

APPENDIX B

SUMMARY OF ORIGINAL WORK PLAN, MODIFICATIONS, AND EXPLANATIONS

Summary of Original Work Plan, Modifications, and Explanations

YEAR 1

Task 1 – Lab Development and Field Placement

- 1) *Determine engineering properties required for the feedlot surfaces.*

Completed. No modifications.

- 2) *Ash characteristics will be assembled from a previous North Dakota Industrial Commission (NDIC) study and industrial partners.*

Modification: Additional information on eight North Dakota and Minnesota coal-fired power plants was collected from other Energy & Environmental Research Center (EERC) publications to conduct a variability study. Included were bulk oxides, trace element concentrations, and synthetic groundwater leaching procedure (SGLP) leachate results.

Explanation: The variability study (see Appendix J) was done to show the North Dakota Department of Health (NDDH) historical fly ash data.

- 3) *Added testing will be performed as needed.*

Completed. No modifications.

- 4) *Additional literature will be obtained if necessary.*

Completed. No modifications.

- 5) *Laboratory-scale ash–soil mixtures will be produced and tested using standard methods. These simulated products will take advantage of moisture conditioning, combining materials, compaction, and other techniques noted in the literature to produce candidate surfaces. The surfaces will be evaluated for strength development, permeability, freeze–thaw durability, erosion susceptibility, and other characteristics deemed appropriate. Standard test methods will be used where appropriate. Up to six surface treatments will be selected for placement at the Year 1 field site.*

Modification: A total of eight mix designs were developed, with four incorporating bottom ash in addition to fly ash. The mixes with bottom ash were ultimately not used because of the complexity of incorporation of an additional raw material in limited pen space.

Explanation: Information from previous work, the literature, and project sponsors indicated most of this information was either not required for evaluating ash in soil stabilization

applications or that adequate data were already available from those resources. See supporting documents in Appendix K.

- 6) *Surface treatments identified will be placed at the bison research facility at North Dakota State University Carrington Research Extension Center (NDSU CREC). One series of four pens was partly surfaced with concrete in the feeding/watering areas. This series of pens will serve as a project control for various performance criteria. Ash will be shipped to the site. Conventional farm tractors and equipment will be used to place the surfaces. CREC staff will perform the on-site materials handling, with direction from EERC research staff and a consulting engineer with experience placing ash in full-scale applications.*

Modification: Fly ash from three sources (Coal Creek Station [CCS], Hoot Lake, and Stanton Station) was incorporated into the surfaces of 12 pens (1–4 and 9–16) at the CREC bison research facility. Three addition levels were used for each fly ash source to determine a range of fly ash addition from ~12% to ~25%. Various placement, mixing, and compacting techniques were employed.

One off-site placement using a concrete like flowable mixture was performed near Flasher, North Dakota. This mixture was also placed in eight experimental pens around feeding and watering areas instead of a more standard concrete mix. A limited amount of CCS bottom ash was used to surface feed haul roads in front of Pens 1–4.

Explanation: A concrete-like mixture consisting of cement, CCS fly ash, and CCS bottom ash (as the aggregate) was placed in a silage pit. NDDH had previously approved all materials for use (see letter dated January 10, 2000, in Appendix I), so this application was intended to provide demonstration of the simplified application of the flowable mixture and a performance evaluation under crop storage circumstances. The concrete like material was needed in the CREC pens to provide comparable surfaces to the standard concrete used in control pens and one set of ash-modified pens. Since CCS bottom ash was previously approved for use by NDDH, the placement was intended to provide an opportunity to demonstrate its effectiveness for farm applications such as feed roads, laneways, and other unsurfaced driving surfaces. These flowable mixture and bottom ash demonstrations were stopped after Year 1 on request of NDDH representatives (see July 5, 2001, NDDH letter Item 5 and the EERC response letter dated July 10, 2001, in Appendix I), who indicated a desire to limit the project to ash-modified soil feedlot surfaces.

