solid bowl centrifuge.

1935 – Bird was the first to apply continuous centrifuges to municipal waste sludges . . . at New Haven, Rahway, and Cedar Rapids.

1947 – Bird was the first to apply a solid bowl centrifuge to lime sludge . . . at Miami.

1959 – Bird installed the first multiple centrifuge system in a major waste treatment plant . . . at Los Angeles.

1963 – Bird was first to thicken sludge for barging to sea . . . at Westchester County.

1963 – Bird was the first centrifuge used to thicken activated sludge . . . at San Antonio.

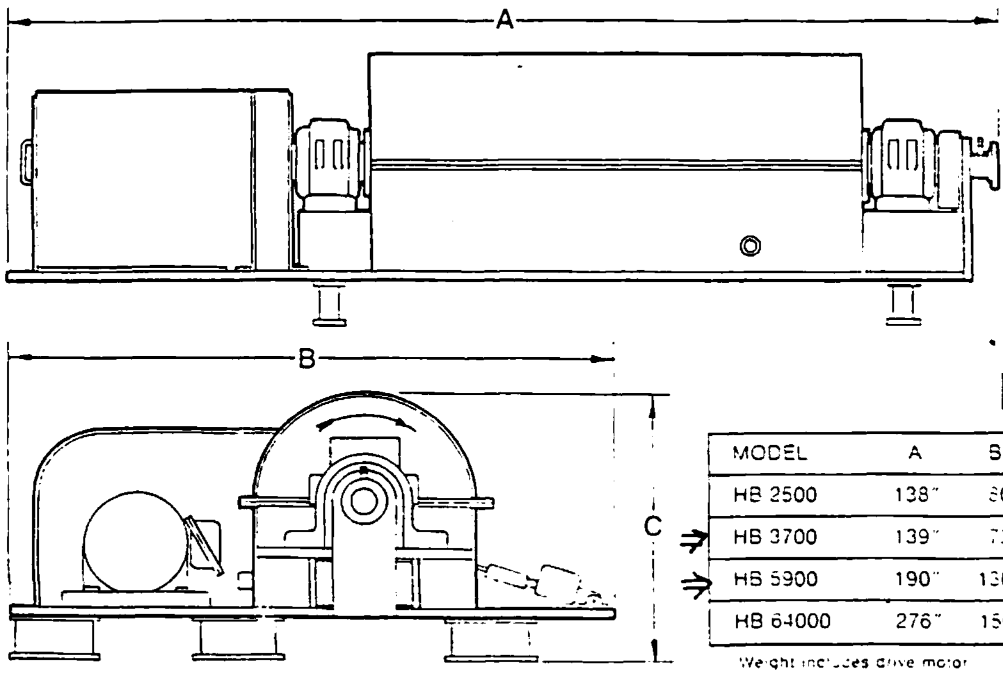
1964 – Bird was the first to apply a centrifuge to dewatering sludge for incineration . . . at New Orleans.

1967 – Bird was the first to apply centrifuges to tertiary treatment . . . at South Lake Tahoe.

1971 – Bird was the first to use field-replaceable ceramic conveyor blade tips and feed ports.

1973 – First use of the patented Bird "Dual Floc" chemical dosage application system.

1974 – Bird introduced the low speed "H" Series Centrifuge to the U.S. wastewater industry.



