

# Heritage Minerals, Inc.

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SMB-1541

May 9, 1997

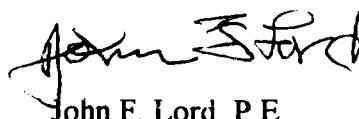
Ms. Marie Miller  
USNRC  
Region 1  
475 Allendale Road  
King of Prussia, PA 19406-1415

Dear Marie:

As requested, enclosed please find copies of the following documents:

1. Asarco/Heritage Revised Mine Tailing Radiological Assessment Plan (MTRAP) which was submitted to and approved by the New Jersey Department of Environmental Protection (NJDEP).
2. NRC Export License No. XSOU8718.

Very truly yours,



John F. Lord, P.E.

JFL:vg  
enclosures

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THIS LICENSE EXPIRES 30 April 2002

XSOU8751

**United States of America****Nuclear Regulatory Commission**

Pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974 and the regulations of the Nuclear Regulatory Commission issued pursuant thereto, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued

to the licensee authorizing the export of the materials and/or production or utilization facilities listed below, subject to the terms and conditions herein.

LICENSEE		ULTIMATE CONSIGNEE IN FOREIGN COUNTRY	
<b>Heritage Minerals, Inc.</b> <b>One Hovchild Plaza</b> <b>4000 Route 66</b> <b>Tinton Falls, NJ 07753</b>  <b>Attn: John F. Lord</b>		<b>L&amp;T Minerals Sand &amp; Separation Plant</b> <b>Batang, Berjuntal</b> <b>Selangor, Malaysia</b>  <b>(For separation of thorium from the monazite sand.</b> <b>Thorium will be used in lantern mantles and related non-</b> <b>nuclear products; monazite will be used for various</b> <b>commercial uses.)</b>	
INTERMEDIATE CONSIGNEE IN FOREIGN COUNTRY <b>NONE</b>		OTHER PARTIES TO EXPORT <b>Heritage Minerals, Inc.</b> <b>Manchester Township</b> <b>Ocean County, New Jersey</b>  <b>(Supplier)</b>	
APPLICANT'S REF. NO. <b>SMB1541</b>		COUNTRY OF ULTIMATE DESTINATION <b>Malaysia</b>	
QUANTITY <b>28,000.0</b> kilograms	DESCRIPTION OF MATERIALS OR FACILITIES <b>Thorium</b> Contained in 1,200,000.0 kilograms of crude monazite sand.  The following conditions apply: 1. Prior U.S. Government consent is required for the use or retransfer of the separated thorium for nuclear end use. 2. No re-export to countries listed as embargoed destinations in 10 CFR 110.28 of the monazite sand or separated thorium. <hr style="border-top: 1px dashed black;"/>		

Neither this license nor any right under this license shall be assigned or otherwise transferred in violation of the provisions of the Atomic Energy Act of 1954, as amended and the Energy Reorganization Act of 1974.

This license is subject to the right of recapture or control by Section 108 of the Atomic Energy Act of 1954, as amended and to all of the other provisions of said Acts, now or hereafter in effect and to all valid rules and regulations of the Nuclear Regulatory Commission.

THIS LICENSE IS INVALID UNLESS SIGNED BELOW  
BY AUTHORIZED NRC REPRESENTATIVE

  
**Donna C. Chaney, Acting Director**  
**Division of Nonproliferation, Exports**  
**and Multilateral Relations**  
**Office of International Programs**

**MAY 2 1997**

DATE OF ISSUANCE \_\_\_\_\_

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REVISED MINE TAILINGS RADIOLOGICAL  
ASSESSMENT PLAN (MTRAP)

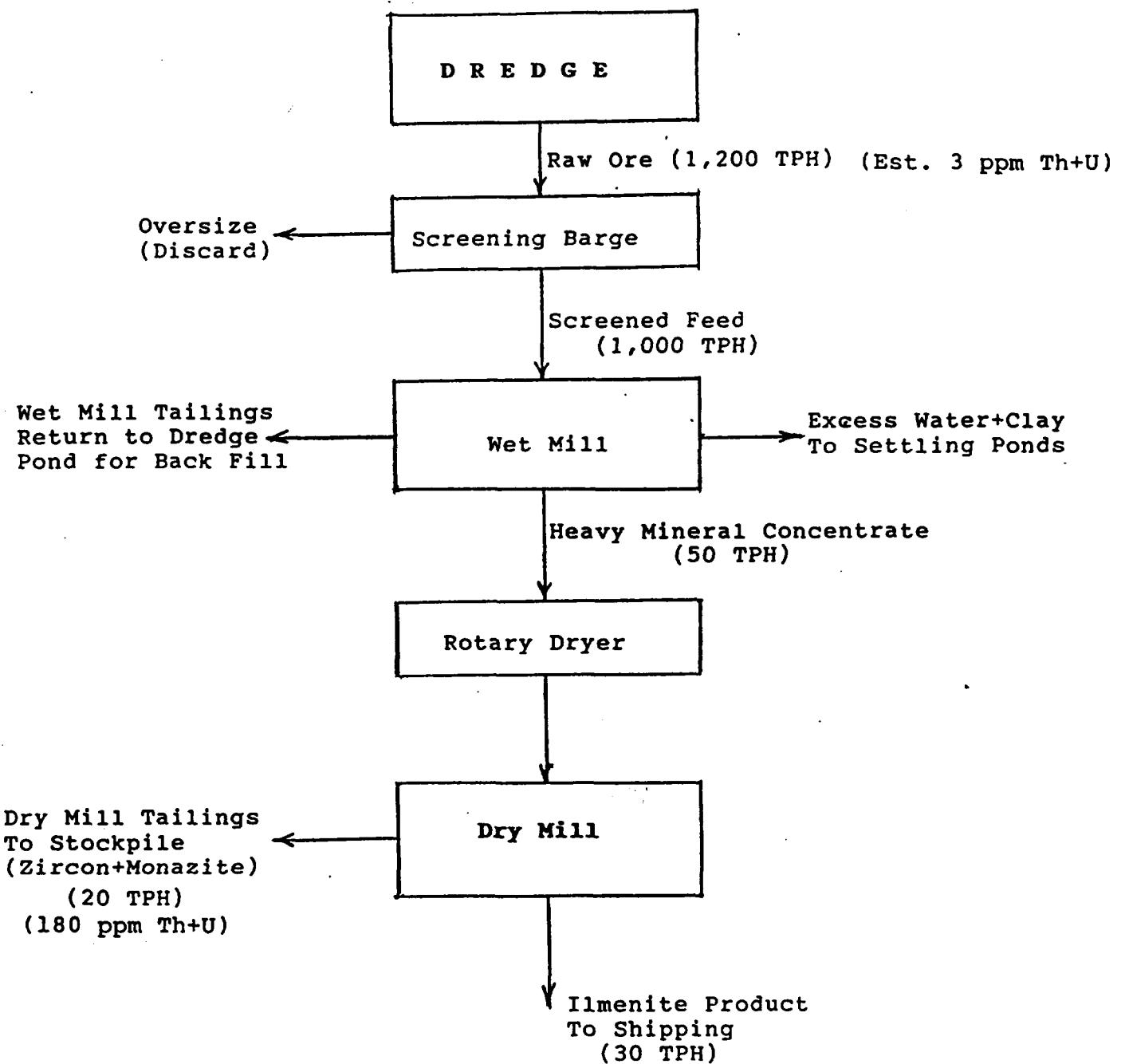
HISTORY OF THE SITE:

1. ASARCO Operation

The site was operated by ASARCO, Inc. between 1973 and 1982. The operation consisted of hydraulic mining (dredging) of the sand deposits and processing those sands to extract the titanium mineral ilmenite. The mineral composition of the sand deposits at the site were ascertained by earlier geological and mineralogical studies conducted by ASARCO. The deposits contained approximately 95% silica sand (common sand) and 5% heavy minerals. There are many mineral constituents in the deposits that are heavier than silica, which is why they are called heavy minerals. Ilmenite is the predominant heavy mineral, followed by zircon, kyanite, sillimanite, rutile, staurolite, tourmaline and monazite. Monazite is the mineral that contains thorium and uranium which cause the radioactivity in the deposits.

The following is a description of ASARCO's process, which is also illustrated in Figure 1:

- 1- At the very beginning, since there was no pond for the dredge, one was created by removing the top soil and sufficient sand using a dragline. The material so removed was stockpiled in a location west of the railroad tracks.
- 2- The dredged sand was pumped to a screening barge where large roots, clay balls and gravel were removed from the sand. The dredging rate was about 1,200 tons per hour.
- 3- The screened sand was pumped, still in slurry form, to a land-based concentrating plant consisting of a wet mill and a dry mill. The slurry went first to the wet mill wherein the heavy minerals were concentrated using spiral separators known as Humphreys spirals. The wet mill tailings, consisting primarily of silica sand and water were pumped back to the dredge pond as back-fill of the mined out areas. At the start of dredging, there was no place to back fill in the newly created dredge pond. Therefore, the wet mill tailings were stored west of the railroad tracks in the same location as the top soil removed by the dragline. This practice created a pile of roughly one million tons of material consisting of top soil and wet mill tailings. This pile is being referred to as Asarco wet mill tailings or old tailings. Based on its history, the radionuclide concentration of this pile is below the natural background concentration of the area.



**FIGURE 1**  
**ASARCO's OPERATION SCHEMATIC**

The heavy minerals followed a different path down the spiral and were dewatered and stockpiled outside the wet mill. Approximately 50 tons per hour of heavy-mineral concentrate were produced.

- 4- A great deal of wash water was used to assist the separation on the spirals and to wash away the fine clay which coated the mineral particles. The excess wash water and suspended clay were decanted off using large holding tanks (sumps) before pumping the sand.
- 5- The clay-laden water was pumped to a series of large-area settling ponds (about 10 acres) on the north side of the wet mill. The clay was allowed to settle out and the clarified water was recycled to the wet mill. This is the area which is now known as the "Blue Area". The reference came from the color-coded map which was presented to the US NRC by Heritage Minerals during licensure in 1990.
- 6- It should be noted that the monazite concentration and hence the radioactivity was increased by the ratio of 24:1 as a result of going through the wet mill and concentrating the heavy minerals from 1,200 tons to 50 tons.
- 7- The heavy mineral concentrate was allowed to drain for several days then transferred to a 200-ton storage silo.
- 8- Using a disc feeder at the bottom of the storage silo and a conveyor belt, the heavy mineral concentrate was fed to an oil-fired rotary dryer wherein the heavy mineral sands were completely dried and heated to about 300 degrees F.
- 9- The heated sand was conveyed to the dry mill which contained high-tension electrostatic separators and high-intensity magnetic separators.
- 10- The ilmenite was separated from the other heavy minerals using the high-tension separators which take advantage of the difference in electrical conductivity among minerals. Ilmenite, which was the desired titanium mineral, is electrically conductive. All the other heavy minerals in the concentrate are non-conductors.
- 11- The conductor product was then fed to the high-intensity magnetic separators for final cleaning of the ilmenite which was then placed in storage bins pending shipping to customers by rail or truck. About 30 tons per hour were produced.
- 12- The non-conductor rejects from the high tension separators were referred to as the Dry Mill Tailings. They were mixed with water and pumped to a storage area east of the mill. This is the area now referred to as the "Gray Area".

13- The Dry Mill Tailings, at about 20 tons per hour, contained virtually all the monazite that was contained in 50 tons of heavy minerals concentrate. Therefore the concentration of monazite was increased by the ratio of 2.5:1 relative to the heavy mineral concentrate. Since this is also the monazite that was contained in 1,200 tons of dredge output, it can be concluded that the monazite and its contained thorium and uranium were concentrated by a factor of 1,200:20, or 60:1 above natural deposits. A sample of the Dry Mill Tailings was analyzed by the US NRC during an inspection of the Heritage operation in January, 1988. It was found that the ASARCO Dry Mill Tailings (later referred to as the New Feed by Heritage) contained 180 ppm (parts per million) thorium plus uranium (Th+U). Approximately one million tons of Dry Mill Tailings were accumulated in the Gray Area during the ASARCO operation.

Based on the above, it is estimated that the unprocessed sand deposits contained about 3 ppm Th+U ( $180 - 60 = 3$ ).

14- ASARCO had planned to process the Dry Mill Tailings at a later date for the extraction and sale of zircon and monazite. Extensive laboratory and pilot-plant testing was performed by ASARCO on the recovery of zircon and monazite. However, deteriorating market conditions caused ASARCO to discontinue all operations at the site in 1982 and sell the property to Heritage Minerals, Inc. in 1986.

The process described above was carried out without any change in materials or techniques for the entire operating period. This leads to the conclusion that, except for minor fluctuation in the mineral content of the sand deposits, the Dry Mill Tailings were homogeneous in both mineral constituents and the concentration of those constituents.