Task 2 – Environmental Monitoring

- 1) *With input from NDDH, an environmental monitoring plan will be developed early in Year 1. It is anticipated that the monitoring plan will include sampling of both groundwater and runoff. The parameters for evaluation will be determined with assistance from NDDH.*

Completed. No modifications.

2) *Background leaching data will be collected from various sources, and additional leaching information will be generated if needed. It is anticipated that the monitoring plan will include sampling of both groundwater and runoff.*

Completed. No modifications.

3) *It is proposed to collect and analyze two sets of background samples from the site prior to placement of the ash surfaces.*

Completed. No modifications.

Task 3 – Performance Monitoring

1) *The engineering performance of the placed surfaces will be monitored both by observation by CREC staff during daily activities at the bison research facility and by periodic testing and evaluation on-site by EERC researchers and the consulting engineer. The engineering performance monitoring will continue throughout the duration of the project. Observational monitoring will include surface conditions, cracking, impact of cleaning procedures, and other general wear-related information. These observations will be dated and recorded. The formal performance monitoring will include standard tests to evaluate surface integrity, strength, and erosion. These data will be compared with observations made by CREC staff.*

Task 4 – Technology Transfer

1) *CREC staff will collect material for a video and publication outlining ash utilization in feedlots. This information will be used to show feedlot operators how ash is being used in the demonstration project and make them aware of the potential for their operations. The NDSU CREC staff will have primary responsibility for this information transfer and will offer it through the NDSU Extension Service and at various locations and events in North Dakota. These materials will also be available to EERC staff for technology transfer activities.*

Modification: Visitors to a CREC Field Day in Year 1 viewed an ash placement activity. This was originally planned for Year 2. Video footage was taken of an ash placement.

Explanation: Researchers were able to schedule a field placement activity in conjunction with the 2000 CREC Field Day, providing an excellent opportunity for interested parties to view this activity.

Task 5 – Economic Evaluation

1) *An economic evaluation will be done comparing the costs of placing North Dakota lignite ashes and concrete on feedlots. Animal weight gains will be considered.*

This activity was not completed during Year 1.

Task 6 – Feedlot Design Manual

No plans for Year 1.

YEAR 2

Task 1 – Lab Development and Field Placement

- 1) Two to three commercial feedlots will be identified that will use ash treatment in their feedlot surfaces. Conventional farm tractors and equipment will be used to place and compact the surfaces. As in Year 1, EERC research staff and a consulting engineer with experience placing ash will oversee the placement.*

Modification: No ash placement was performed in any volunteer sites identified.

Explanation: NDDH did not allow placement off the CREC site, stating that insufficient data was available to provide justification to place in commercial feedlot settings.

The EERC's request can be found in the September 25, 2001, letter to NDDH, in Appendix I. The NDDH response is the letter dated October 19, 2001, in Appendix I.

Task 2 – Environmental Monitoring

- 1) Groundwater and runoff water monitoring continued at the CREC site. This continued monitoring will possibly be modified from Year 1, depending on those results. NDDH will provide the input for any parameters that no longer need to be monitored or those that might be added from Year 1. Samples will be taken on a quarterly basis for a full suite of analyses.*

Modification 1: Three groundwater and runoff sampling events were accomplished in Year 2. All parameters were analyzed in the samples. One of the runoff-sampling events was performed by NDDH.

Explanation 1: Because of scheduling conflicts, the second groundwater-sampling event planned for Year 1 was delayed until early in Year 2. Runoff ponds were frozen when the groundwater samples were collected in January, so runoff collection was performed throughout the remainder of the year. A fourth set of runoff samples was collected from individual pens.

Modification 2: A runoff study was performed for the individual pens. There was not enough sample collected in one of the control pens for evaluation.

Explanation 2: NDDH wanted to determine the contribution of each individual pen to the runoff pen evaluated.

Modification 3: Fly ash and bottom ash samples were analyzed for trace element composition.

Explanation 3: Total concentrations of trace elements in the samples included in this study provide important baseline information for interpreting laboratory field results.

Modifications and explanations for Year 2 Task 2 are supported in meeting minutes dated November 2, 2001, in Appendix I.