① S-109 4/B

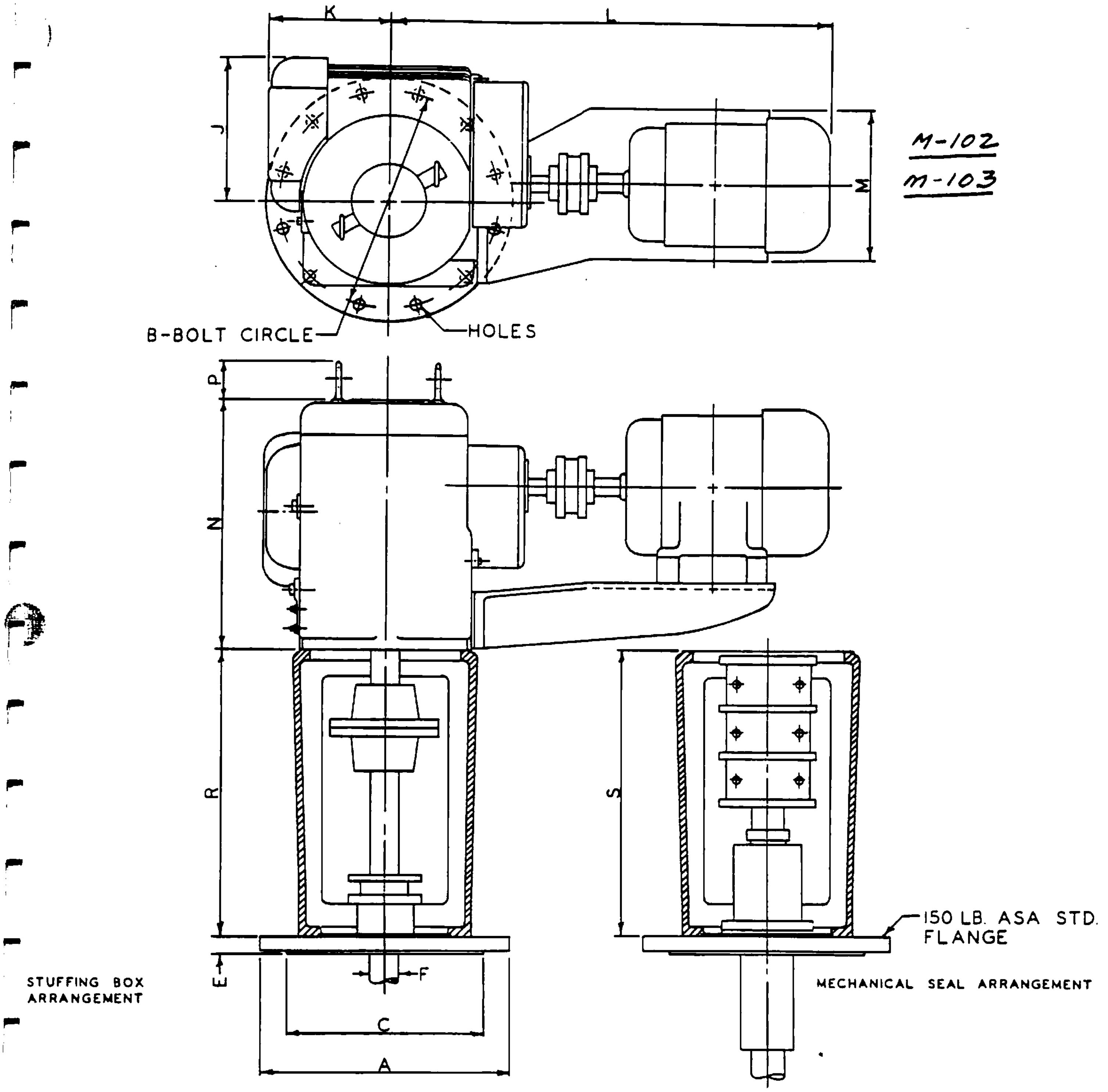
② S-110
S-111
S-112
S-113
S-114

Bird "H" Series Dimensional Chart

MODEL	A	B	C	WT. POUNDS	
HB 2500	138"	60"	36⅜"	6 500	
⇒ HB 3700	139"	72"	41⅜"	9 400	⇐②
⇒ HB 5900	190"	130"	56½"	19 600	⇐①
HB 64000	276"	150"	71"	34 400	

