Process For Obtaining A NPDES Permit Under Subpart H – Western Alkaline Mine Drainage Category

Memorandum of Understanding between the Office of Surface Mining Reclamation and Enforcement and U.S. Environmental Protection Agency, Region IX.

Background

For coal mine sites located on Tribal lands in Arizona and New Mexico, the U.S. EPA Region IX is the permitting authority for the discharge of wastewater from the mine site under the National Pollutant Discharge Elimination System (NPDES), and the Office of Surface Mining Reclamation and Enforcement (OSM) is the permitting authority for the mining permit pursuant to the Surface Mining Control and Reclamation Act (SMCRA).

On January 23, 2002, EPA established a new Subpart H for coverage of surface water runoff from non-processing areas of western alkaline coal mining operations. The subpart removes numeric effluent limitations at the wastewater discharge point, and instead relies on the use of Best Management Practices (BMPs) through implementation of a Sediment Control Plan and based upon sediment yield modeling to demonstrate that average annual sediment yield is not increased over pre-mining conditions. The Sediment Control Plan must identify BMPs and must describe design specifications, construction specifications, maintenance schedules, and criteria for inspection, as well as the expected performance and longevity of the BMPs.

Overlap of permitting, inspection, and enforcement provisions of SMCRA with NPDES permits

Subpart H establishes standards of performance for which there is a considerable overlap of requirements with SMCRA. EPA expects that the Sediment Control Plan and sediment yield modeling required for the NPDES permit will largely consist of materials generated as part of the SMCRA permit application. The SMCRA permitting process requires a coal-mining operator to submit an extensive reclamation plan with the permit application, including detailed hydrologic information and analysis, to OSM for approval. The requirements for the hydrologic reclamation plan are specified in 30 CFR 780.21(h). This regulation requires, in part, that the application include measures to be taken to prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow.

In the preamble to the final regulation EPA envisioned that approval by OSM of the sediment yield modeling and Sediment Control Plan would often be sufficient review to satisfy the NPDES permitting authority.

EPA and OSM believe that the Sediment Control Plan for a mine site should be incorporated into one document that is satisfactory to both the CWA and SMCRA permitting authorities.

Process

The following process will be used by OSM and EPA to review the Sediment Control Plan and sediment yield modeling, issue NPDES and SMCRA permits (or revisions) and inspect and enforce those permits.

1. The Operator will submit the original NPDES permit application (request for modification to a subpart H permit or renewal) along with revision(s) to the SMCRA permit to EPA Region IX. The Operator also will submit the normal number of copies of the NPDES permit application and revisions to the SMCRA permit to OSM Western Regional Coordinating Center (WRCC). OSM will serve as the point of contact for materials related to the review of both Subpart H and SMCRA materials. To meet the requirements of the NPDES and SMCRA programs, the application should include the Sediment Control Plan (BMPs and any maintenance that will be implemented, if not previously submitted), results of watershed sediment yield modeling for pre- and post disturbance, and a location map for the area under review with BMPs identified on the map (1": 400' scale). The sediment yield model will describe the watershed area used in the model and all the assumptions that were used in developing the model.

2. EPA, OSM, the Tribes and BIA will conduct concurrent reviews of the application. All parties will have 60 days to submit comments and deficiencies to OSM. OSM will contact EPA at the end of the 60-day period to determine if EPA has identified any deficiencies. If OSM identifies deficiencies in the application, it will provide EPA with a copy of the letter describing those deficiencies.

3. OSM will send a letter to the operator describing all deficiencies, including any comments from other Agencies. Comments from the EPA on the NPDES application will be identified as such.

4. When the operator submits the response to comments and deficiencies, OSM will distribute the response to all parties and repeat the process as described in steps 2, 3 and 4.

5. Once all deficiencies have been resolved OSM will prepare a final technical review and approval document. OSM will provide a copy of the review and approval document to EPA. The technical review and approval document will be included in the EPA's NPDES public record of decision.

6. After receiving OSM's technical review, EPA will publish public notice of the NPDES permit, and will send the draft permit and fact sheet to OSM and the Tribes. If comments are received, EPA will coordinate with OSM and the Tribes on the response prior to EPA issuing the NPDES permit.

7. EPA, OSM and the Tribes will maintain close communication and coordination on inspections of the Sediment Control Measures included in the NPDES and SMCRA permits.

Dated:

for Alexis Strauss, Director
Water Division
U.S. EPA Region IX
75 Hawthorne St.
San Francisco, CA 94105

Dated: 12/19/03

Pete Rutledge, Chief
Program Support Division
Western Regional Coordinating Center
Office Surface Mining
P.O. Box 46667
Denver, CO 80201

Peabody Western Coal Company

September 24, 2008

Mr. John Tinger
U.S. Environmental Protection Agency
Region IX, CWA Standards and Permits
75 Hawthorne Street
San Francisco, CA 94105

RE: Sediment Control Plan for NPDES Permit No. NN0022179

Enclosed please find Peabody Western Coal Company's (PWCC) Sediment Control Plan for ten outfalls contained in NPDES Permit No. NN0022179. The outfalls are designations assigned to temporary sediment ponds constructed at PWCC's Black Mesa Complex. PWCC is submitting the Plan concurrently to the USEPA and the Office of Surface Mining Reclamation and Enforcement (OSMRE) for approval in order to move the ten outfalls to the 40 CFR Part 434 Subpart H, Western Alkaline Coal Mining effluent limitations in the soon to be renewed NPDES permit. The Sediment Control Plan provides information on the Best Management Practices (BMP's) PWCC has utilized to control sediment in reclaimed areas above the ten outfalls, includes 1"=400' scale maps of each outfall showing BMP's constructed in each outfall's watershed, and a section that describes inspection and maintenance criteria. In addition, the Plan includes surface water and sediment modeling demonstrations that indicate the BMP's are effective measures for controlling sediment. The model predictions show average annual sediment yields from the reclaimed watersheds above each outfall are less than the average annual sediment yields from the watersheds that existed above each outfall prior to mining.

The ten outfalls and corresponding temporary sediment pond names are 049 (J7-CD), 050 (J7-E), 051 (J7-F), 021 (N6-C), 022 (N6-D), 037 (N6-F), 031 (J16-E), 032 (J16-F), 174 (J21-D) and 175 (J21-E). PWCC plans to remove the embankments at outfalls 049 (J7-CD), 037 (N6-F) and 031 (J16-E) during 2008. The remaining outfalls are scheduled for removal in 2009.

If you have any questions or need additional information please don't hesitate to call me at 928.677.5130, email me at gwendt@peabodyenergy.com, or write to me at the address below at your earliest convenience.

Respectfully,

Gary W. Wendt

Gary W. Wendt
Manager Environmental

GWW

Enclosure

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C: w/enclosure

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file

Sediment Control Plan

Peabody Western Coal Company

NPDES Permit No. NN0022179
Kayenta Mine Permit AZ-0001D

September 2008

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LIST OF APPENDICES

1.0 INTRODUCTION

Peabody Western Coal Company (PWCC) has been mining coal in two separate surface-mining operations on Black Mesa, within Navajo County, Arizona, since the 1970s. Mining takes place within the Black Mesa Complex, which is located on contiguous coal leases within the boundaries of the Hopi and Navajo Indian Reservations. The Kayenta Mine operates under the Office of Surface Mining Reclamation and Enforcement (OSMRE) Permanent Program Permit AZ-0001D in accordance with permanent program performance standards at 30 CFR Subchapter K Part 810. The Black Mesa Mine is authorized to operate under an OSMRE initial regulatory program (30 CFR Subchapter B Part 710); however, mining operations are temporarily suspended at the Black Mesa Mine. The combined lease area is commonly referred to as the Black Mesa Complex.

OSM is charged with the regulation of surface coal mining and reclamation operations on Indian Lands, including the administration and enforcement of the performance standards as set forth in the 1977 Surface Mining Control and Reclamation Act (SMCRA). The performance standards include the General Hydrology Requirements for protecting the hydrologic balance at 30 CFR 816.41, and sediment control measures at 30 CFR 816.45. During mining at both the Kayenta and Black Mesa Mines, PWCC constructed numerous temporary sediment ponds around the perimeter of the mining areas to treat runoff from the disturbance area. Although the Black Mesa Mine is authorized to mine in accordance with the initial regulatory program rules, all temporary ponds built at both mines were designed, constructed and maintained in compliance with 30 CFR 816.42, 816.46, 816.47, and 816.49. The ponds collect runoff that drains from watersheds which are tributary to either Moenkopi Wash or Dinnebito Wash, which in turn both drain to the Little Colorado River.

1.1 Purpose and Need

30 CFR 816.45 requires that sediment control measures, including sediment ponds as best technology currently available (BTCA), be designed, constructed, and maintained to meet the more stringent of applicable state or federal effluent limitations. Consequently, PWCC obtained National Pollutant Discharge Elimination System (NPDES) Permit NN0022179 from the U.S. Environmental Protection Agency (USEPA). As part of the wastewater permitting process, USEPA assigned discharge monitoring locations or outfalls that coincide with the spillways at temporary sediment ponds constructed at the Black Mesa Complex where effluent must meet water quality criteria.

The effluent limitations at 40 CFR Part 434 for Subpart H, Western Alkaline Coal Mining are applicable to alkaline drainage from reclaimed areas at western coal mining operations, including permitted outfalls at the Black Mesa Complex that have eligible reclaimed areas. The portions of the watersheds that were mined above several temporary ponds have been regraded to achieve an acceptable post-mining topography. These regraded areas have been topsoiled using suitable salvaged topsoil in accordance with OSMRE requirements in Permit AZ-0001D (Kayenta Mine) or the initial regulatory program (Black Mesa Mine). These areas have also been seeded with a permanent seed mix as required in Permit AZ-0001D (Kayenta Mine) or the initial regulatory program (Black Mesa Mine) and have an established vegetative cover at least two years old.

The following sections present the Sediment Control Plan (Plan) for eligible outfalls (temporary sediment ponds) in NPDES Permit No. NN0022179. The plan includes descriptions of the best management practices (BMP's) PWCC has implemented above the ponds to control sediment and erosion, and to minimize disturbance to the prevailing hydrologic balance. The plan also summarizes design specifications, construction specifications, inspection criteria, and maintenance schedules. The information summarized and referenced in the Plan is contained in the approved Black Mesa and Kayenta Mines permit application package (PAP) for Permit No. AZ-0001D.

Sediment yield demonstrations were conducted using the EASI computer model (Zevenbergen et al. 1990; WET 1990). This model was calibrated using site-specific data collected at the Black Mesa Complex over an eight-year period (RCE, 1993). EASI has been used to predict mean annual runoff and sediment yield from several large areas that were reclaimed under both the initial and permanent regulatory programs. These predictions have been reviewed and approved by OSMRE and other agencies in support of applications for Termination of Jurisdiction (N1/N2 and N7/N8 initial program areas), and in support of a recently submitted Phase II performance bond release application (N14 permanent program reclamation) at the Black Mesa Complex. Therefore, PWCC believes the use of the model is appropriate.

Results of the modeling demonstrations for each temporary sediment pond are provided in separate modeling reports in the Appendices to the Plan. Each appendix also includes a 1"=400' scale map that shows outfall locations, current topography of the entire watershed, affected lands boundary within each pond's watershed, and the BMP's installed in each watershed above each outfall in order to control sediment. The modeling demonstrations show that average annual sediment yields predicted at each outfall location taking into account the postmining, or reclaimed mine-land conditions within the watershed are less than or equal to the average annual sediment yields for the premining, or undisturbed conditions. Average annual sediment yields are provided in each modeling report as tons/acre/yr, which are normalized values that account for differences between premining and postmining acreages and topography. The sediment yield data shows that the BMP's utilized by PWCC at the Black Mesa Complex are effective in minimizing erosion and sediment loads from reclaimed mine-lands, and ultimately, protecting the prevailing hydrologic balance.

2.0 BEST MANAGEMENT PRACTICES

PWCC has developed the Plan for temporary sediment ponds that are eligible for coverage under Subpart H (Western Alkaline Coal Mining) of the 40 CFR Part 434 effluent limitations guidelines to prevent an increase in the average annual sediment yield from areas disturbed by mining and reclamation operations. The Sediment Control Plan utilizes a variety of best management practices (BMP's) to control and minimize erosion and resulting sediment yield that includes, but is not limited to the following:

- Minimize the extent of the disturbance area;
- Stabilize the disturbance area by backfilling and grading to return the land surface to a postmining topography similar to the original landform;
- Develop a postmine drainage configuration that regulates runoff velocities and is designed for the long-term stability of the landscape;
- Regulate runoff velocities of water by collecting runoff in postmine drainage channels, and lining the drainage channels with erosion resistant materials including suitable spoil, as appropriate;
- Salvage and redistribute topsoil material to provide an adequate plant growth medium for revegetation;
- Till and prepare the seedbed to provide initial surface stabilization, prepare the topsoil material for seeding, and enhance seed germination and plant establishment;
- Design and plant reclamation seed mixtures that are permanent and sustainable for rapid and long-term surface stabilization that achieve the postmine land use; and,
- Design and construct sediment ponds to treat and control sediment from the disturbance area.

2.1 Limits of Disturbance

Mining and reclamation operations at the Black Mesa Complex were designed and implemented to minimize the extent of disturbance. The operations were designed to disturb only the land necessary to remove the coal resource. The extent of the disturbance area or affected lands includes the mined area, road right-of-ways, topsoil salvage and storage areas, facilities areas (e.g., temporary sediment ponds) and reclamation areas. Drawing No. 85360, Jurisdictional Permit and Affected Lands Map, contained in Volume 20 of the Black Mesa and Kayenta Mines Permit Application Package (PAP) show the affected lands boundary within the Black Mesa Complex permit areas.