## 2. Heritage Operation

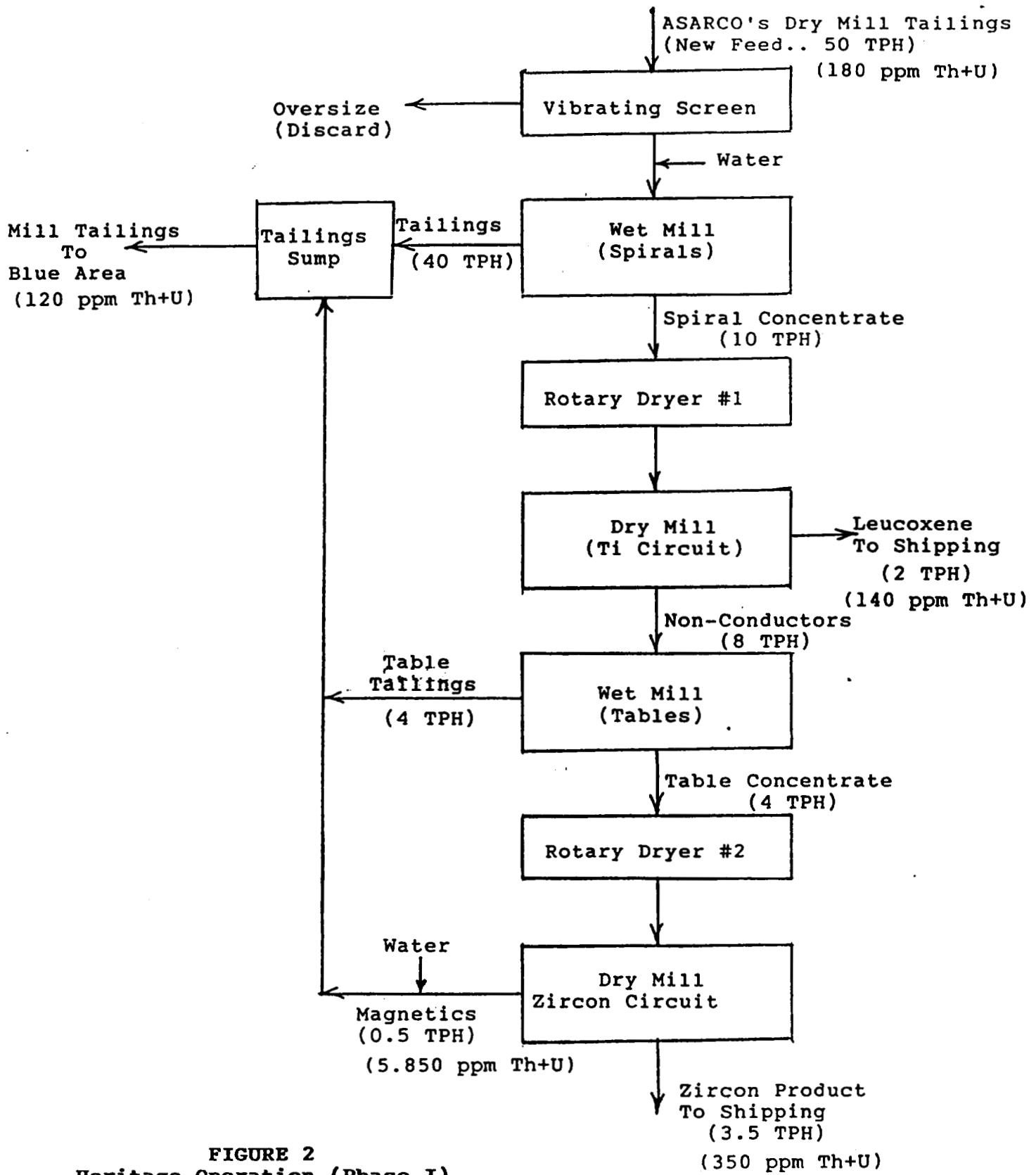
After the property was purchased by Heritage in 1986, the plant facilities were leased to Mineral Recovery, Inc. MRI ran additional laboratory and pilot-plant tests for the recovery of zircon and additional titanium minerals left behind by ASARCO, but not monazite which was to remain a part of the Dry Mill Tailings. The test work was conducted at Hazen Research of Golden, Colorado.

Based on the results of the test work and Hazen's recommendations the plant was modified and additional equipment was purchased. The plant started operation in October, 1986. In August, 1987 MRI's lease was terminated and Heritage Minerals took over the operation until August of 1990 when all production stopped. The operating period between October, 1986 and August 1987 (MRI's operation) was mostly a plant break-in and tune-up period during which actual production was minimal. As a result, the bulk of

the zircon and titanium values in the New Feed remained in the tailings during this period.

The following is a description of the Heritage plant operation, which is also illustrated in Figure 2:

- 1- The ASARCO Dry Mill Tailings located in the Gray Area, which will now be referred to as the New Feed for the zircon plant, were mixed with water and pumped to the wet mill at the rate of 50 tons per hour.
- 2- The slurry was processed over Humphreys spirals to remove any remaining silica sand and some of the aluminum minerals. Although the aluminum minerals are considered heavy minerals, they are considerably lighter than zircon, monazite and titanium minerals. As such it was possible to reject some of those aluminum minerals on the Humphreys spirals. Little or no zircon or monazite were lost in the spiral tailings. Some titanium losses were incurred, however, due to the presence of low-density, weathered ilmenite. The spiral tailings were collected in a large holding tank (sump) and pumped to the area north of the wet mill which was occupied by the clay settling ponds during ASARCO's operation (the Blue Area).
- 3- The spiral concentrate was dewatered using a vacuum filter then dried and heated to 300 degrees F in an oil-fired rotary dryer, similar to the one used by ASARCO but much smaller.
- 4- The dry, heated sand was fed to the first section of the dry mill (the Ti circuit) where the titanium minerals were separated using high tension machines. The primary titanium mineral recovered was leucoxene, which is a transition mineral between ilmenite and rutile. Leucoxene is a conductor as are ilmenite and rutile, and hence could be separated using high-tension machines.
- 5- The conductor product from the high-tension separators was cleaned using high-intensity magnetic separators to produce market-grade leucoxene. Because there is a certain degree of imperfection in any separation process, some zircon and monazite remained with the leucoxene. As a result, the leucoxene product, when analyzed by NRC, was found to contain 140 ppm Th+U. This was well below any regulatory or safety concerns and was acceptable to the customers.
- 6- The non-conductor product from the high-tension separators contained the zircon, monazite and the remaining aluminum minerals. It was reslurried with water and pumped back to the wet mill.
- 7- In the wet mill, the non-conductors were fed to a hydraulic classifier and then shaking tables, which were used to



**FIGURE 2**  
**Heritage Operation (Phase I)**

reject the remaining aluminum minerals. The table tailings were combined with the spiral tailings in the same holding tank, and were pumped together to the Blue Area.