Weight includes drive motor

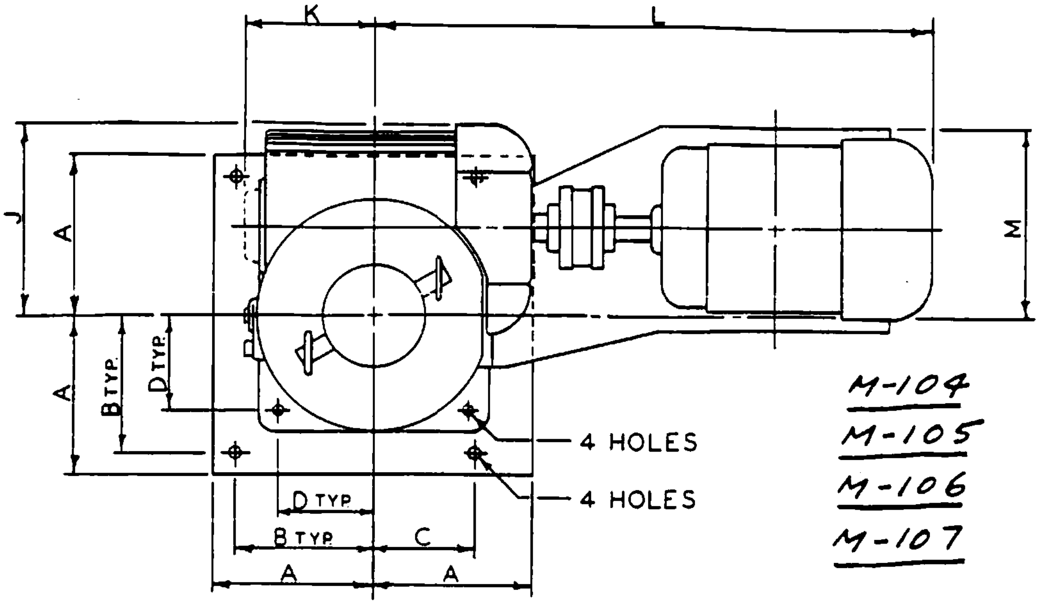
FLANGE MOUNT DIMENSIONS
NETTCO MARK II MODEL T AGITATOR DRIVES



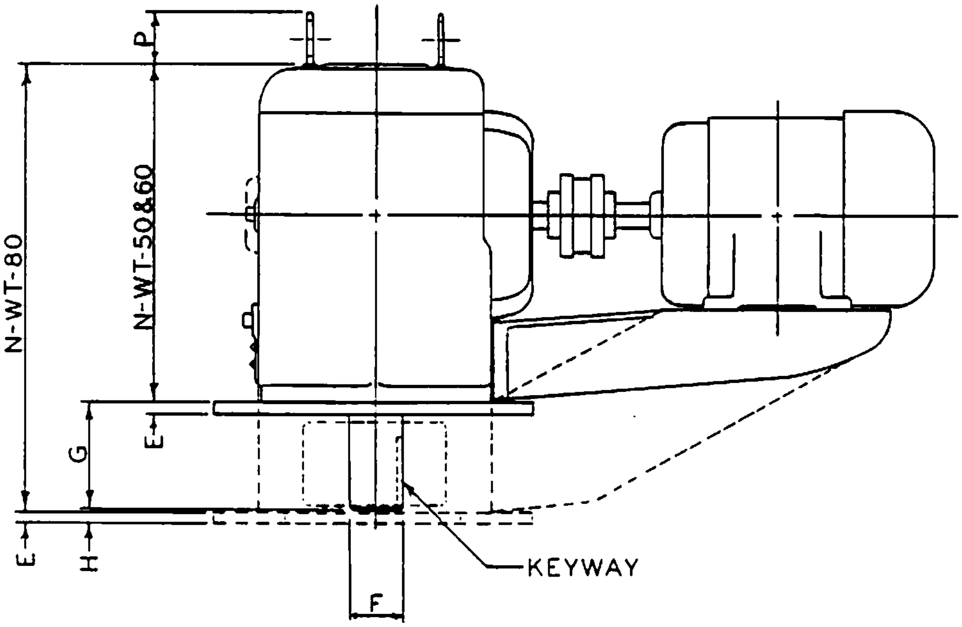
M-102
m-103

DRIVE	FLANGE	A	B	C	HOLES	E	F	J	K	L	M	N	P	R	S
T-50	12	19	17	15	12—1	1¼	$\frac{2\frac{3}{16}}{2\frac{13}{16}}$	10¾	$9\frac{5}{16}$	34	11½	19⅛	2½	22	22
T-60	14	21	18¾	16¼	12—1⅛	1⅜	$\frac{2\frac{15}{16}}{3\frac{15}{16}}$	12¼	10⅞	39	13½	24½	3	21½	27½
T-80	16	23½	21¼	18½	16—1⅛	$1\frac{7}{16}$	$\frac{3\frac{13}{16}}{4\frac{15}{16}}$	16¼	13½	44	14½	$32\frac{9}{16}$	3⅜	31	$39\frac{7}{16}$
⇒ T-100	18	25	22¾	21	16—1¼	$1\frac{9}{16}$	$\frac{4\frac{15}{16}}{5\frac{7}{16}}$	$19\frac{1}{16}$	$16\frac{5}{16}$	56	18½	35¾	2½	31	40¼ ⇐