Current watershed areas above each temporary sediment pond are shown on 1"=400' maps in each appendix to the plan. The current watershed areas may differ from the premining watershed areas due to the reclaimed topography. The affected lands boundary within the watershed disturbance boundary is also shown on each 1"=400' map.

The reclamation operations were designed to complete reclamation and revegetation activities as quickly as possible, site conditions and weather permitting, to restore the disturbed area to the postmine land use and minimize adverse impacts to the environment. The reclamation timetable at the Black Mesa Complex is summarized in Chapter 20, Reclamation Schedule of the PAP (Volume 11). The reclamation schedule outlines the sequence and timing of each major phase of the reclamation operations.

2.2 Postmining Topography

Following coal removal, the disturbed area is returned to a postmining topography that is similar to the original landform in accordance with 30 CFR 715.14, Backfilling and Grading, for initial program lands, and with 30 CFR 816.102, Backfilling and Grading: General Requirements, for permanent program lands. OSMRE approved the postmining landforms above the eligible temporary sediment ponds as part of the permit approval process for Permit AZ-0001D.

Chapter 21, Backfilling and Grading in Volume 11 of the PAP describes how PWCC developed the postmine landform. The design of the postmining topography required adjusting the original landform elevations for the removed coal seam and the swell of the overburden or spoil material. The postmine topography was designed to blend into the surrounding undisturbed hills and slopes. The approved postmining topography is shown on Drawing No. 85352, Estimated Postmining Topographic Map in Volume 29 of the PAP. PWCC also implemented a Surface Stabilization Program (SSP) in 1990 as outlined in Chapter 26 of the PAP (Volume 28) to develop the postmining landform for areas disturbed after 1990.

PWCC designed the backfilling and grading sequence to produce a postmining land surface similar to the original landform. Methods used to backfill and grade the mine spoils are also described in Chapter 21, Backfilling and Grading, of the PAP (Volume 11). As the mining sequence progressed, spoil materials from the "active" pit are used to backfill the previous pit. Backfilled materials were placed to minimize adverse affects on groundwater, minimize off-site effects, and to support the approved postmining land use.

Final grading of the spoil material was performed to create surface irregularities to minimize erosion, increase infiltration, improve soil moisture holding characteristics for the revegetation process, and improve range and wildlife habitat. The graded spoil is sampled to insure that there is a minimum of four feet of suitable plant growth material for revegetation.

2.3 Postmining Water Conveyance Features

The postmine drainage configurations for the reclaimed portions above the eligible temporary sediment ponds were developed during the backfilling and grading process to blend with undisturbed drainages above and below the disturbed area. The conveyances were included in the post-mining topography to provide drainage through the reclaimed areas, restore the premine drainage pattern where practicable, and minimize adverse impacts to the hydrologic balance.

The premining drainage network on Black Mesa typically features high drainage densities and deeply-incised ephemeral channels that convey large runoff events due to heavy localized thunderstorms and regional frontal storms. Most of the events feature supercritical flows that carry very high sediment loads. Utilization of the SSP as outlined in Chapter 26 of the PAP results in creating postmining drainage networks that develop characteristics similar to the premining drainage systems. In order to minimize deeply-incised channels within the postmining drainage network, PWCC utilizes topsoiled and revegetated swales in the flatter interior portions of reclaimed areas. Gradient terraces, reclamation downdrains and reclamation channels are utilized in steeper reclaimed areas such as outslopes from initial box cuts of the mine pits, and final pit areas. Reclamation channels are also utilized to convey runoff from reclaimed areas into the undisturbed receiving stream channels.

Gradient terraces are constructed on a positive grade in steeper reclaimed slopes to break up slope lengths and thereby minimize hillslope erosion, and to convey runoff to downdrains or reclaimed channels. Criteria for spacing gradient terraces on reclaimed hillslopes are provided in Attachment A (Terrace Spacing Justification) of Chapter 26 in the PAP (Volume 28). Design criteria for constructing gradient terraces are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

Reclamation downdrains are erosion-resistant grade control structures used to convey concentrated flow from steep areas into reclaimed channels. These structures are built with appropriate surface protection to limit velocities, trap sediment, and minimize erosion. Design criteria for constructing reclamation downdrains are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

Reclamation channels may vary in size depending on the drainage area. Reclamation channels that drain less than 640 acres are designed for the 10-year, 6-hour precipitation event, and reclamation channels that drain more than 1 square mile are designed for the 100-year, 6-hour event. The reclamation channels are not topsoiled. Rather, four feet of suitable plant growth spoil material form the bottom and sides of the channels. The spoil material is typically comprised of coarse rock fragments that form an armored surface, minimize erosion and enhance channel stability. In addition, no topsoil is placed for 15 feet on each side of the reclamation channel bottoms adequately containing high flows and confining low meandering flows within the channel area and away from the topsoiled and revegetated areas. Design criteria for the reclamation channels are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

2.4 Topsoil

PWCC developed an overburden/spoil handling plan to ensure a minimum of four feet of suitable growth material was placed on backfilled and graded lands prior to topsoiling activities. Overburden was tested to determine suitability as a plant growth material. Chapter 8, Soils

Resources and Overburden in the PAP (Volume 8) presents results of the overburden suitability assessment. Chapter 22, Minesoil Reconstruction in the PAP (Volume 11) presents the overburden and spoil handling plan.

Site-specific soil survey data (Chapter 8, Soils Resources and Overburden) were used to ensure the most suitable topsoil was salvaged. Chapter 22, Minesoil Reconstruction also describes topsoil redistribution operations. PWCC utilized direct hauling of topsoil material whenever possible. If direct hauling was not possible then the material was stored in approved stockpiles. Except where regraded materials were determined to be suitable as a surface plant growth material, topsoil was replaced after approved postmine contours were achieved, water conveyance structures were identified and preliminary construction initiated, and when no additional disturbance was anticipated. Residual soils with high levels of coarse rock fragments are used in limited areas to support the reestablishment of cultural and woody plants. OSM requires a minimum topsoil depth of 0.5 feet over initial program graded spoil. Assessments of overburden suitability and available topsoil salvaged from each mine pit area prior to mining indicate a minimum average of 1.0 feet of topsoil has been replaced over suitable graded spoil at permanent program areas of the Black Mesa Complex (Chapter 22, Minesoil Reconstruction). Upon completion of topsoiling activities, the areas were scarified to a minimum depth of 18 inches to enhance the rooting medium, increase infiltration, and reduce erosion. Following scarification, the replaced soil was disked on contour with a large furrowing disk.

2.5 Revegetation Practices

Following the completion of backfilling and grading activities and topsoil redistribution, the reclaimed areas were revegetated to support the proposed postmining land uses – livestock grazing and wildlife habitat. Chapter 23, Revegetation Plan in the PAP (Volume 11) contains detailed information on methods used to revegetate the postmining areas within the watersheds above the eligible temporary sediment ponds. Across the majority of the reclaimed lands at the Black Mesa Complex, the revegetation plan was developed with herbaceous production emphasized over development of large woody plants. Emphasizing herbaceous vegetation ensures the quick establishment of a vegetation community, enhances long-term stability, and minimizes erosion.

PWCC developed several seed mixes for permanent revegetation at the Black Mesa Complex. The most prevalent seed mix used for revegetation was a rangeland mix comprised primarily of grasses and forbs, but also includes fourwing saltbush. This mix establishes a permanent and sustainable vegetative cover that includes shrubs. Other seed mixes have been developed for providing temporary stabilization to minimize erosion, for repairing rills and gullies, and for key habitat areas along drainages and ridge lines. Seeding was generally accomplished by broadcasting or drilling on the contour. PWCC conducts both qualitative and quantitative revegetation monitoring in order to evaluate seeding success, determine the success of applied reclamation practices and collect data for termination of jurisdiction applications for interim program areas or bond release applications for permanent program areas (see Chapter 23, Revegetation Plan). Qualitative evaluations are carried out at least annually during the growing season, while quantitative measurements and evaluations are conducted on a more periodic basis during May and September of each year through bond release. Revegetation monitoring data is submitted to the OSM in the Annual Reclamation Status and Monitoring Reports. The 2007 Annual Revegetation Monitoring Report (ESCO, 2008) indicates the average total vegetative cover measured at various locations in the reclaimed mined-lands at the Black Mesa Complex was greater than the reference area, which represents the premine condition. The report also presents information regarding herbaceous production and species diversity, and indicates PWCC is successfully establishing vegetation on reclaimed mine-lands at the Black Mesa Complex that meet the postmine land use. The revegetation will enhance the long-term erosional stability of the site as the revegetated areas are effective and self-sustaining. RUSLE evaluations contained in Chapter 26 of the AZ-0001D PAP support these conclusions.

2.6 Sediment Ponds and Alternative Sediment Control Methodologies

PWCC designed and constructed numerous temporary sediment ponds in the drainages surrounding the affected lands at the Black Mesa Complex to treat disturbed area runoff and to minimize off-site adverse impacts to the hydrologic balance, The ponds were designed, constructed and maintained in compliance with 30 CFR 816.46, 816.47, and 816.49. The eligible temporary sediment ponds that are included with the Plan were designed in accordance with the aforementioned rules.

The 1"=400' maps that are included in each appendix to the plan show the location of the eligible temporary sediment ponds in relation to current topography. Drawing No. 85400, Drainage Area and Facilities Map in Volume 21, and Drawing No. 85405, Sediment and Water Control Structures Map in Volume 22 of the PAP shows the location of all temporary sediment ponds constructed at the Black Mesa Complex.

Chapter 6, Facilities in the PAP (Volumes 1 through 7F) contains design methodology and as-built certifications for all temporary sediment ponds constructed at the Black Mesa Complex, including regulatory requirements. In addition, individual design reports for the eligible temporary sediment ponds in this Plan can be found in Chapter 6, which include details on pond capacities and configurations, spillway designs, and pond-specific calculations of sediment trapping performance.

In addition to using sediment ponds to control sediment, PWCC uses alternative sediment control methodologies (ASCM) either in conjunction with the sediment ponds or individually. These ASCM's include straw dikes, filtration structures (silt fence), sediment traps, gabions, and check dams to reduce overland flow velocity, reduce runoff volume, or trap sediment. Most of these are temporary measures, but some may be left as permanent features in the reclaimed landscape. Design and construction specifications for the ASCM's are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

PWCC plans to eventually breach the embankments of the eligible temporary sediment ponds. Breaching will involve removing either a portion or all of each embankment to restore the natural stream channel course and gradient in the vicinity of the pond. Breaching involves less disturbance of established vegetation than complete removal of the entire embankment. The area disturbed by the breaching of the embankments will be graded to blend in with the surrounding topography, mechanically manipulated as needed, and seeded with an appropriate seed mix. ASCM's will be installed in the vicinity and downstream of the breached structure and will serve as BMP's. ASCM's will be installed in accordance with design and construction specifications contained in Chapter 26, Surface Stabilization Plan in the PAP (Volume 28). ASCM's that are temporary such as silt fences and/or straw bales may be removed once revegetation in the vicinity becomes established. The BMP's will be maintained until termination of jurisdiction is achieved for initial program lands or final bond release is granted for permanent program lands above each breached embankment. Modifications to this plan and other portions of the PAP to reflect PWCC's plans to breach the embankments will be submitted to OSMRE as a technical revision to Permit AZ-0001D in the near future.

3.0 CRITERIA FOR INSPECTIONS AND MAINTENANCE

As an active surface coal mine with ongoing reclamation operations, OSMRE conducts quarterly inspections of all areas of the Black Mesa Complex to assure compliance with the 30 CFR performance standards and the provisions of Permit AZ-0001D. The quarterly inspections include the BMP's that have been discussed in previous sections of this Plan, such as backfilling and grading to confirm the reclaimed land surface conforms to the approved postmine topography. Reclaimed areas in which topsoiling and revegetation activities have been completed are inspected to identify potential problem areas as indicated by rilling or gullying or other signs of instability or excess erosion. Postmine water conveyance structures and sediment ponds are also inspected to assure these structures are stable and retain the capacity of the approved design(s). If a problem is identified during an inspection, OSMRE may require an immediate fix, request a remedial plan, and/or they may issue a notice of violation which includes a specified time period to solve the problem depending upon the magnitude and severity.

In addition, PWCC is required by Permit AZ-0001D to conduct ongoing inspections of the reclaimed mine-lands including engineered structures to record and monitor the reclamation process and identify any potential problems. If problems are identified by either OSMRE or PWCC in the course of an inspection, then a remedial plan is developed and implemented. After the problem is fixed, the remedial work is monitored to assure the corrective action was successful.

PWCC is required to monitor the salvage, storage and redistribution of topsoil and spoil handling operations. Specific programs include determining final graded spoil suitability and verifying topsoil redistribution thickness. The topsoil and spoil handling monitoring data collected for each calendar year is reported to OSMRE in the Annual Reclamation Status and Monitoring Report.

PWCC conducts annual vegetation monitoring of permanently revegetated areas to document revegetation success. Revegetated areas are also surveyed for noxious weeds to evaluate potential adverse impacts to adjacent desirable vegetation. The revegetation monitoring data collected for each calendar year is reported to OSMRE in the Annual Reclamation Status and Monitoring Report.

PWCC is required to inspect all temporary sediment ponds on a quarterly basis for embankment stability, inlet and outlet conditions, and sediment storage capacities. The annual sediment pond inspection report is certified by a Professional Engineer and submitted to OSMRE.