- 8- The table concentrate was dewatered on a vacuum filter then dried and heated in a second oil-fired rotary dryer.
- 9- The dry, heated table concentrate was conveyed to another section of the dry mill (the zircon circuit) where it was treated on high-tension machines to remove any remaining traces of titanium minerals. Those were collected as conductors and returned to the Ti circuit.
- 10- The non-conductor product from the high-tension machines contained the zircon and monazite plus traces of aluminum minerals. The non-conductors were then fed to high-intensity magnets to remove magnetic minerals (monazite, staurolite and tourmaline) and thus produce market-grade zircon for sale to customers. Once again, because of the nature of the separation processes, some monazite remained in the zircon product. A sample of zircon was also taken and analyzed by NRC and found to contain 350 ppm Th+U. This was again below the regulatory threshold of 500 ppm set by NRC for "Source Material" requiring licensing. The Th+U content of the zircon was also below the specifications set by customers.
- 11- The magnetic product, which contained the monazite, was mixed with water and pumped back to the wet mill where it was combined with the spiral tailings and the table tailings in the holding tank to make up the plant tailings that were pumped to the Blue Area. When analyzed by NRC along with the other materials, the combined plant tailings were found to contain 120 ppm Th+U, which is less than the 180 ppm that was found in ASARCO's dry mill tailings (Heritage's New Feed). The decrease in Th+U concentration is explained by the loss of monazite to both the zircon and leucoxene product.

The analyses show that the Heritage operation resulted in a net improvement in the radiological condition of the site when compared with what it was at the end of ASARCO's operation and before the property was purchased by Heritage.

While these numbers are one-time analyses of single samples, they represent the correlation amongst the various products, since all the samples were taken at the same time.

- 12- When the ASARCO Dry Mill Tailings in the Gray Area (the New Feed) were exhausted, Heritage decided that sufficient zircon and leucoxene had remained in the plant tailings in the Blue Area, especially during MRI's initial operation period, to warrant the recycle of those tailings through the plant for a second round of processing to extract additional

zircon and leucoxene products. This became known as Phase II of the operation.

- 13- Some minor variations on the above-described process were tested and incorporated in the plant operations in the efforts to improve product quality and yield. For example, additional stages of spirals were added to improve silica and alumina rejection. Another variation, which was later incorporated to reduce fuel consumption, was eliminating the second rotary dryer and processing the spiral concentrate directly on the shaking tables prior to processing in the dry mill. A third variation, which was dictated by NRC during the licensing process, involved isolating the monazite-rich magnetic product in a separate holding area rather than combining it with the other tailings. When that practice started, the mill tailings were no longer pumped to the Blue Area but were sent to a separate area east of the wet mill. The monazite-rich magnetics were stored separately in an area to the southeast of the dry mill. This is the area known as "the Monazite Pile".
- 14- The above-mentioned variations were incorporated at the start of reprocessing of the plant tailings (phase II). After about 200,000 tons of tailings were reprocessed through the plant, Heritage decided to terminate all operations due to the economic downturn which resulted in reduced demand and prices for the plant products.

The reprocessing of the 200,000 tons of Blue Area tailings during which the monazite was isolated in the Monazite Pile resulted in further improvement in the condition of the site through producing about 150,000 tons of tailings that were virtually monazite free. These tailings were stored separately in an area east of the Blue Area and north of the Gray Area. As a consequence of this practice, approximately 695 cubic yards (1,400 tons) of monazite-rich product were generated and are stored in the Monazite Pile. The Monazite Pile, as well as the plant buildings, are under the control of the NRC according to the terms of License No. SMB-1541.

Figure 3 is a schematic of phase II of the plant operation.

The materials and techniques used in the Heritage operation did not vary significantly from those employed by ASARCO and, once again, it can be concluded that the sand in the Blue Area and the Gray Area are homogeneous in nature by virtue of being products of processing the local sand deposits.

#### AREAS REQUIRING INVESTIGATION:

The specific areas which require radiological investigation under the ACO are those areas which exhibit gamma radiation levels