BASE PLATE DIMENSIONS — NETTCO MARK Ⅱ MODEL WT AGITATOR DRIVES



M-104
M-105
M-106
M-107



DRIVE	A	B	C	D	E	F	G	H	J	K	L	M	N	P	HOLES	KEYWAY
WT-50	9	7 3/4	5 3/4	5 3/8	5/8	2 3/16 2 15/16	6		10 3/4	7 1/4	32	10 3/4	19 1/8	2 1/2	3/4	1/2 x 1/4 x 3 1/2 3/4 x 3/8 x 4 1/4
WT-60	10	8 3/4	8 3/4	6 3/8	3/4	2 15/16 3 15/16	6 1/16		12 1/4	9	38	13 1/4	24 1/2	3	7/8	3/4 x 3/8 x 4 3/4 1 x 1/2 x 5 1/2
WT-80	15	13 1/2	13 1/2	7 1/2	1	3 15/16 4 15/16		1 1/16	16 1/4	10 7/8	43	16 1/4	32 5/16	3 3/8	1	1 x 1/2 x 5 1/2 1 1/4 x 5/8 x 7 1/2

NETTCO CORPORATION • EVERETT, MASSACHUSETTS

NETTC

Data WT-T-2-2C

Printed in U.S.A.

Single Head Metering Pump - Type D (0-60mm)

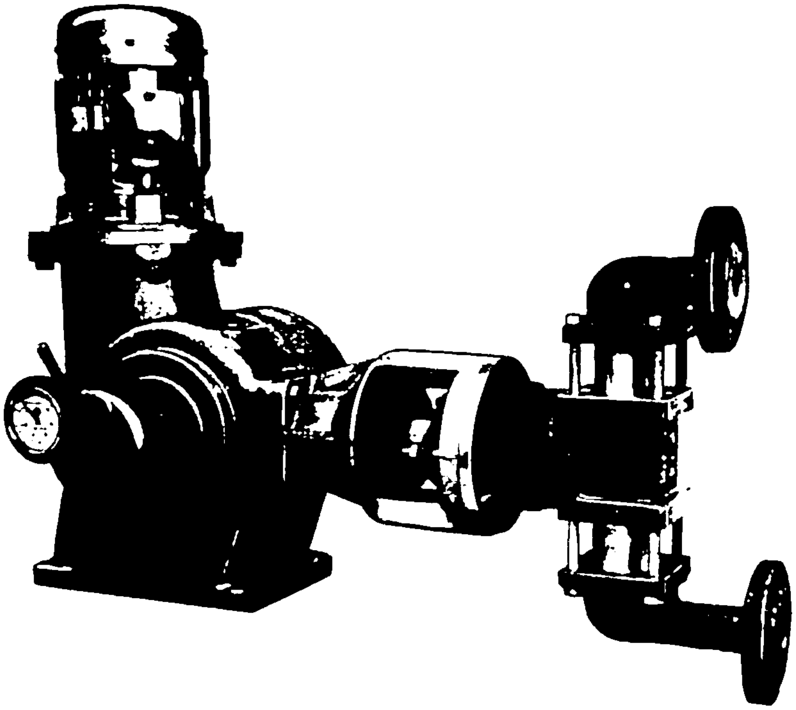


Photo shows N-D31 with stroke length adjustable while pump is stationary or running.

Bran & Lubbe metering pumps are reciprocating, positive displacement pumps of plunger design whose capacity is linearly adjustable over the complete range from zero to maximum capacity.

The "D" gear has oil bath lubrication and incorporates a worm and wheel reduction combined with a variable excenter stroke adjustment mechanism to alter the stroke length setting and therefore, capacity. The stroke length setting, which is indicated on an easy to read dial, can be altered manually, electrically or pneumatically and each type of adjustment is interchangeable.

Drive Motors

The drive motor may be for AC or DC supply and have TEFC, Explosion-proof or other enclosure.