Comprehensive Site Inspections and Reporting

PWCC will conduct comprehensive site inspections of the BMP's at the eligible temporary sediment ponds included with this Plan. The inspections will assess the following:

- The accuracy of the area covered by Plan,
- 1"=400' site maps are to be updated or otherwise modified to reflect current conditions,
- Effective implementation of the BMP's identified in the Plan,
- Necessity to maintain existing BMP's or install additional BMP's, and
- Necessity to revise the Plan.

Once the Plan becomes approved by OSMRE and USEPA, inspections will be conducted quarterly as part of OSMRE's quarterly inspections. If the comprehensive site inspection determines changes to the plan are warranted, PWCC will revise the Plan and submit the revisions to both OSMRE and USEPA for approval within 30 days.

PWCC will develop an Annual Compliance Evaluation Report and submit the report to OSMRE and USEPA by March 31st of each year for the preceding calendar year's inspections. The report will identify personnel making the inspections, dates of inspections, and summarize observations made and actions taken in accordance with the Plan. The report will identify any incidents of noncompliance, and where a report does not identify any incidents of noncompliance, the report will contain a certification that the facility is in compliance with the Plan. Annual Compliance Evaluation Reports will be retained with the Plan.

4.0 WATERSHED MODELING DEMONSTRATIONS

In accordance with 40 CFR Part 434.82, PWCC has prepared several watershed demonstrations that evaluate the performance of BMP's for controlling sediment in the reclaimed watersheds above eligible temporary sediment ponds at the Black Mesa Complex. The demonstrations involved using the EASI model to predict average annual sediment yields for the entire watershed area above each eligible temporary sediment pond. Sediment yields predicted for premining conditions reflect natural conditions in the watershed above each pond location prior to mining. Sediment yields predicted for postmining conditions reflect the BMP's that PWCC has implemented within the affected lands in the watershed above each sediment pond. The modeling demonstrations were conducted to show the BMP's result in average annual sediment yields from the postmining landscape that are less than or equal to the average annual sediment yields from the premining landscape.

The demonstrations are provided in modeling reports developed by Ayres Associates of Fort Collins, Colorado (Ayres). The reports were developed for eligible temporary sediment ponds (outfalls) that share adjacent watershed boundaries in which similar BMP's have been used for sediment control within the reclaimed portions of each watershed. The reports provide information on the EASI model development and reference previous EASI modeling reports developed for PWCC that were submitted to OSMRE in support of applications for termination of jurisdiction of initial program areas and bond release for permanent program areas. They also discuss data used to develop each model, modeling methodology, and model results. The model results are provided as average annual sediment yields on an acre-unit basis above each pond for both premine and postmine watershed condtions.

The following is a list of the temporary sediment ponds and corresponding NPDES Permit NN0022179 outfall designations at the Black Mesa Complex that have been evaluated for eligibility under the effluent limitations at 40 CFR Part 434 for Subpart H. The list also provides the Appendix to the Plan in which the modeling demonstration reports for each pond can be found. Each appendix also contains a 1"=400' scale map that shows pond locations, current topography of the entire watershed, affected lands boundary within each pond's watershed, and the BMP's installed in each watershed.

Pond ID	Outfall	Appendix No.
J7-CD	049	Appendix 1
J7-E	050	Appendix 1
J7-F	051	Appendix 1
N6-C	021	Appendix 2
N6-D	022	Appendix 2
N6-F	037	Appendix 2
J16-E	031	Appendix 3
J16-F	032	Appendix 3
J21-D	174	Appendix 4
J21-E	175	Appendix 4

5.0 SUMMARY AND CONCLUSIONS

The EASI modeling results indicate that the average annual sediment yield from the watersheds above the eligible temporary sediment ponds at the Black Mesa Complex, including the reclaimed areas above each pond, is less than or equal to the average annual sediment yield from the premining watershed that existed prior to building the pond. The sediment yield data demonstrates that the BMP's utilized by PWCC at the Black Mesa Complex are successful at minimizing erosion and sediment loads from the reclaimed mine-lands. The results also demonstrate that the ponds no longer serve as the best practicable control technology available for minimizing erosion and sediment, and the sediment ponds could be removed and reclaimed.

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Appendix 1

Surface Water Modeling of the Reclaimed J7-CD, J7-E, and J7-F Watershed Area at Black Mesa Mine

SURFACE WATER MODELING OF THE RECLAIMED J7-CD, J7-E, and J7-F WATERSHED AREA AT BLACK MESA MINE

Prepared for

Peabody Western Coal Co.
Highway 160, Navajo Route 41
Kayenta, Arizona 86033

AYRES ASSOCIATES

SURFACE WATER MODELING OF THE RECLAIMED J7-CD, J7-E, and J7-F WATERSHED AREA AT BLACK MESA MINE

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PEAB-J7.DOC

August 2008

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1. RECLAIMED PARCEL MODELING

1.1 Introduction

The objective defined by PWCC for this project is to use a previously calibrated and validated runoff and erosion model (EASI, Zevenbergen et al. 1990; WET 1990) for the Black Mesa and Kayenta Mines to predict mean annual runoff and sediment yields from the reclaimed J7-CD, J7-E, and J7-F watersheds. This objective included computation of runoff and sediment yields under premine conditions for the same area. All soils and rainfall input to the model are to be taken from models calibrated in the previous study (RCE 1993). The input variables that were calibrated to the mine areas and used in this study include soil infiltration parameters, erodibility parameters, and the grain size distribution. Parameters that are specific to this study are vegetative canopy and ground cover percentages from data collected on site.

The model calibration was conducted in a previous study (RCE 1993) using data obtained from instrumented watersheds and small hillslope plots collected under natural rainfall conditions. For a detailed discussion of data collection and model calibration, please refer to the previous study (RCE 1993).

1.2 Background

The J7-CD, J7-E, and J7-F Watershed Area (WA) that is the focus of this project was reclaimed between 1983 and 1990. The fundamental purpose of this study was to quantify the expected behavior and hydrologic response of the reclaimed areas above each pond relative to the conditions that existed prior to the occurrence of mining activities.

Runoff and sediment yield response from the reclaimed lands should be managed by implementing Best Management Practices (BMP's) in conjunction with an OSM approved sediment control plan in order to not adversely impact the prevailing hydrologic balance and to limit additional contributions of suspended sediment to streamflow or runoff outside the mine permit areas. BMP's include regrading, replacing salvaged topsoil, revegetation, and other controls such as riprapped channel bottoms, check dams, and where practicable, contour terraces. The natural watersheds on the mesa contribute significant quantities of sediment to the channel system. It is expected that the postmine condition will also produce comparable amounts of sediment without adverse impact on the hydrologic balance.

This section describes the data and procedures used to evaluate the J7 WA. This area was modeled to determine the average annual hydrologic response following the completion of reclamation activities taking into account BMP's implemented as part of the reclamation process. Infiltration, runoff, and erosion processes from both hillslopes and channels within the J7 WA were modeled using EASI. Results were determined for concentration points at the outlets of the reclaimed watersheds, which correspond to the embankments associated with Ponds J7-CD, J7-E, and J7-F. The locations of these points are shown in **Exhibit 1**. Modeling was also conducted to determine hydrologic response under premine conditions based on the topography, soils, cover, and other conditions that typified the undisturbed watersheds draining to each concentration point. **Exhibit 2** shows the modeling endpoints for the premine J7 WA.

1.3 Data

1.3.1 Soils

Soils data used for the current study (J7 WA) were based on data developed from the calibration of models used in the previous study for Coal Resource Areas (CRAs) N1/N2 and J27 (RCE 1993). The composition of postmine soil in the current study is depicted along with the composition of postmine soils from the previous study in **Figure 1.1**. This figure shows that the soil composition of WA J7 is very similar to soils evaluated during model calibration. Therefore, the soil properties developed in the previous study are valid for this modeling project. These properties include calibrated parameters, such as infiltration and erodibility coefficients, and measured soil size distributions. **Table 1.1** lists the premine and postmine soils data used during EASI modeling of WA J7.

1.3.2 Vegetation

Vegetative cover data representative of both pre- and postmine conditions in WA J7 were supplied by PWCC. For the premine condition, land was characterized as being covered by sagebrush or pinon juniper. The spatial distribution of vegetative cover for the J7 WA premine condition appears in **Figure 1.2**. Average cover properties for CRAs N1/N2 and J27 of the previous study and WA J7 of the current study appear in **Table 1.2**. For the postmine condition, the reclaimed area was assigned the postmine cover type and the unmined area was assigned the same cover type as the premine condition. **Table 1.3** lists the pre- and postmine vegetative cover data used in the EASI model runs generated for the J7 WA. Note that if a unit contained significant portions of both sagebrush and pinon juniper cover types, it was classified as half pinon juniper and half sagebrush.

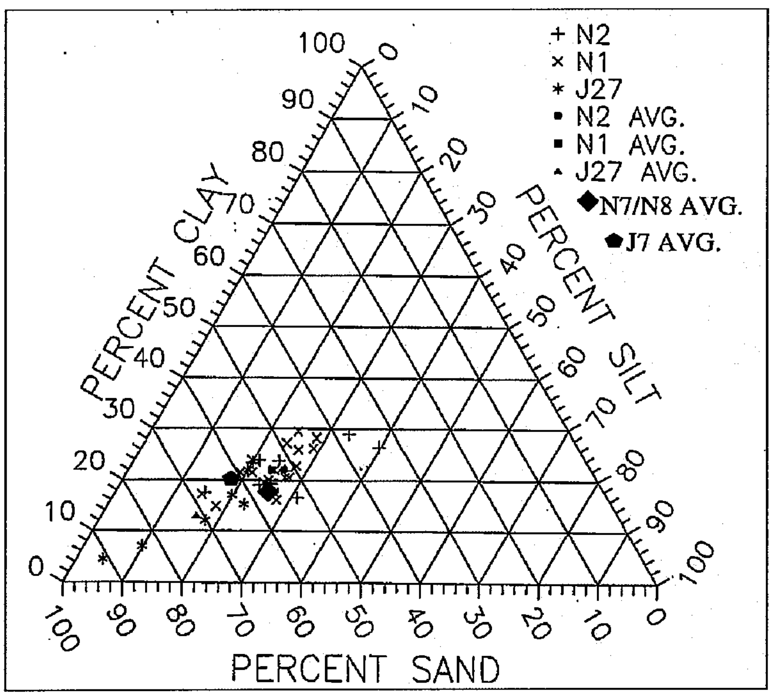

Figure 1.1. Reclaimed area soils trilinear graph.

Table 1.1. Soils Data.			
Condition	Premine	Postmine	Rock Chutes
Rainfall detachment	0.005	0.005	0
Overland flow detachment	0.44	0.44	0
Channel flow detachment	0.5	0.5	0
Initial soil moisture, %	70	70	70
Final soil moisture, %	90	90	90
Soil porosity, %	45	45	46
Temperature, *F	70	70	70
Hydraulic conductivity, in/hr	0.23	0.29	0.3
Capillary suction, in	3.7	2.6	2.6
	Particle Size Distribution (all conditions)		
	Size, mm	% Finer	
	0.001	0	
	0.004	18.0	
	0.016	27.4	
	0.062	36.6	
	0.125	56.2	
	0.250	64.3	
	0.500	72.4	
	1.000	80.5	
	2.000	88.6	
	4.000	92.4	
	16.000	100	

1.3.3 Topography

Pre- and postmine topography was supplied by PWCC in the form of ArcGIS geodatabase. Basin delineations, hillslope delineations, subwatershed delineations, as well as areas, slopes, and lengths of all units of the study area were defined and calculated using ArcGIS software. **Figures 1.3 and 1.4** show the watershed delineation and numbers assigned to the basins used in the EASI model for the post- and premine conditions, respectively. Channel dimensions input to EASI were based on the topography supplied and limited field observations.

1.4 Methodology

Runoff and sediment yield in the semiarid western United States is largely governed by the occurrence of high-intensity, short-duration rainstorms of limited areal extent (Renard and Simaton 1975). Research has indicated that relatively few events may produce the greatest erosion (e.g., Hjelmfelt et al. 1986 reported that only 3 to 4% of rainfall events accounted for 50% of long-term sediment yields). Although there is perhaps a relatively limited physical basis for definition of an "average annual" runoff or sediment yield in a semiarid environment due to the extreme variability in response and importance of single infrequent events, such a term does provide a useful basis for long-term comparison between reclaimed and undisturbed conditions.