Task 3 – Performance Monitoring

1) Performance will continue consisting primarily of observation of the integrity of the placement. Strength tests will be performed on intact core samples, and determinations will be made of shrink/swell properties.

Modification 1: Shrink/swell properties were not evaluated; however, cores were taken and evaluated for moisture content, density, permeability, and strength. A commercial testing laboratory determined in-place field densities.

Explanation 1: Attempts to retrieve intact core samples met with limited success. Cores were only successfully taken when the pen surfaces had significant levels of moisture. In cases where the moisture content was low, the surface material would not adhere well enough to maintain a cylindrical shape. Additionally, access to animal pens was often restricted because of the presence of bison.

Modification 2: Animal performance (weight gain and general animal health) evaluations were added to this task. Observation of hooves was also made when possible. Gross evaluations were made of animal carcasses on slaughter.

Explanation 2: CREC was performing feeding studies on the animals in the project pens, so these data were collected as part of animal studies; however, CREC researchers made these data available for this effort (see Appendix G) and included comparative analysis between control pens and ash-modified pens.

Task 4 – Technology Transfer

1) With the assistance of the NDSU Extension Service, feedlot operators will be invited to visit the CREC site to see for themselves how the placements have performed.

Modification: Visitors to a CREC Field Day in Year 1 viewed an ash placement activity.

Explanation: Researchers were able to schedule a field placement activity in conjunction with the 2000 CREC Field Day, providing an excellent opportunity for interested parties to view this activity.

Task 5 – Economic Evaluation

No activity planned for Year 2.

Task 6 – Feedlot Design Manual

No activity planned for Year 2.

YEAR 3

Task 1 – Lab Development and Field Placement

No plans for Year 3.

Modification: An additional field placement was proposed for Year 3 to evaluate initial runoff from freshly placed ash–soil mixtures. The initial proposed plan was sent to NDDH on September 13, 2002, and the revised plan was sent October 18, 2002. Both documents can be found in Appendix I.

Explanation: Modifications were made on request of NDDH to address questions about initial runoff quality. As of November 2002, the research staff and project sponsors have determined that questions posed by NDDH on initial runoff quality can be adequately addressed with laboratory data and data from other field studies. The research staff withdrew the proposed work plan in a letter to NDDH on February 7, 2003, and submitted a summary of existing data to address NDDH questions on February 14, 2003 (see Appendix I).

Task 2 – Environmental Monitoring

1) Quarterly samples of groundwater and runoff will continue to be monitored through Year 3. Any modification of parameters will be done in conjunction with NDDH.

Modification 1: Groundwater sampling was limited to one event in Year 3. Postproject groundwater monitoring will be addressed during the final stages of the project, but since part of the feedlot permit requires annual groundwater monitoring, these samples can be used to evaluate all parameters deemed necessary by NDDH. Runoff pond monitoring was limited to one event in Year 3.

Explanation 1: Because of limited rainfall, runoff was not available in the runoff holding ponds over the duration of summer–fall of Year 3. On review of standard management practices for runoff, CREC staff indicated typical use as irrigation water would likely be performed on an annual basis.

Modification 2: Manure samples were collected for evaluation of ash content.

Explanation 2: In a March 14, 2003 letter (see Appendix I), NDDH requested the ash content of surface manure samples and the total elemental analyses of collected manure samples.

Task 3 – Performance Monitoring

- 1) Performance of the placements will be evaluated for their durability. It has been reported that bison are considerably more active than cattle. Because of this activity, the performance of the CREC site will be critically evaluated for wear caused by the animals as well as the wear caused by 2 years of exposure to the elements. Two to three other placements will also be evaluated for comparative purposes.*

Modification: Animal performance was monitored again in Year 3. No other ash-modified soils were monitored.

Explanation: As stated in an October 19, 2001 letter (see Appendix I), no commercial ash placements were allowed by NDDH in Year 2, so these sites were not available for monitoring.