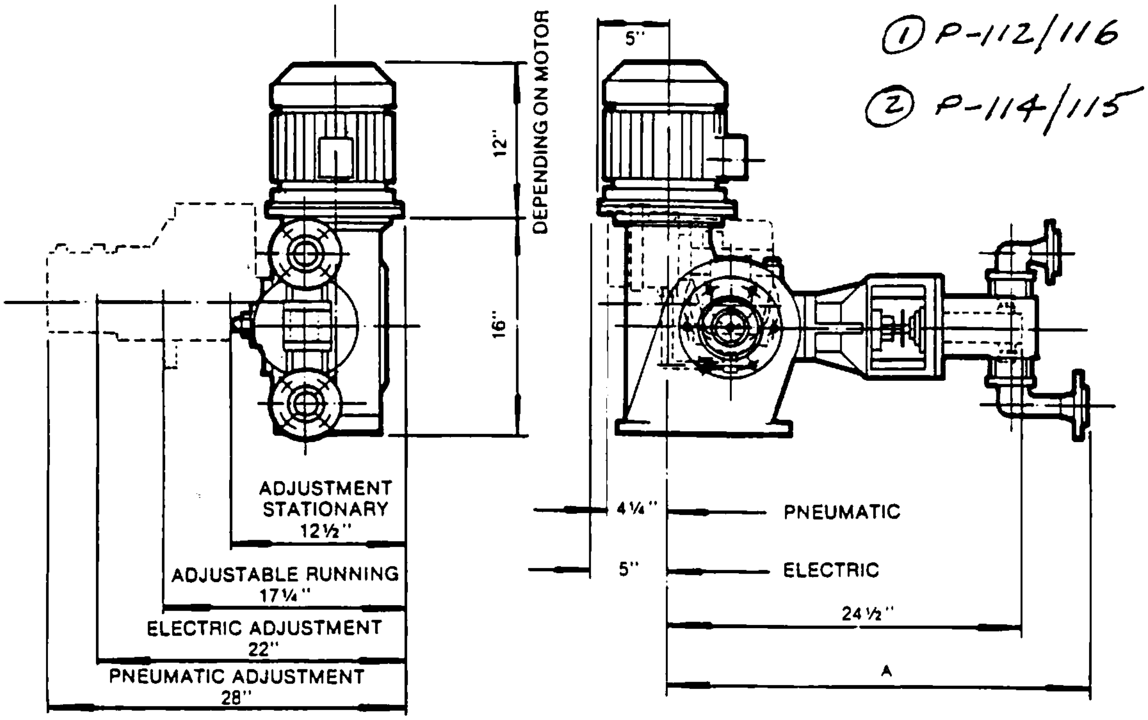
Pumphead Materials

Our materials of construction are Stainless steel 316, Polypropylene, and Ceramic. Other material available are Monel, Hastelloy, Titanium, Alloy 2 Rubber lined steel etc.

GEAR TYPE D

This unit has a stroke length of 0-60mm. The same design features are retained for this pump as K type units, but it is much larger and has a far greater capacity range (see below). These units normally require a drive of 2-7.5 H.P.

Plunger Size	Dimension 'A'	Plunger Size	Dimension 'A'
8-16 dia	24½"	62-75 dia	30½"
16-30 dia	29"	82-90 dia	31¼"
36-42 dia	29½"	110-110 dia	31¼"
50-56 dia	30"	125 dia	32¼"



① P-112/116

② P-114/115

D GEAR CAPACITY CHART

At pressures above 250 Bar compressibility and efficiency have not been taken into account. A comprehensive range of double acting pumpheads can also be fitted.

CAPACITY AND PRESSURE RATINGS AT 120 STROKES PER MINUTE

Plunger Diameter m m	U.S. Gal./Hr.	Liters/Hr.	P.S.I.	Bar	Nominal Size Connection
8	5.6	21.2	22,560	1,590	½" O/D Pipe Coupling
10	8.76	33.16	14,480	1,020	
12	12.6	47.7	10.070	709	
16	22.3	84.4	5,650	398	½" ASA Flanged
20	35.05	132.7	3,620	255	
25	54.8	207.4	2,308	162	
30	78.9	298.6	1,605	113	
36	113.6	430	1,108	78	½"ASA Flanged
42	154.6	585.2	809	57	
50	219	829	582	41	
①⇒ 56	274	1037	454	32	⇐
62	337	1275	369	26	1½" ASA Flanged
68	405	1533	312	22	
75	493	1866	256	18	
82	591	2237	213	15	
90	711	2691	178	12.5	
100	875	3313	142	10	
110	1061	4015	121	8.5	
②⇒ 125	1370	5185	100	7	2" ASA Flanged ⇐