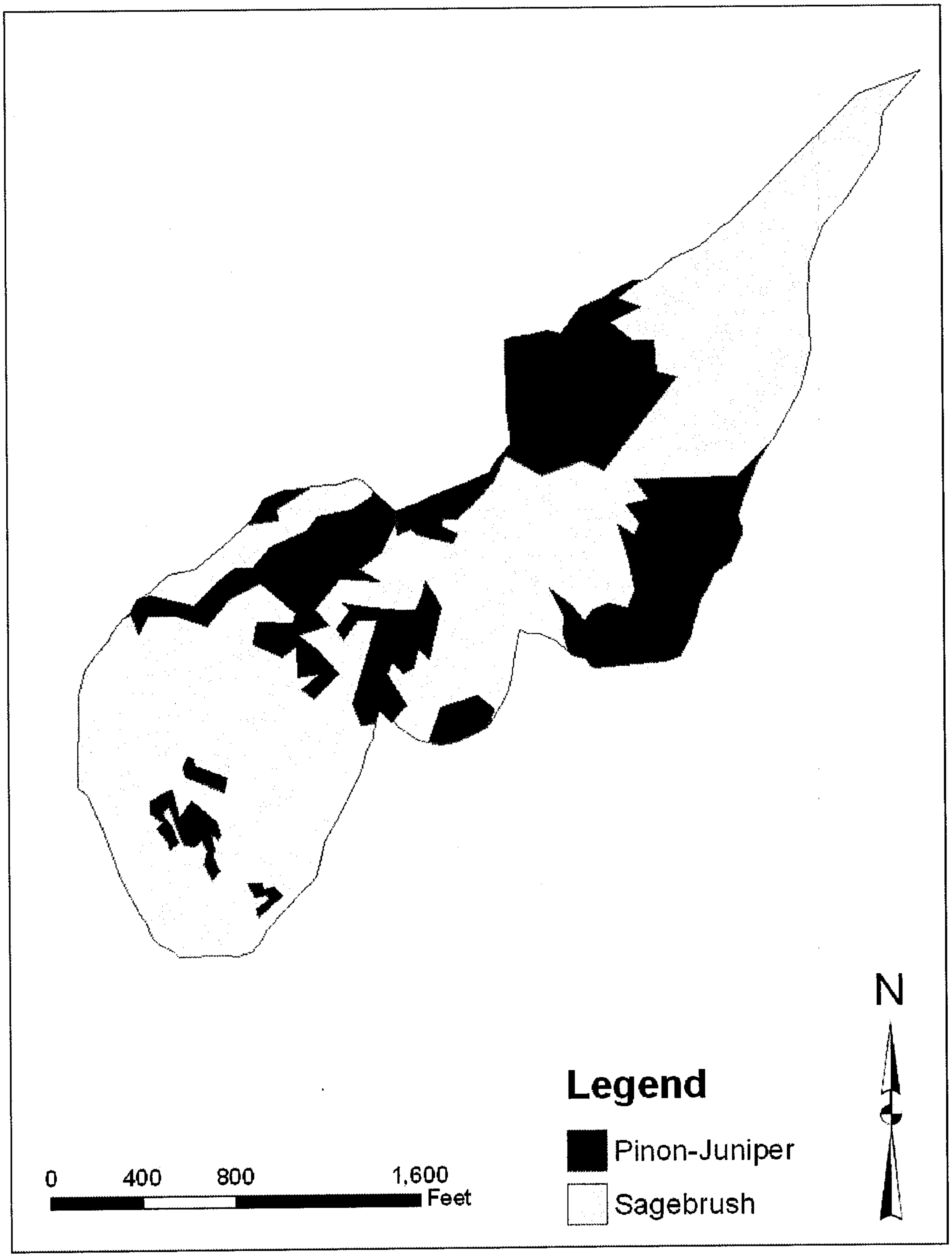

Figure 1.2. Spatial distribution of vegetative cover types for WA J7 premine condition.

Table 1.2. Cover Sampling Data.								
Area	Condition	Cover Type	Nonstratified Vegetation Cover (%)	Vegetation Canopy Cover (%)	Vegetation Ground Cover (%)	Litter* (%)	Rock (%)	Total Ground Cover (%)
N1/N2	Postmine	Postmine	25.6	1.4	24.2	13.6	4.2	41.9
J7 WA	Postmine	Postmine		0.3	20.9	26.2	1.4	48.5
N1/N2/J27	Premine	Pinon Juniper	32.7	31.1	3.0	44.0	19.7	66.7
J7 WA	Premine	Pinon Juniper		11.7	3.2	19.1	18.5	40.8
N1/N2	Premine	Sagebrush	25.1	16.0	10.3	25.3	18.1	53.7
J27	Premine	Sagebrush	30.6	9.7	22.0	24.0	1.6	47.6
J7 WA	Premine	Sagebrush		0.6	7.3	21.7	6.8	35.8
*Including standing dead litter								

Table 1.3. Cover Data for J7-CD, J7-E, and J7-F Watersheds.				
Condition	Pinon Juniper	Sagebrush	Half Pinon Juniper-Half Sagebrush	Postmine
Canopy cover, %	11.7	0.6	6.1	0.3
Ground cover, %	40.8	35.8	38.3	48.5
Canopy storage, in	0.05	0.05	0.05	0.05
Ground storage, in	0.05	0.05	0.05	0.05
Depression storage, in	0.03	0.03	0.03	0.03
Impervious area, %	0	0	0	0
Manning n	0.07	0.07	0.07	0.05

To make comparisons between reclaimed lands and associated undisturbed lands at the Black Mesa Mining Complex on the basis of average annual sediment yield, a procedure was used that considers the importance of infrequent storm events in defining sediment yield in the semiarid west. First, however, the site-specific rainfall data available for the Black Mesa Mining Complex were used to evaluate the frequency and magnitude of the measured events relative to existing predictions for rainfall depth-duration (Miller et al. 1973). The analysis of the rainfall data was performed as part of a previous study of the N1/N2 and J27 CRAs (Resource Consultants and Engineers 1993).

Comparisons between runoff and sediment yield from undisturbed and reclaimed areas in WA J7 were developed for specific modeling endpoints shown in Exhibits 1 and 2. Mining and reclamation activities did not exactly replicate the topography, drainage network, or drainage areas that existed prior to mining. Consequently, direct comparisons of total runoff and sediment yield cannot be made between undisturbed and reclaimed response at a given point in a watershed. Comparisons were made on the basis of unit rates of runoff (inches) and sediment yield (tons/acre) at the various modeling computation endpoints. Although the same disturbance boundary was used to model extents for both pre- and postmine conditions, the topographic differences that resulted after mining and reclamation occurred in the J7 WA dictated that some small areas would be included or excluded from the modeling. The total area modeled (combined area for J7-CD, J7-E, and J7-F watersheds) for premine conditions is 102.2 acres and for postmine conditions is 99.8 acres. The difference in area results from the sediment ponds in postmine conditions. The area bounded by the modeling boundary identified by PWCC as shown in Exhibits 1 and 2 is 102.2 acres.

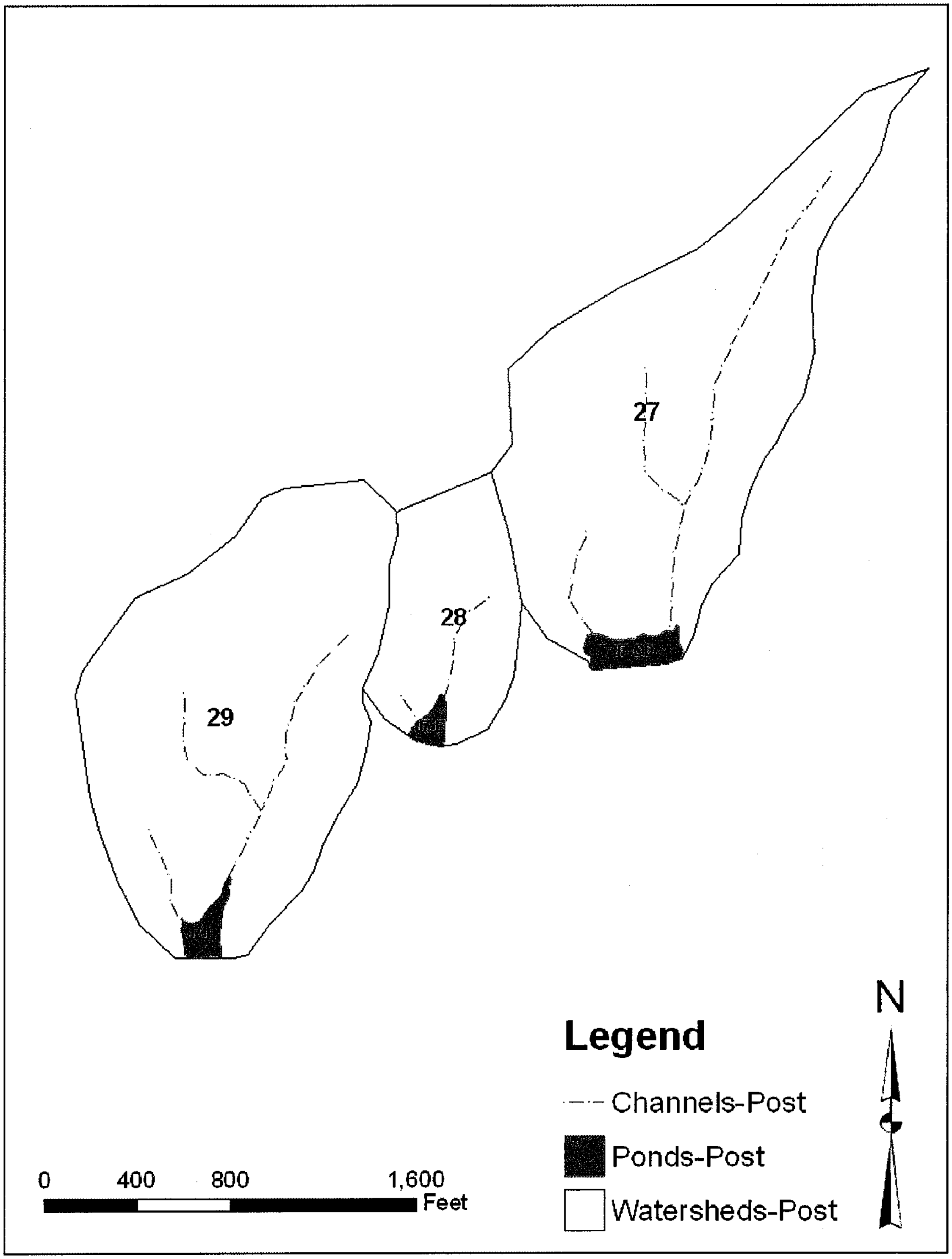

Figure 1.3. J7-CD, J7-E, and J7-F postmine basins.

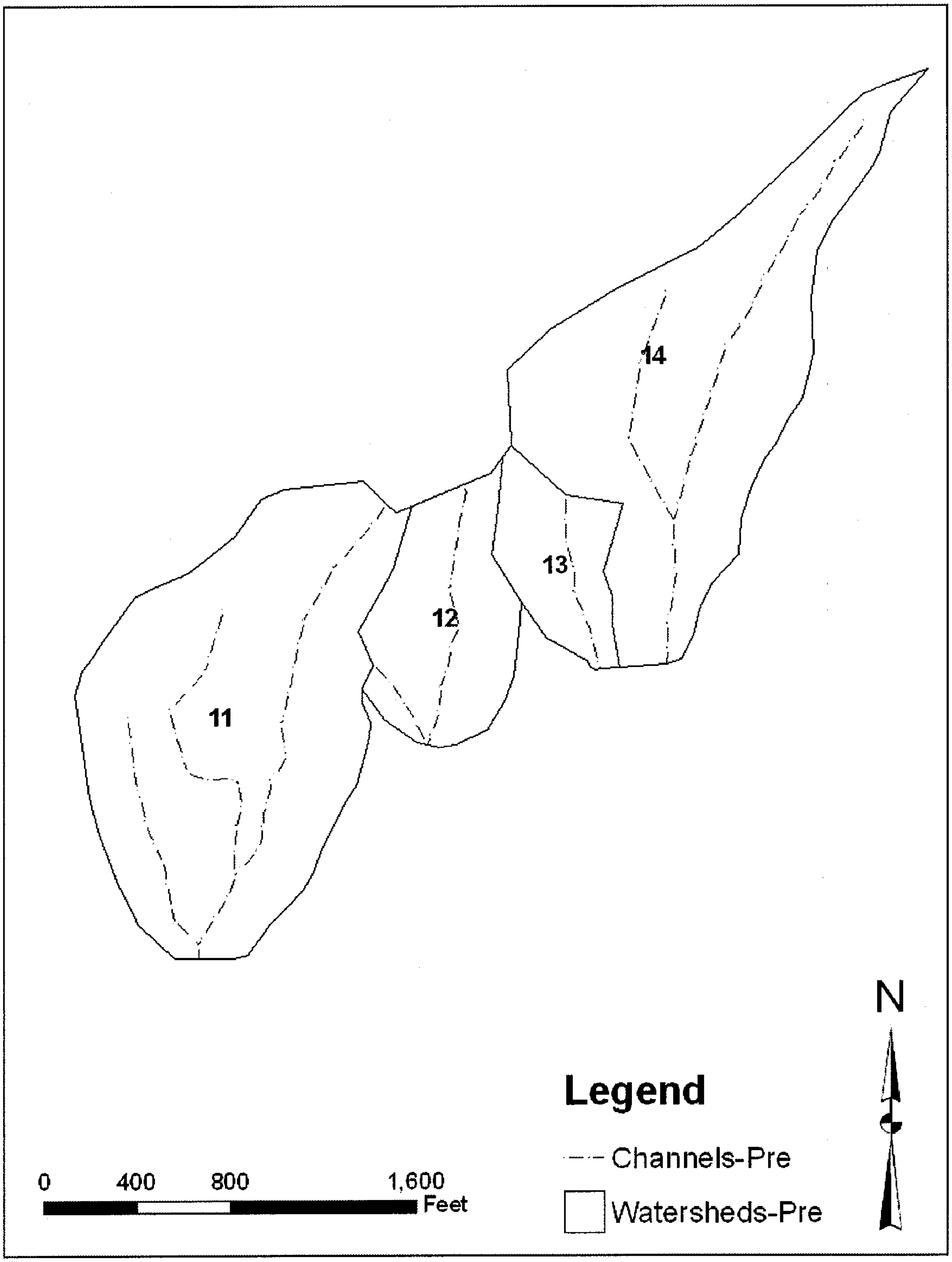

Figure 1.4. J7-CD, J7-E, and J7-F premine basins.

1.4.1 Synthetic Rainfall

Synthetic storms of 2-, 5-, 10-, 25-, 50-, and 100-year return periods were used as input to the EASI model. Actual hyetographs were taken from the previous study (RCE 1993) and are based on both local data collection and the NOAA Atlas (Miller et al. 1973).