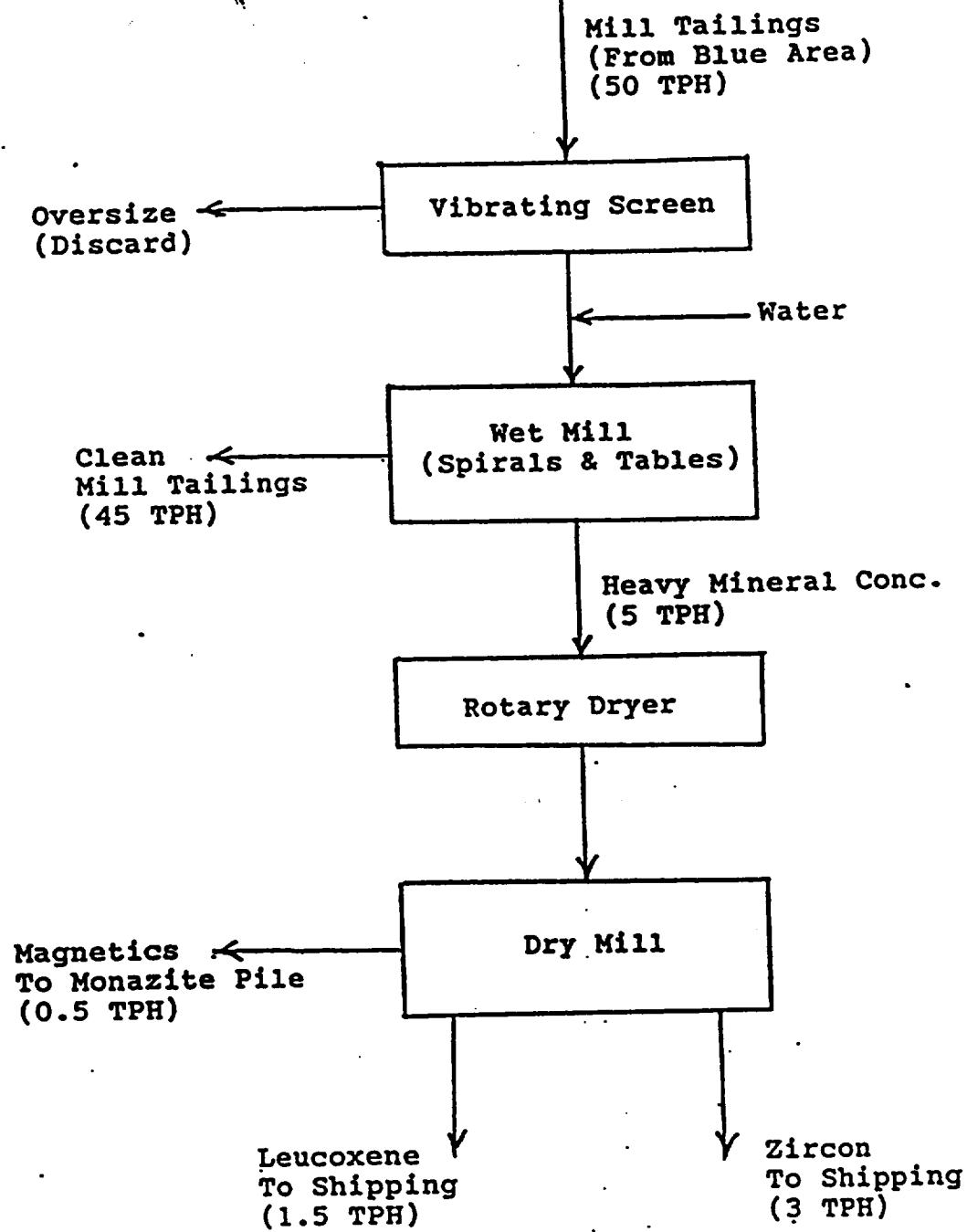


FIGURE 3  
Heritage Operation (Phase II)

above natural background, excluding those areas under the jurisdiction of the US NRC according to the terms of the license issued by NRC on January 2, 1991 (#SMB-1541) which covers "all areas in the plant buildings and at the monazite pile".

The following is a listing of the areas in question based on exhibiting gamma radiation levels above natural background:

- 1- The Blue Area. That is the storage site of the Heritage mill tailings.
- 2- The Gray Area. That is the area which was occupied by the ASARCO Dry Mill Tailings and was cleared by Heritage during plant operations.
- 3- The area east of the wet mill which is now occupied by the clean tailings produced by Heritage during the recycle phase of operations (phase II).

#### SITE CHARACTERIZATION:

The historical background discussed above and in the ACO show that a great deal of information is already available about the site. This information is summarized below:

- 1- History is well defined;
- 2- Process by which the tailings were generated is well known;
- 3- The quantities of tailings are known;
- 4- The radioisotopes present are known;
- 5- The activities of the radioisotopes are known;
- 6- Gamma radiation levels at the site are known.

A scaled site map has been prepared, on which all past radiation surveys and soil analyses were plotted for easy reference. The map was provided to NJDEP previously.

Reference is made to the report entitled "Review of Radiological Data, Heritage Minerals Site, Manchester Twp., New Jersey" prepared by SENES Consultants Limited, dated 10 February, 1995. In the report, a detailed statistical analysis of the radiation surveys and soil analyses conducted at various times at Heritage.

The report concludes that "the Blue area tailings should be considered spatially homogeneous". Some "augmentations" were suggested to facilitate confirmation of this conclusion.

### Proposed Additional Testing

There are two areas of proposed additional testing that will be addressed based on the recommendations received since the original submission of the Tailings Investigatory Plan

#### I. Further Characterization of Mine Tailings:

In addition to the information already available, it is proposed to carry out a test program which would serve (1) to delineate the physical boundaries of the tailings piles and (2) to confirm the absence of any pockets of sand with high radionuclide concentration in the tailings. To achieve both of these objectives, the following test program is proposed:

- 1- Establish a grid 100'x100' on the tailings areas. The grid points would be marked with wooden stakes with information identifying each point.
- 2- Carry out a gamma survey at the grid points using a micro-R meter. This is a walking survey during which the meter is observed continuously. In addition to recording the meter readings at the grid points, any abnormally high readings encountered, i.e., more than 40% above the previous reading, would also be recorded, regardless of location. Note that all readings in the tailings area are expected to be above the established range of ambient natural background. The walking survey continues in all direction until readings of natural background are encountered. This will provide accurate delineation of the boundaries of the tailings.
- 3- Establish a larger grid, 200'x200' to be superimposed on the first grid. Using an auger drill, collect a soil sample at each grid point by drilling a hole as deep as the tailings are at that point. In the event that the variation in radiation levels between grid intersections exceeds two times the generally accepted accuracy range of typical calibrated instruments (Approximately 40%), soil samples shall also be taken at the center of each adjacent grid square.
- 4- For each hole to be drilled, take down-the-hole gamma survey measurements at one-foot intervals as the drilling proceeds. This will indicate whether there are any pockets of high-radionuclide concentration in the pile. The individual one-foot sections of core extracted from the hole are kept in separate containers and properly identified.
- 5- In any event that gamma logging data indicate variation in radiation levels along the length of each core which exceeds two times the accuracy range of the instrument (40%), the individual one-foot sections of the core shall be stored separately for analysis. If the variation in gamma

radiation levels does not exceed 40%, then the individual one-foot sections shall be combined and blended into one composite representing the hole in question.

- 6- The composite samples collected in steps 3-5 are blended and stored in sealable plastic bags and taken to the sample staging area in preparation for radionuclide determination analysis. Analytical methods will be discussed in the next section.
- 7- The data collected, both gamma surveys and radionuclide concentrations, are plotted on a map of the site which will give an accurate delineation of the tailings, both in terms of quantity and area, as well as the radiological make up of the tailings.

#### II. Defining Natural Background:

The naturally occurring background at the site is determined by carrying out gamma surveys and collecting soil samples from several unaffected locations at the Heritage property.

The number of soil samples required to establish background has been determined by Radiation Science, Inc. according to NUREG/CR-5849. RSI determined that a total of 32 samples need to be collected and analyzed in order to achieve the required statistical confidence.

#### III. Ground Water Investigation:

Past testing and the geochemical nature of monazite both point to the fact that no dissolution of radionuclides in water can take place. However, additional well and surface water sampling and analysis will be carried out.

Ground water samples will be collected from existing wells in the plant and tailings areas and at the monazite pile. In addition, surface water samples from the various lakes and ponds will also be collected. All water samples will be sent to a commercial lab to be analyzed for gross alpha and gross beta. The data will be used to determine whether there is any detectable radioactive contamination of the water as a result of the presence of the tailings or the monazite pile.