Task 4 – Technology Transfer

- 1) Interested feedlot operators will be asked to visit one of the commercial demonstration sites. It is anticipated that performance and environmental data will be available for 2 full years on the CREC site and 1 full year on the commercial sites. Preliminary economic evaluation data will also be available.*

Modification 1: Interested parties were directed to visit the CREC bison research facility as no commercial feedlot demonstrations were performed as originally planned in Year 2. Researchers and project sponsors decided to eliminate the production of a professional-grade videotape, but video footage may still be taken and used for various technology transfer purposes.

Explanation 1: A list of commercial livestock and dairy producers willing to participate as demonstration sites for ash placement was developed. NDDH was approached to determine if the sites suggested were acceptable candidates. NDDH indicated that it feels the demonstration work needed to be limited to CREC until further environmental data were available. The EERC complied with the NDDH request and initiated work to develop an additional demonstration site at CREC. Planning and preparation of runoff containment is under way to meet NDDH requirements.

Modification 2: A Web site containing data from surface and ground water analyses was created using the University of North Dakota's HTML-eZ.

Explanation 2: The Web site was created to give industrial sponsors and NDDH easy access to project data.

Task 5 – Economic Evaluation

- 1) An economic evaluation will be conducted comparing the costs of placement using ashes and concrete. Construction costs will include materials and the equipment needed for the*

placements. Lack of weight gains by animals in extremely soft surfaces will be factored in as well.

Modification: This task was not completed.

Explanation: This information did not prove to be critical for NDDH in making a decision regarding use of the material in the state. It is widely documented in previous studies on coal ash in general that stabilizing feedlots with coal ash in an economical option.

Task 6 – Feedlot Design Manual

1) A manual will be produced describing how to best use the various ashes for feedlot placements. This manual will describe the mix design, mixing methods, and placement methods by conventional farm equipment.

Modification. A draft manual was created (see Appendix H).

Explanation: The project team did not want to publish a manual prior to a final determination on the use of coal ash for feedlot surfaces from NDDH. If NDDH approves this application, the manual will be completed.

YEAR 4 – All Year 4 activities are extensions or modifications

Task 1 – Lab Development and Field Placement

No plans for Year 4.

Modification: The additional field placement proposed for Year 3 to evaluate initial runoff from freshly placed ash–soil mixtures will be performed in Year 4; however, the purpose is to provide CREC improved surfaces for research pens and to demonstrate the use of Coyote Station fly ash in a full-scale setting.

Explanation: Researchers and sponsors are assembling data to address questions on the initial runoff quality. This task will be used as a demonstration at the 2003 CREC Field Day.

Task 2 – Environmental Monitoring

No plans for Year 4.

Modification 1: Manure samples will be evaluated for trace element content.

Explanation 1: In a March 13, 2003 meeting (Appendix I), NDDH requested the ash content of surface manure samples and the total elemental analyses of collected manure samples.

Modification 2: Cores of the ash–soil mixtures will be taken in the spring of Year 4 to evaluate any special needs for deconstruction of ash-modified soils in feedlot settings. The

sampling will be limited to pens with the highest ash content for each of the three ashes used, and total trace element content will be determined.

Explanation 2: In a March 13, 2003 meeting (Appendix I), NDDH requested this sampling and analysis be performed to address any issues potentially related to the deconstruction of ash-modified feedlot surfaces. The question is whether or not the ash-soil mixture can be safely land-applied. Total elemental analyses results will be compared to limits used to evaluate sewage sludge land application.

Task 3 – Performance Monitoring

No plans for Year 4.

Modification: Limited performance monitoring may be performed in Year 4.

Task 4 – Technology Transfer

No plans for Year 4.

Modification: Technology transfer continues in Year 4.

Task 5 – Economic Evaluation

No plans for Year 4.

Modification: An economic evaluation comparing coal ash to other options for improving feedlot surfaces will be performed if the application is approved by NDDH.

Task 6 – Feedlot Design Manual

No plans for Year 4.

Modification: The feedlot manual will be completed in Year 4, pending a review of the document by NDDH and that NDDH makes a decision regarding the use of coal ash for feedlot stabilization.