1.4.2 Computation of Average Runoff and Sediment Yield

The EASI model was used to evaluate runoff and sediment yield from a series of storm events having recurrence intervals of 2-, 5-, 10-, 25-, 50-, and 100 years. To define average annual conditions, the average annual runoff and sediment yield generated from storm events were computed using the commonly used equation of Lagasse et al. (1985).

1.5 Results

Figures 1.3 and 1.4 show the post- and premine basin delineations. Since the individual subareas differ in number, acreage and outlet locations, a direct comparison is not possible on a subarea basis. Therefore, the best way to compare the results is on an average basis for the WA. **Table 1.4** shows pre- and postmine drainage area, runoff, and sediment yield for the J7 WA. To consider the situation of pond removal for the postmine condition, the EASI model replaces a sediment pond with a channel, which lies near the location of the pond and discharges to the basin outlet. The channel is assumed to have a length equal to the pond's length and a slope of 2%. Runoff is defined as the total volume of water leaving the WA on an average annual basis and, therefore, does not include water stored in depression areas and ponds. For the premine condition, this is equal to the amount of water that drains off the hillslopes and subwatersheds because there are no ponds or significant depressions. For the postmine condition, this is equal to the amount of hillslope runoff less the amount stored in ponds. No ponds or significant depressions exist within the reclaimed J7 WA that was modeled. Similarly, the sediment yield is the amount of eroded material that leaves the WA on an average annual basis computed using the equation of Lagasse et al. (1985). The sediment yield is the production from the hillslope areas and erosion from the channels. The amount of erosion is the sediment yield from the hillslopes and subwatersheds only and does not include channel erosion, channel deposition or sediment trapped in ponds. Sediment yield can be greater or less than erosion, depending on the amount of channel erosion and the capacity of the channel network to convey sediment off the leasehold.

Table 1.4. Average Runoff and Sediment Yield Results.

Area	Condition	Drainage Area (ac)	Runoff (in)	Sediment Yield (t/ac/yr)
J7 WA	Premine	102.2	0.42	2.46
J7 WA	Postmine	99.8	0.42	2.02
J7-CD	Premine	45.7	0.42	2.30
J7-CD	Postmine	44.2	0.42	2.05
J7-E	Premine	13	0.42	1.96
J7-E	Postmine	12.6	0.42	1.58
J7-F	Premine	43.6	0.42	2.77
J7-F	Postmine	43.0	0.42	2.12

For the postmine condition, the overall sediment yield is less than those in the premine condition. Sediment yield is approximately 80% of the premine amount, and runoff is the same as the premine amount. The reduction of sediment yield is primarily due to the channel erosion control measures (BMP's) for the postmine condition.

Table 1.4 also shows pre- and postmine drainage area, runoff, and sediment yield for three individual watersheds (J7-CD, J7-E, and J7-F) within the J7 WA. Modeling results of individual watersheds are similar to the overall J7 WA.

1.6 Discussion

Table 1.5 gives an overview of the geometric properties of the pre- and postmine disturbed areas. Postmine hillslopes are gentler than premine hillslopes, while postmine channels are as steep as premine channels. It is because most ridges within the J7 WA were mined and reclaimed and most valleys with the J7 WA were not disturbed. The drainage density of the postmine condition is smaller than that of premine condition because the postmine topography has simple geometric characteristics and the premine topography is highly dissected.

Table 1.5. Average Physical Properties of the J7 WA.

	Premine	Postmine
Total Area (ac)	102.2	99.8
Total Channel Length (ft)	10541	6209
Mean Channel Slope	0.0625	0.0628
Drainage Density (mi/mi^2)	12.5	7.5
Mean Hillslope Length (ft)	213	255
Mean Hillslope Gradient	0.0918	0.0686

2. COMPARISONS WITH MEASURED SEDIMENT TRANSPORT

As discussed in Section 1, PWCC has monitored flow and sediment on the main channels, principal tributaries and small watersheds within the leasehold. These data, along with the runoff plots, were used to calibrate the EASI model soil erodibility and infiltration input variables. **Figures 2.1** and **2.2** show sediment transport and sediment concentration versus discharge for measured unmined (background), measured reclaimed, WA J7's modeled unmined (premine) and modeled reclaimed (postmine) data. Although there is significant scatter shown in the data (as is expected with any sediment transport conditions), there are several conclusions that can be drawn from this data.

The open symbols in both figures depict measured data and whether the data were collected from reclaimed areas (the small watershed study) or from unmined or background surface water monitoring stations. The range of flows is generally greater for the background data but there is significant overlap between the two data sets between 0.1 and 100 cfs. This is because the reclaimed data are from small watersheds and the unmined data are from channels draining larger basins. These data show the same trend for sediment transport and sediment concentration over the entire range of flows and very close agreement in the area of discharge overlap. This, in itself, is strong evidence that (1) the sediment yields are channel transport capacity limited, (2) overlap of model predictions for both pre- and postmine conditions with measured data strongly indicate that EASI model predictions are representative and reasonable, and (3) sediment yields from reclaimed areas will not be additive to yields on the receiving streams.

The closed symbols depict data from WA J7's pre- and postmine EASI model runs. They represent data generated by EASI for both subwatersheds and channels for peak discharges resulting from 2-, 5-, 10-, 25-, 50-, and 100-year storms. Using the peak flows from extreme events results in discharges that generally exceed 10 cfs. The trend of the model-derived data is similar and the ranges of concentration and sediment transport are similar to the measured data and between pre- and postmine conditions.

The sediment discharge plot (Figure 2.1) shows a stronger trend because it is plotting discharge (sediment) against discharge (flow). This is expected because the sediment discharge does depend on flow discharge. The concentration plot (Figure 2.2) shows the two separate variables and, therefore, a less significant trend. PWCC believes that data measurement may have some influence on the scatter (outliers were removed), but the process variability is probably the major influence. The majority of the data, however, fall in a group centered on 100 cfs and 100,000 mg/l, both in the observed data and in the model results. These plots support the use of the EASI model, the results of the modeling, the conclusion that sediment yields from reclaimed areas are not additive to receiving stream sediment loads, and that sediment impacts to the prevailing hydrologic balance have been minimized.

From Figures 2.1 and 2.2 it is apparent that sediment loads and concentrations are dependent on the channel sediment transport capacity for both pre- and postmine conditions. Channel sources of sediment in this arid environment are virtually unlimited. Therefore, channel transport capacity and channel derived sediment limits and governs sediment yields from the small tributaries, large channels and the WA as a whole. The similarity of sediment discharge (or concentration) between pre- and postmine conditions appears to be inconsistent with the lower rates of sediment yield shown in Table 1.4.

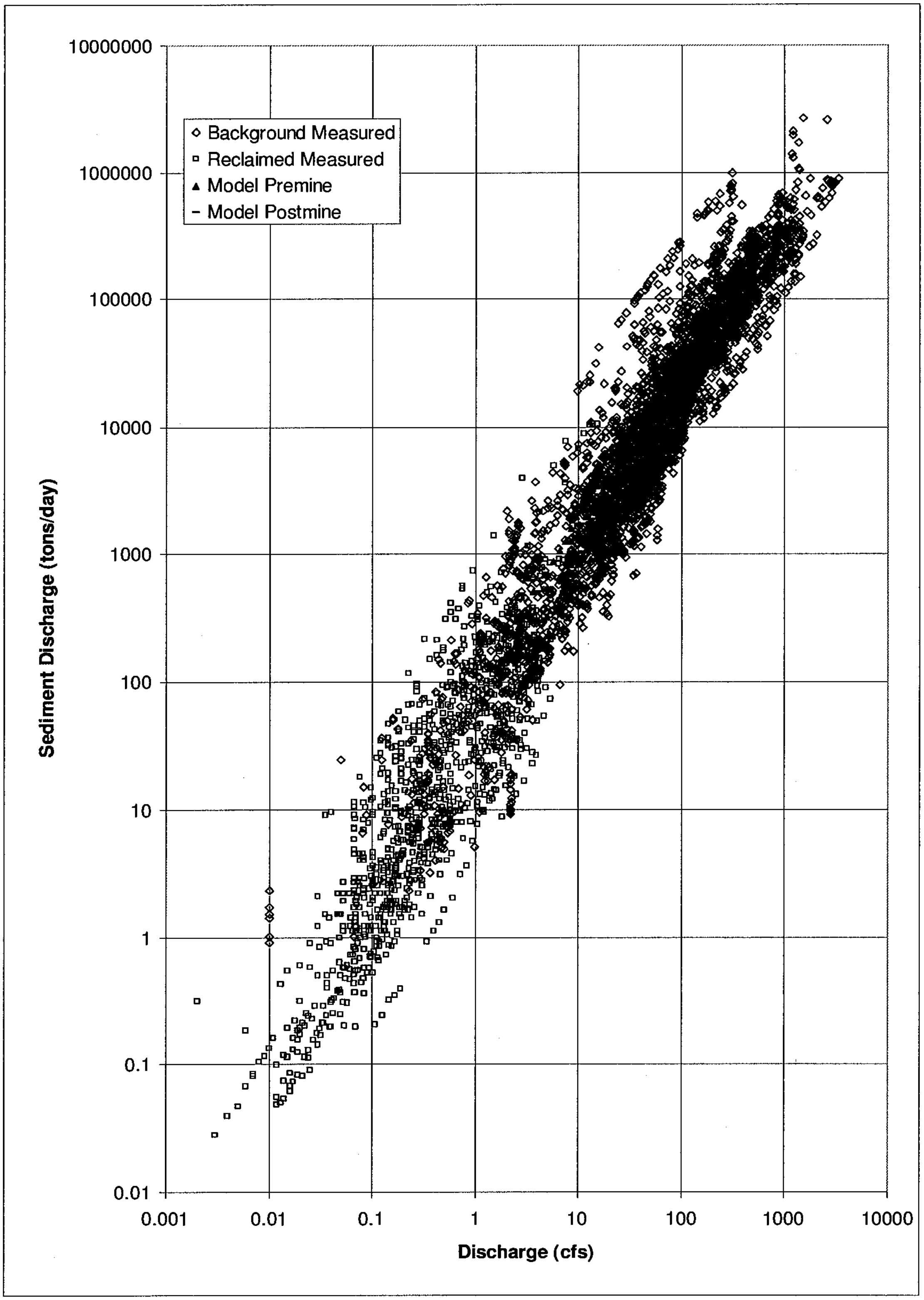

Figure 2.1. Observed and modeled sediment and water discharge.

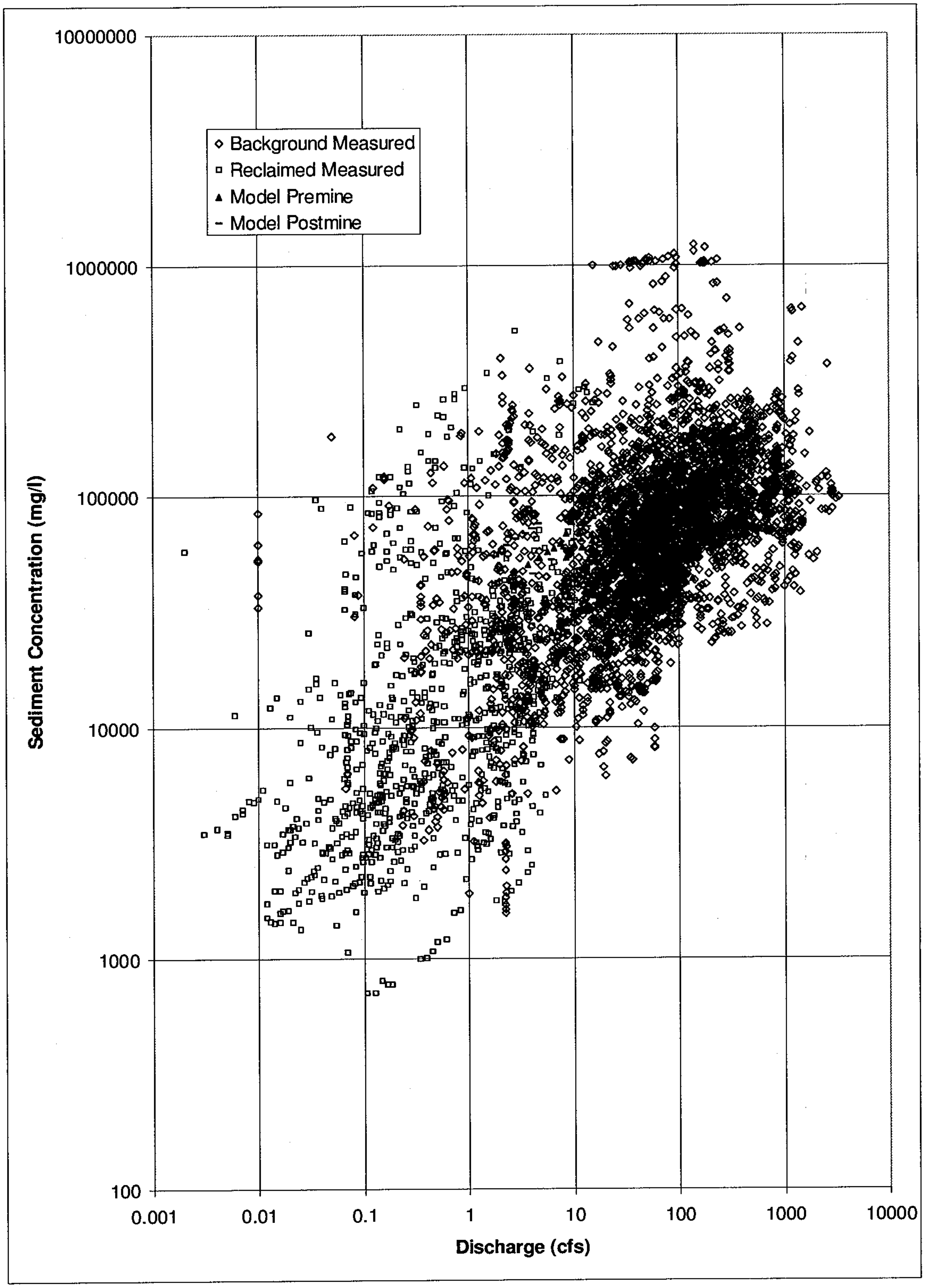

Figure 2.2. Observed versus modeled sediment concentration and discharge.