#### IV. Quality Assurance/Control:

The procedures prescribed in the "Field Sampling Procedures Manual" published by the NJDEP in May, 1992 will be used to formulate the QA/QC program for this work. In order to generate data of known and defensible quality, an established quality assurance protocol will be followed. Quality assurance measures coupled with a statistically based sampling plan will improve sample collection while maintaining the integrity of the samples prior to analysis.

## 1. Sample Containers

The bulk of this investigation involves field-collected soil samples. To eliminate any possibility of cross contamination, sample containers will be new, one-time-only use polyethylene bags. The closures will be either built in "zip-lock" closures or coated wire "twist ties". Sample identification will be done using pencil-marked sample tags to be inserted inside the bags. Additionally, the outside of the bags will be marked using an ink marker. There is no concern about the reactivity of the container bags with the samples since the samples are chemically inert natural mineral sands, sometimes moist with water. Clear plastic bags are satisfactory for this application since there is no concern about photosensitivity of the soil samples. The sample bags will be stored in cardboard boxes which will also be used for shipping the samples to the analytical laboratory. The boxes will be packed with sufficient foam or other packing material in order to minimize movement of sample bags inside the box.

Water sample containers will be new or thoroughly washed plastic buckets with gasketed lids. The buckets are whit high density polyethylene which is opaque, thereby prevent light intervention.

## 2. Decontamination of Sampling Equipment

Soil sampling will be carried out in the field using hand or mechanical augers. Other field sampling equipment are stainless steel pans for sample collection and stainless steel spatulas for sample blending, homogenization and splitting. Field sampling equipment will be cleaned using hand scrubbing with water to remove all adhering sand from the previous sample before proceeding to the next sampling point. It is not necessary to use high pressure steam or detergent because the sand is easy to remove completely using water scrubbing or dry brushing if the sand is completely dry.

## 3. Blank and Duplicate Samples

Laboratory duplicate and blank analyses will be performed as part of the program. Duplicate samples will be prepared by splitting the soil sample into equal halves using the standard cone-and-quartering method. The duplicate samples will be labelled in such a way that they could not be identified by the analytical laboratory as duplicates. One duplicate sample will be analyzed for every 20 soil samples.

Blanks for soil analyses will be done using ASARCO wet mill tailings, which is silica sand from the same origin but with all heavy minerals removed. Past results of gamma-spec. analysis of this material showed Th and U levels well below natural background for the site. One blank sample will be analyzed with every 10 soil samples as prescribed in the Field Sampling Procedures Manual.

#### 4. Analytical Methods

The radiological assessment of the tailings will be conducted with the use of two basic techniques; exposure rates (gamma surveys) and gamma spectroscopy.

Gamma surveys at the site will be conducted using a Ludlum model 19 micro-R meter which is capable of readings down to below natural background. For quality assurance, the meter is calibrated on a yearly basis as required by the NRC and the manufacturer. In addition, daily measurements of a known location will be made to ascertain the consistency of the survey readings.

Gamma spectroscopy will be performed by a commercial laboratory that is equipped and qualified to perform these determinations. Teledyne Isotopes of Westwood, New Jersey is believed to be suitable for this purpose.) It has been established that the primary radionuclides in this site are naturally occurring uranium and thorium and their daughters in secular equilibrium. Consequently, future gamma-spec. analyses will be done for the specific purpose of determining the activities of these two nuclides.

A field testing procedure, which combines gamma spec. analysis and exposure rate determinations is being proposed as a field screening technique intended to reduce the excessive time and costs involved in the use of gamma-spec. analyses alone for testing every soil sample. Details of this proposed field testing methodology are presented in Appendix I.

#### IV. Work Schedule:

A Chart depicting the MTRAP work schedule is presented in Appendix III. It is estimated that all phases of the investigation could be completed in approximately 4-6 months from the time DEP's approval of the plan is received.) Several tasks may take place at the same time. For example, while water sampling is not mentioned in the time chart, it is expected that it will be done very early in the program in order to allow ample time for analysis.

The work schedule assumes that the proposed field testing method will be approved by the Department and used to test 75% of the soil samples. The balance would be analyzed by gamma-spec. analysis at Teledyne Isotopes. It was also assumed that no significant delays would occur as a result of weather conditions.

APPENDIX I  
PROPOSED METHODOLOGY FOR FIELD TESTING  
HERITAGE MINE TAILINGS

A proposed field testing technique is presented as a supplement to gamma spectroscopy for use in the Mine Tailing Radiological Assessment Plan (MTRAP) for Heritage Minerals. There are several reasons for proposing the field testing technique:

1. Significant savings in time and money would result from the use of an on-site method for testing most of the soil samples to be collected during the MTRAP.
2. When used in conjunction with gamma spectroscopy, which would be used for analyzing a duplicate of every 10-20 samples being tested in the field, this approach can produce very reliable information about the radiological nature of the tailings. Gamma spectroscopy would be used on all samples that fall outside a preset upper limit for the field test.
3. It has been established that naturally-occurring thorium and uranium, along with their daughters, are the radioisotopes present in the tailings, and they are always present in the natural minerals monazite and, to a lesser extent, zircon. Therefore, it is believed that analyzing every sample for thorium and uranium separately, using a precise analytical technique like gamma spectroscopy may be unnecessary. It should be sufficient to take a gamma radiation measurement which can be used to infer the total activity of the sample. Once again, sufficient samples would still be run by gamma spec. for confirmation. In addition, all samples which fall outside a preset upper limit would be analyzed by gamma spectroscopy.
4. Since the primary objective of the site assessment phase is to define the extent of the presence of elevated radioactivity in the soil and uncover any potential "hot spots", there should be no reason for concern about the reduced accuracy of the proposed field testing method at low concentrations. It is understood that this method will probably not be adequate for soil testing during the post-remediation verification phase when radioactivity levels will be considerably lower.

For the reasons outlined above, the proposed field testing technique is a rationale approach on both a technical and practical level. It will provide NJDEP and Heritage Minerals with the details required to address fully issues regarding the mine tailings.

#### **Proposed Method Description:**

The proposed test method is simply a measurement of the gamma exposure rate (in micro R/hr) of a standardized volume of soil placed in a plastic cubical box and surrounded by lead shielding to exclude the effects of ambient radiation. A drawing of the proposed test arrangement is shown in Appendix II. The exposure rate, measured using the Ludlum Model 19 micro R meter pressed against the side of the box, is then converted to total radioactivity (in picocuries per gram) using a site-specific calibration curve. The calibration curve is established by collecting a number of samples from the tailings areas, sending them to Teledyne for gamma-spec. analysis, then testing the same samples with the box method. Plotting the exposure rates against the thorium-plus-uranium activities obtained by gamma spec. will yield the calibration curve. Statistically reliable measurements can be assured by employing a sufficiently large number of samples covering the range of activities to be expected in the tailings piles.