However, the sediment yield shown in Table 1.4 is the average annual amount of sediment leaving the J7 WA whereas the sediment discharge shown in Figure 2.1 is the peak rate of sediment in transport occurring in any channel represented by the data, whether the channel is located upstream or downstream of a pond. Therefore, it should be concluded that with or without a pond left in the postmine landscape that traps sediment or stores water, the mine reclamation is not contributing additional sediment to the receiving streams and sediment impacts to the prevailing hydrologic balance have been minimized.

Smith and Best (2000) analyzed the measured data (background and reclaimed) shown in Figure 2.1 to develop an approach that can be used to determine if channels in reclaimed areas have similar sediment transport characteristics as background channels. The method that they used was to develop Sen lines (Sen 1968) and confidence intervals around the data. The slope of the Sen line is a non-parametric statistic computed as the median slope of all possible slopes determined from pairing all the data points. The Sen line is drawn through the median coordinate of the data. Smith and Best first showed that the large channel flume data (background) and the small watershed background data could be combined. They concluded that since the data from one data set fall within the Sen line bounds of the other data set then the two data sets are merely extensions of each other and could be combined. Also, because the main channel and background small watershed site data could be combined, it indicated there is an unlimited supply of sediment and the channels are conveying sediment at (or near) capacity. The Sen line and bounds are shown with the background measured data in **Figure 2.3**.

They then plotted the reclaimed measured data (**Figure 2.4**) with the Sen line and bounds from the background data to show that the reclaimed data have the same characteristics even though the flow range of the measurements is lower. The data indicate that channel flows in this environment achieve the sediment transport capacity of the channel, whether in reclaimed or background conditions.

Using the same approach with the modeled data generated for the J7 WA, **Figures 2.5 and 2.6** show the pre- and postmine computed sediment transport rates with the Sen lines and bounds. One difference between the plots is that the measured data occur throughout the flow hydrograph whereas the modeled data are tabulated at the peak of the simulation flow hydrograph. The premine data plot (Figure 2.5) shows the data grouped above the Sen line and well within the bounds. The postmine data (Figure 2.6) plot most densely around the Sen line. On these graphs data plotting above the Sen line indicate that there is more sediment in transport for a given discharge.

Several conclusions can be drawn from these data plots: (1) EASI model well replicates erosion and sediment transport processes at the mine site for background and reclaimed conditions, (2) all data show similar trends and are within the same bounds, (3) data trends indicate that channels are transporting sediment at or near capacity, and (4) amounts of sediment leaving the WA for postmine conditions are similar to premine conditions and within the range expected for the background conditions. Therefore, the overall conclusion is that the postmine reclaimed condition in J7 WA is not contributing additional suspended solids to receiving streams, and related impacts to the hydrologic balance have been minimized.

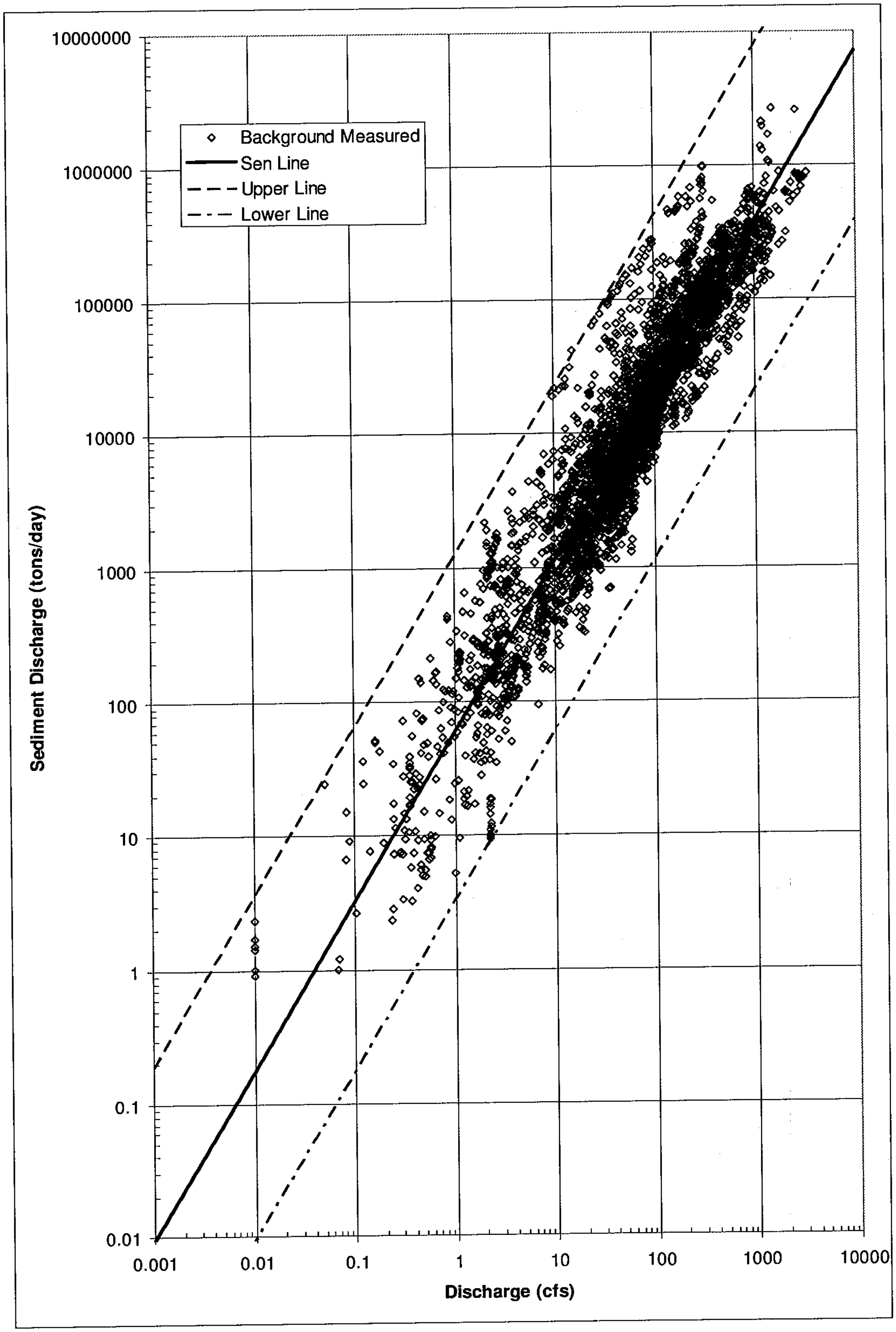

Figure 2.3. Background measured sediment and water discharge with Sen lines.

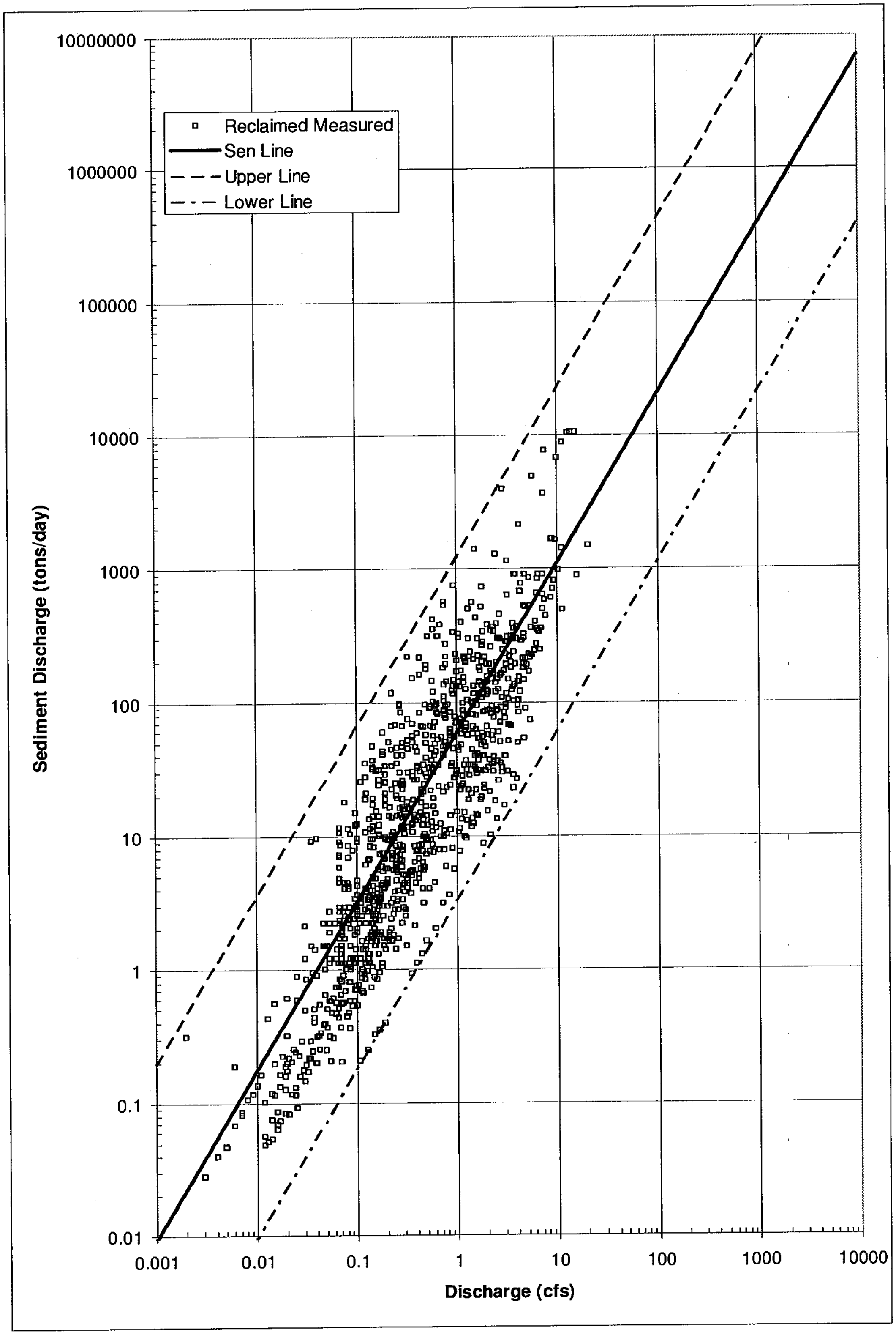

Figure 2.4. Reclaimed measured sediment and water discharge with Sen lines.

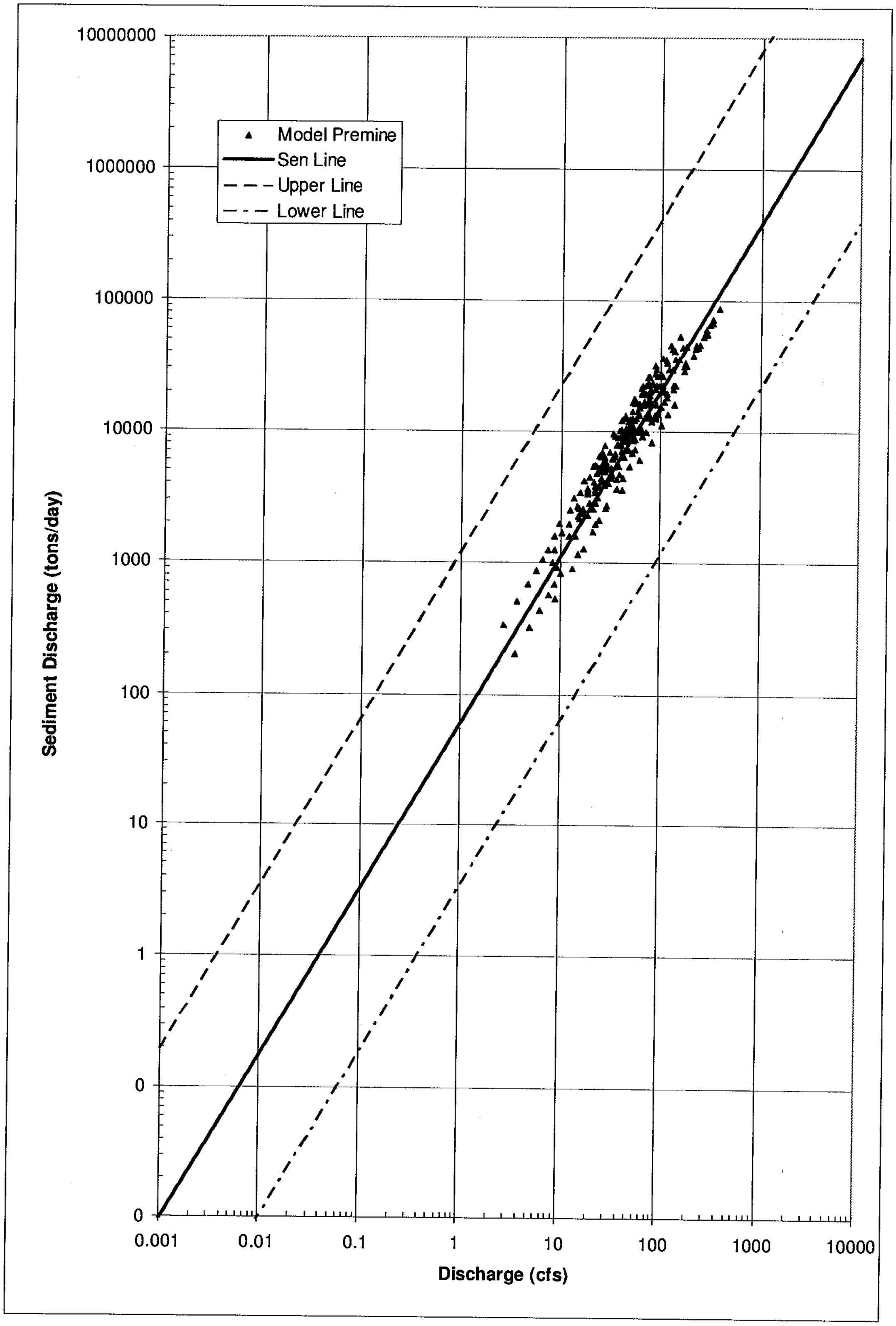

Figure 2.5. Modeled premine sediment and water discharge for the J7 WA with Sen lines.