#### **Proposed Application in Field Testing:**

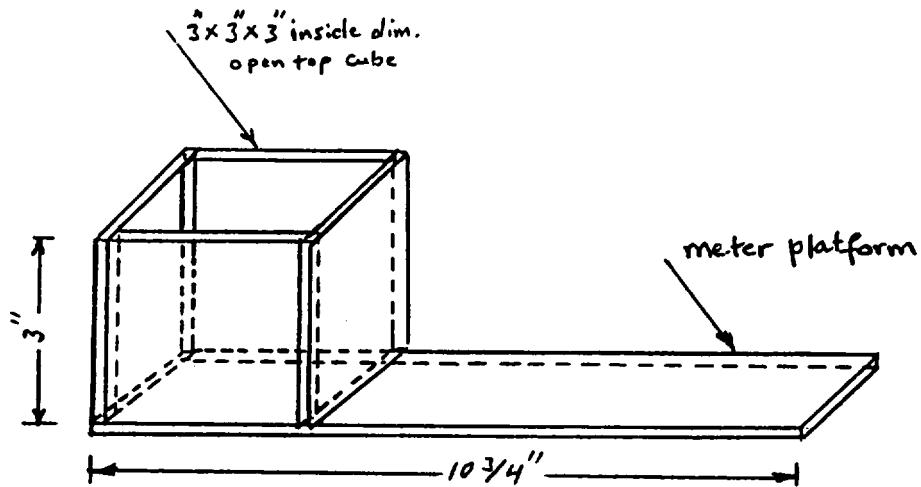
The following steps are proposed for implementing the field testing methodology as part of the Mine Tailing Radiological Assessment Plan (MTRAP) for Heritage Minerals:

1. The MTRAP, as revised by the NJDEP, is started with all soil samples being collected at the grid intersection. Every sample is blended and split in into two halves.
2. Initially, and until sufficient data have been obtained to establish the accuracy of the proposed methodology, one half split of each sample is sent to Teledyne for gamma spec. analysis and the other half is tested by the proposed field testing method then stored securely.
3. The exposure measurement is made by placing the soil sample in the box, making sure that the sample is thoroughly blended and that a sufficient amount is used fill the box completely. This will assure that a standard volume of sample is used every time. The micro-R meter is placed with the measuring surface against the thin window of the box (see Appendix II). The lead shielding is placed around the box and the meter. The meter is turned on and a stopwatch started at the same time. The time required to obtain a stable reading is established with the first measurement and used consistently thereafter. When the time elapses, the meter reading is recorded and the sample removed from the box and replaced in its storage bag.
4. The QC/QA part of the MTRAP dictates the inclusion of a number of duplicate and blank samples. Those will also be included in the proposed test program.

5. The information from steps 1 and 2 above is used to plot the total radioactivity obtained by gamma spec. against the exposure rate obtained from the box.
6. As the number of data points on the calibration curve increases, it will become clear whether or not the results of comparable samples can be reproduced.
7. A statistical analysis is performed to define the confidence level associated with the measurements. The statistical analysis will also assist in determining the required number of data points necessary to produce a calibration curve that could be used to estimate the total activities of soil samples with acceptable accuracy.
8. The data obtained thus far is then submitted to the NJDEP for their review of the quality and reliability of the measurements before further field testing with the proposed method is performed.
9. When the review is completed and the statistical reliability of the measurements is confirmed by the Department, it will be no longer necessary to send every sample to Teledyne for gamma spec. Instead, the proposed method would be used for field testing most samples.
10. A trigger value of exposure rate is established from the statistical analysis and agreed upon with DEP, which, when exceeded by any sample, that sample would be sent to Teledyne for gamma spec.
11. As an ongoing quality control measure, a confirmatory gamma spec. analysis will also be run on one in every 10-20 samples being analyzed by the proposed method.