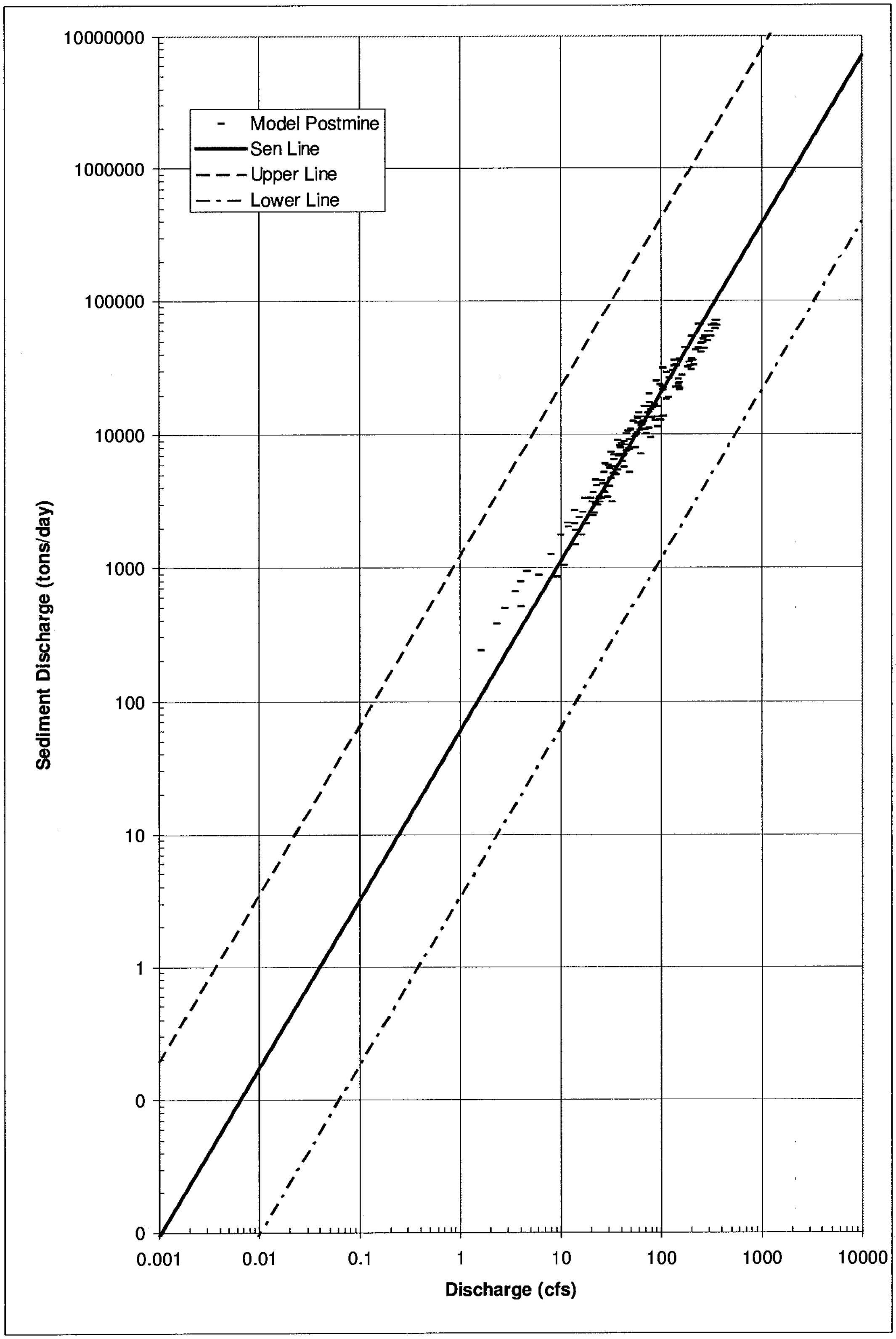

Figure 2.6. Modeled postmine sediment and water discharge for the J7 WA with Sen lines.

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EXHIBIT 1
Postmine Topography

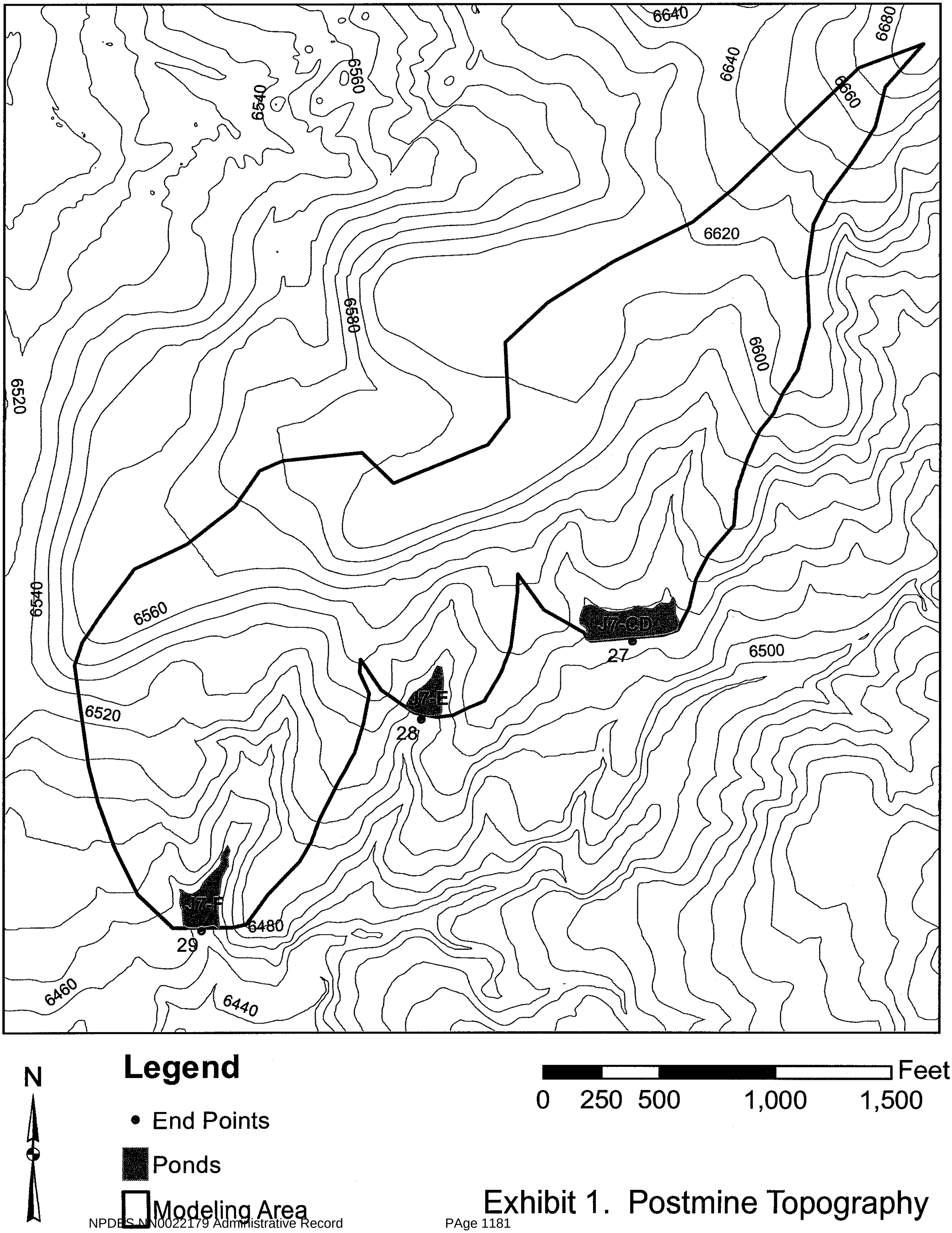

Exhibit 1. Postmine Topography

EXHIBIT 2
Premine Topography

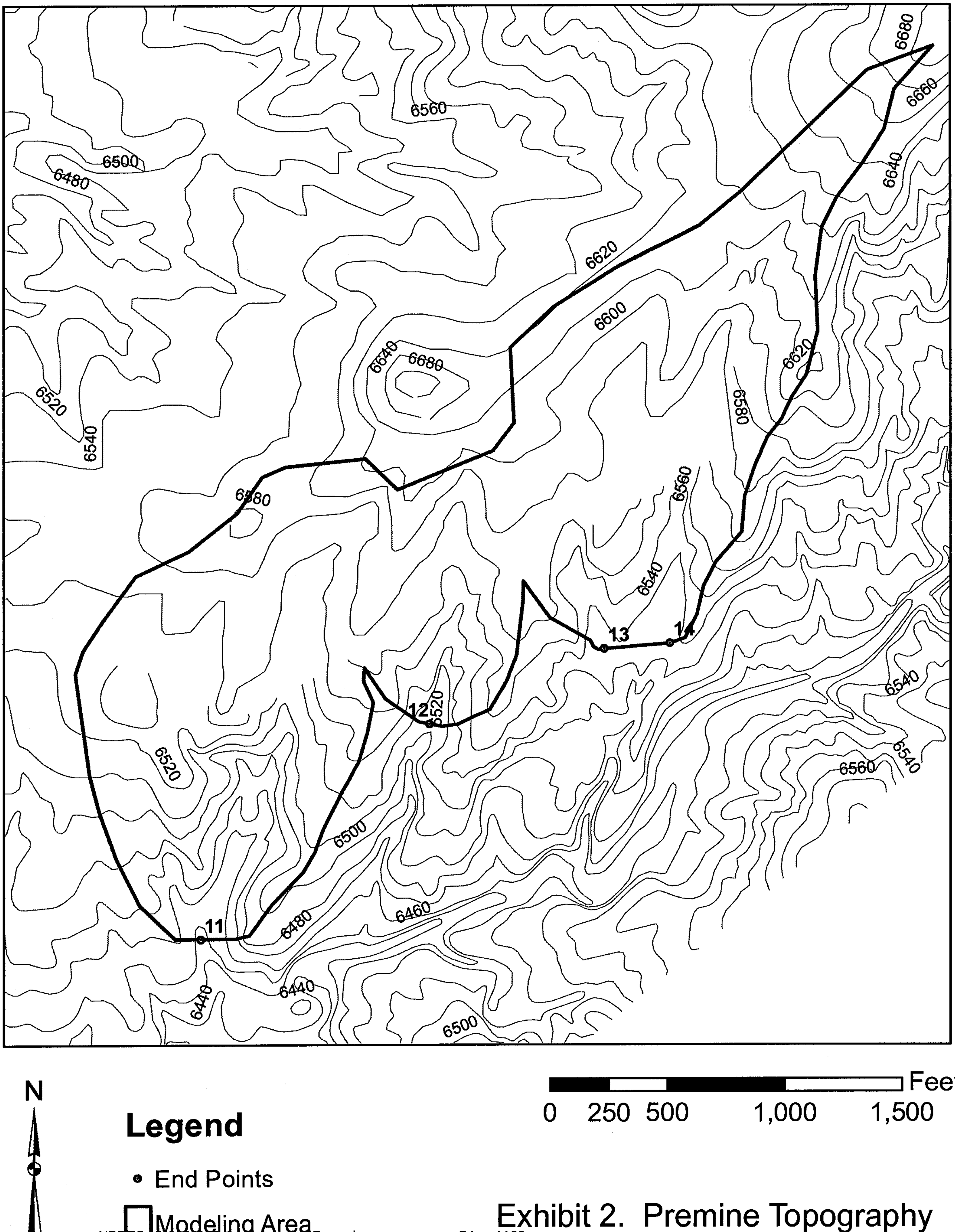

Exhibit 2. Premine Topography

Appendix 2

Surface Water Modeling of the Reclaimed N6-C, N6-D, and N6-F Watershed Area at Black Mesa Mine

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Ayres Project No. 32-1304.00
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1. RECLAIMED PARCEL MODELING

1.1 Introduction

The objective defined by PWCC for this project is to use a previously calibrated and validated runoff and erosion model (EASI, Zevenbergen et al. 1990; WET 1990) for the Black Mesa and Kayenta Mines to predict mean annual runoff and sediment yields from the reclaimed N6-C, N6-D, and N6-F watersheds. This objective included computation of runoff and sediment yields under premine conditions for the same area. All soils and rainfall input to the model are to be taken from models calibrated in the previous study (RCE 1993). The input variables that were calibrated to the mine areas and used in this study include soil infiltration parameters, erodibility parameters, and the grain size distribution. Parameters that are specific to this study are vegetative canopy and ground cover percentages from data collected on site.

The model calibration was conducted in a previous study (RCE 1993) using data obtained from instrumented watersheds and small hillslope plots collected under natural rainfall conditions. For a detailed discussion of data collection and model calibration, please refer to the previous study (RCE 1993).