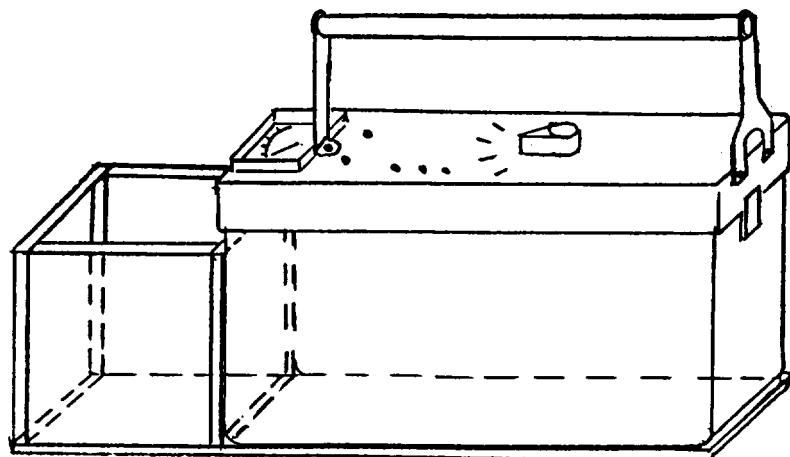
## APPENDIX II

### Drawing of Field Testing Apparatus



TEST BOX

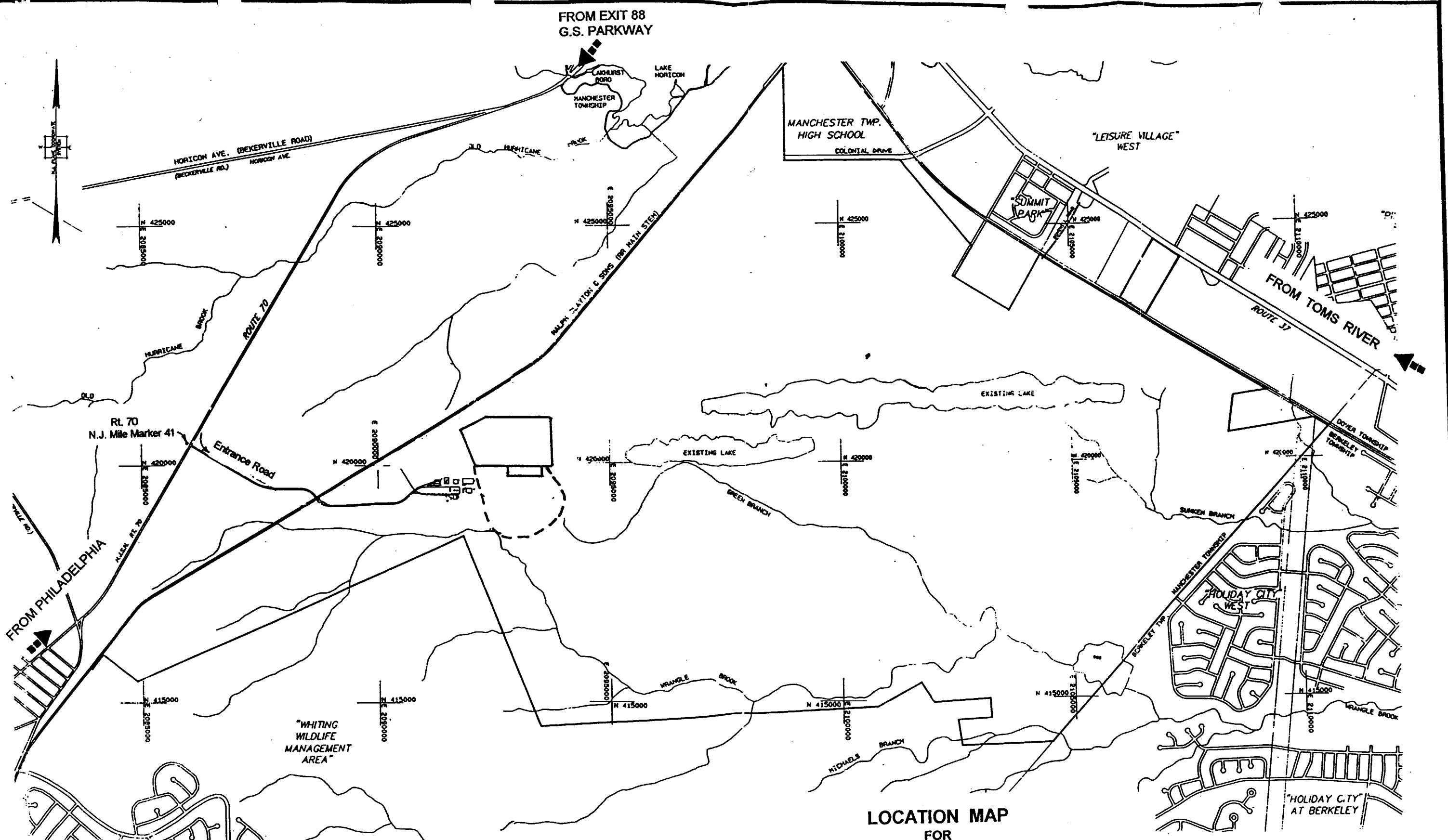
Construction Material:  $\frac{1}{8}$ " clear "Plexiglas" Plastic



TEST BOX & SURVEY METER

## WORK SCHEDULE FOR MTRAP

<u>Task Description</u>	<u>Start Date</u>	<u>End Date</u>	<u>Remarks &amp; Conditions</u>
Establish Grid & Place Markers	11/18/96	Plus One Week	Starting date and duration may vary depending on weather conditions.
Initial Walking Survey	11/25/96	Plus 3 Days	Duration may be affected by ground conditions and possible accumulation of water in low areas after heavy rain.
Drilling Program at Grid Intersections	End of Survey	Plus 9 Weeks	Frozen ground and poor weather may interfere with the drilling program and cause delay in completion
Additional Drilling, If Needed	End of Drilling	Plus 2 Weeks	Depending on the outcome of the initial drilling program, soil and weather conditions, this may take longer or shorter than two weeks.
Ground Water Sampling & Analysis	May Start With Drilling	Plus 4 Weeks	Depending on manpower availability this may be done concurrently with some of the above tasks.
Sample Preparation for Analysis	Starts With Drilling	End of Drilling + 2 Weeks	This activity goes hand-in-hand with the drilling program. It is, therefore, controlled by the same circumstances.
Sample Analysis by Gamma Spec & Field Testing	One Week After Prep.	Plus 10 Weeks	Depending on the number of samples that must be sent out for gamma spec., this task may require considerably more time.
Data Evaluation and Additional Testing as Needed	Overlaps With Prep Analysis	Plus 4-6 Weeks	May require longer time, depending on the extent of additional testing needed.
Final Report	End of Data Evaluation	Plus 2 Weeks	



**LOCATION MAP  
FOR  
ASARCO/HMI ROUTE 70, MILE MARKER 41  
CLEAN - UP SITE**

**APERTURE  
CARD**

**NOTE:**  
GRID BASED ON N.J. SYSTEM OF  
PLANE COORDINATES (1927 VERSION)

SCALE : 1 " = 2,000'

Also Available on  
Aperture Cards

980812 0087-01

## ADDENDUM - I

## COST ESTIMATION OF NRC LICENSE TERMINATION

The following is a summary of the costs involved in packaging and shipping the monazite sand to L&T Mineral Company of Malaysia and conducting the Final Status Survey (FSS). Note that the cost estimates related to freight charges are based on quotes obtained in 1994. Informal inquiries with potential shippers indicate that no significant changes have occurred since that time.

I. Packaging and Preparation:

Purchase of 83 sea containers at \$1,400 each	\$116,200
Purchase of 3000 steel drums at \$6.00 each	18,000
Labor cost for filling drums and loading containers	10,000
Timber and nails for securing drums in containers	2,000
Miscellaneous materials, supplies and rentals	<u>7,000</u>
Item I sub-total	\$153,200

II. Shipping-Related Costs:

Ocean freight at \$3,500 per container	\$290,500
Trucking containers from mine to pier at \$500 each	41,500
50-ton crane rental for 6 days at \$1,000 per day	6,000
Labor charges at pier and freight forwarding fees	<u>5,000</u>
Item II sub-total	\$343,000

III. Final Status Survey:

Labor cost for pre-cleaning	\$ 7,000
Labor cost for surveys	34,900-42,000
Total analytical	10,200-12,000
Data analysis and FSS report preparation	<u>7,200-8,500</u>
Item III sub-total	\$ 59,300-69,500

In the event one or more of the survey units designated as "unaffected" proved to be "affected", thus requiring more detailed survey work, the FSS costs are presented as a range with a 20% contingency at the high end to account for potential additional survey work.

Grand Total Cost of License Termination: \$555,500-\$65,700

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