1.2 Background

The N6-C, N6-D, and N6-F Watershed Area (WA) that is the focus of this project was reclaimed between 1982 and 1988. The fundamental purpose of this study was to quantify the expected behavior and hydrologic response of the reclaimed areas above each pond relative to the conditions that existed prior to the occurrence of mining activities.

Runoff and sediment yield response from the reclaimed lands should be managed by implementing Best Management Practices (BMP's) in conjunction with an OSM approved sediment control plan in order to not adversely impact the prevailing hydrologic balance and to limit additional contributions of suspended sediment to streamflow or runoff outside the mine permit areas. BMP's include regrading, replacing salvaged topsoil, revegetation, and other controls such as riprapped channel bottoms, check dams, and where practicable, contour terraces. The natural watersheds on the mesa contribute significant quantities of sediment to the channel system. It is expected that the postmine condition will also produce comparable amounts of sediment without adverse impact on the hydrologic balance.

This section describes the data and procedures used to evaluate the N6 WA. This area was modeled to determine the average annual hydrologic response following the completion of reclamation activities taking into account BMP's implemented as part of the reclamation process. Infiltration, runoff, and erosion processes from both hillslopes and channels within the N6 WA were modeled using EASI. Results were determined for concentration points at the outlets of the reclaimed watersheds, which correspond to the embankments associated with Ponds N6-C, N6-D, and N6-F. The locations of these points are shown in **Exhibit 1**. Modeling was also conducted to determine hydrologic response under premine conditions based on the topography, soils, cover, and other conditions that typified the undisturbed watersheds draining to each concentration point. **Exhibit 2** shows the modeling endpoints for the premine N6 WA.

1.3 Data

1.3.1 Soils

Soils data used for the current study (N6 WA) were based on data developed from the calibration of models used in the previous study for Coal Resource Areas (CRAs) N1/N2 and J27 (RCE 1993). The composition of postmine soil in the current study is depicted along with the composition of postmine soils from the previous study in **Figure 1.1**. This figure shows that the soil composition of WA N6 is very similar to soils evaluated during model calibration. Therefore, the soil properties developed in the previous study are valid for this modeling project. These properties include calibrated parameters, such as infiltration and erodibility coefficients, and measured soil size distributions. **Table 1.1** lists the premine and postmine soils data used during EASI modeling of WA N6.

1.3.2 Vegetation

Vegetative cover data representative of both pre- and postmine conditions in WA N6 were supplied by PWCC. For the premine condition, land was characterized as being covered by sagebrush or pinon juniper. The spatial distribution of vegetative cover for the N6 WA premine condition appears in **Figure 1.2**. Average cover properties for CRAs N1/N2 and J27 of the previous study and WA N6 of the current study appear in **Table 1.2**. For the postmine condition, the reclaimed area was assigned the postmine cover type and the unmined area was assigned the same cover type as the premine condition. **Table 1.3** lists the pre- and postmine vegetative cover data used in the EASI model runs generated for the N6 WA. Note that if a unit contained significant portions of both sagebrush and pinon juniper cover types, it was classified as half pinon juniper and half sagebrush.

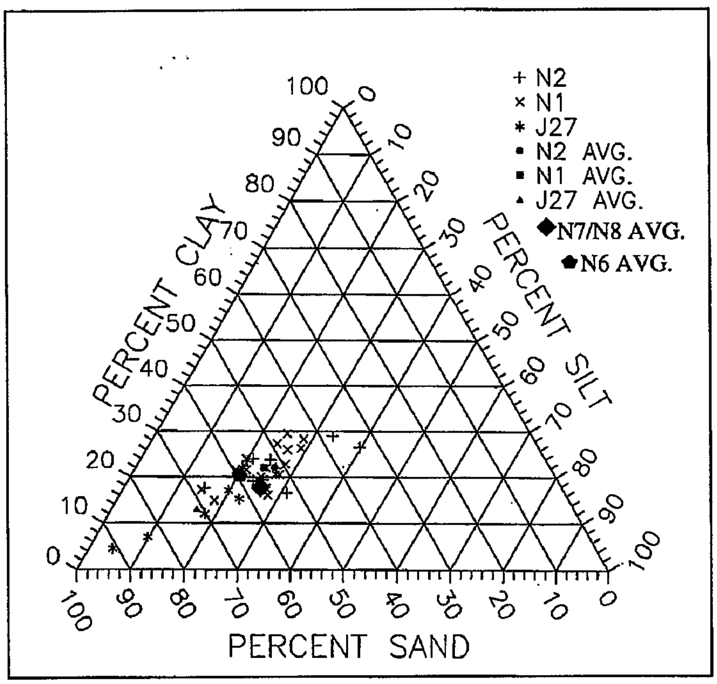

Figure 1.1. Reclaimed area soils trilinear graph.

Table 1.1. Soils Data.			
Condition	Premine	Postmine	Rock Chutes
Rainfall detachment	0.005	0.005	0
Overland flow detachment	0.44	0.44	0
Channel flow detachment	0.5	0.5	0
Initial soil moisture, %	70	70	70
Final soil moisture, %	90	90	90
Soil porosity, %	45	45	46
Temperature, *F	70	70	70
Hydraulic conductivity, in/hr	0.23	0.29	0.3
Capillary suction, in	3.7	2.6	2.6
	Particle Size Distribution (all conditions)		
	Size, mm	% Finer	
	0.001	0	
	0.004	18.0	
	0.016	27.4	
	0.062	36.6	
	0.125	56.2	
	0.250	64.3	
	0.500	72.4	
	1.000	80.5	
	2.000	88.6	
	4.000	92.4	
	16.000	100	

1.3.3 Topography

Pre- and postmine topography was supplied by PWCC in the form of ArcGIS geodatabase. Basin delineations, hillslope delineations, subwatershed delineations, as well as areas, slopes, and lengths of all units of the study area were defined and calculated using ArcGIS software. **Figures 1.3 and 1.4** show the watershed delineation and numbers assigned to the basins used in the EASI model for the post- and premine conditions, respectively. Channel dimensions input to EASI were based on the topography supplied and limited field observations.

1.4 Methodology

Runoff and sediment yield in the semiarid western United States is largely governed by the occurrence of high-intensity, short-duration rainstorms of limited areal extent (Renard and Simaton 1975). Research has indicated that relatively few events may produce the greatest erosion (e.g., Hjelmfelt et al. 1986 reported that only 3 to 4% of rainfall events accounted for 50% of long-term sediment yields). Although there is perhaps a relatively limited physical basis for definition of an "average annual" runoff or sediment yield in a semiarid environment due to the extreme variability in response and importance of single infrequent events, such a term does provide a useful basis for long-term comparison between reclaimed and undisturbed conditions.

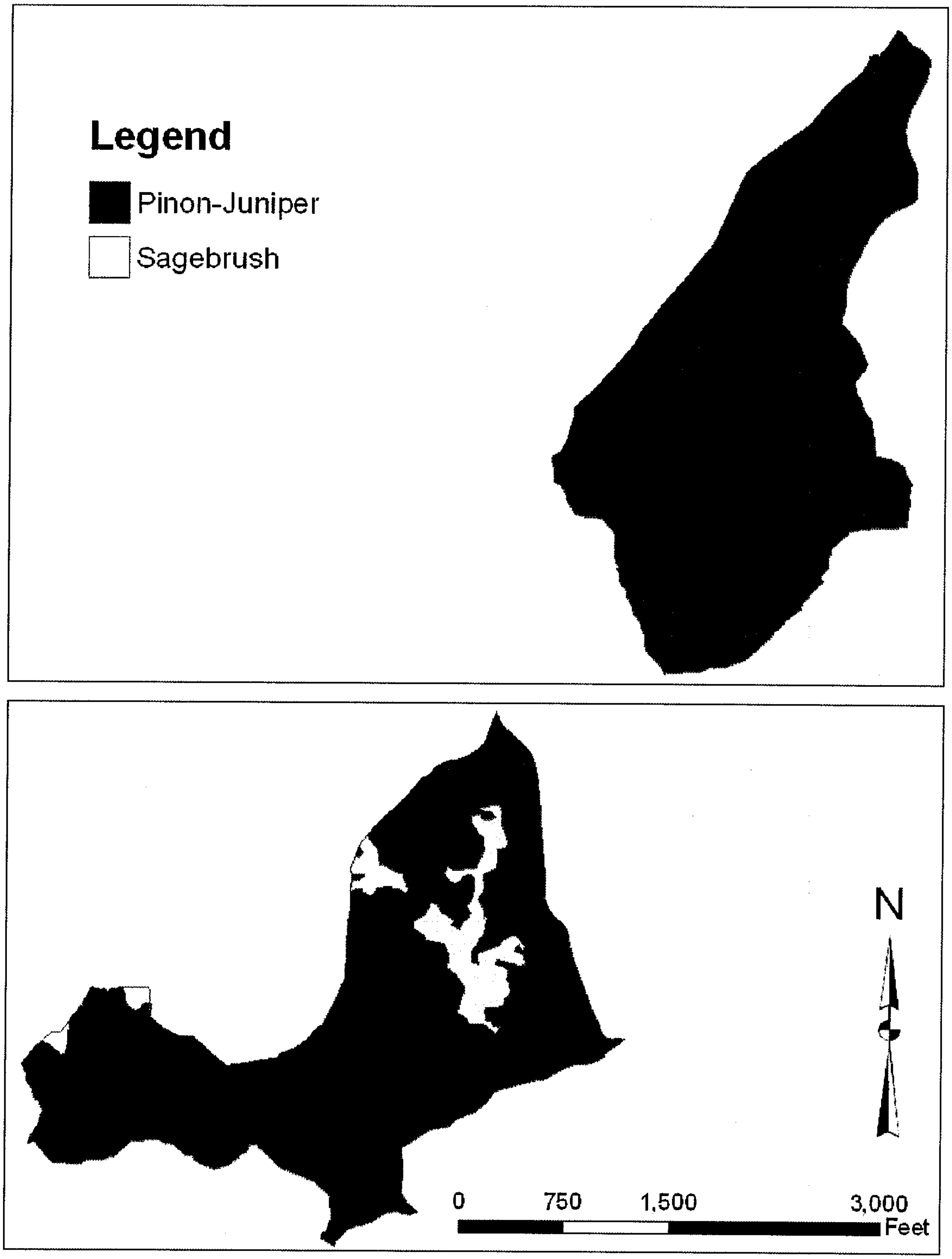

Figure 1.2. Spatial distribution of vegetative cover types for WA N6 premine condition.

Table 1.2. Cover Sampling Data.								
Area	Condition	Cover Type	Nonstratified Vegetation Cover (%)	Vegetation Canopy Cover (%)	Vegetation Ground Cover (%)	Litter* (%)	Rock (%)	Total Ground Cover (%)
N1/N2	Postmine	Postmine	25.6	1.4	24.2	13.6	4.2	41.9
N6 WA	Postmine	Postmine		0.9	20.5	15.5	2.7	38.2
N1/N2/J27	Premine	Pinon Juniper	32.7	31.1	3.0	44.0	19.7	66.7
N6 WA	Premine	Pinon Juniper		14.6	2.7	18.8	17.3	38.8
N1/N2	Premine	Sagebrush	25.1	16.0	10.3	25.3	18.1	53.7
J27	Premine	Sagebrush	30.6	9.7	22.0	24.0	1.6	47.6
N6 WA	Premine	Sagebrush		1.3	11.2	24.7	2.5	38.3
*Including standing dead litter								

Table 1.3. Cover Data for N6-C, N6-D, and N6-F Watersheds.				
Condition	Pinon Juniper	Sagebrush	Half Pinon Juniper-Half Sagebrush	Postmine
Canopy cover, %	14.6	1.3	8.0	0.9
Ground cover, %	38.8	38.3	38.5	38.2
Canopy storage, in	0.05	0.05	0.05	0.05
Ground storage, in	0.05	0.05	0.05	0.05
Depression storage, in	0.03	0.03	0.03	0.03
Impervious area, %	0	0	0	0
Manning n	0.07	0.07	0.07	0.05

To make comparisons between reclaimed lands and associated undisturbed lands at the Black Mesa Mining Complex on the basis of average annual sediment yield, a procedure was used that considers the importance of infrequent storm events in defining sediment yield in the semiarid west. First, however, the site-specific rainfall data available for the Black Mesa Mining Complex were used to evaluate the frequency and magnitude of the measured events relative to existing predictions for rainfall depth-duration (Miller et al. 1973). The analysis of the rainfall data was performed as part of a previous study of the N1/N2 and J27 CRAs (Resource Consultants and Engineers 1993).

Comparisons between runoff and sediment yield from undisturbed and reclaimed areas in WA N6 were developed for specific modeling endpoints shown in Exhibits 1 and 2. Mining and reclamation activities did not exactly replicate the topography, drainage network, or drainage areas that existed prior to mining. Consequently, direct comparisons of total runoff and sediment yield cannot be made between undisturbed and reclaimed response at a given point in a watershed. Comparisons were made on the basis of unit rates of runoff (inches) and sediment yield (tons/acre) at the various modeling computation endpoints. Although the same disturbance boundary was used to model extents for both pre- and postmine conditions, the topographic differences that resulted after mining and reclamation occurred in the N6 WA dictated that some small areas would be included or excluded from the modeling. The total area modeled (combined area for N6-C, N6-D, and N6-F watersheds) for premine conditions is 284.0 acres and for postmine conditions is 280.9 acres. The difference in area results from the sediment ponds in postmine conditions. The area bounded by the modeling boundary identified by PWCC as shown in Exhibits 1 and 2 is 284.0 acres.

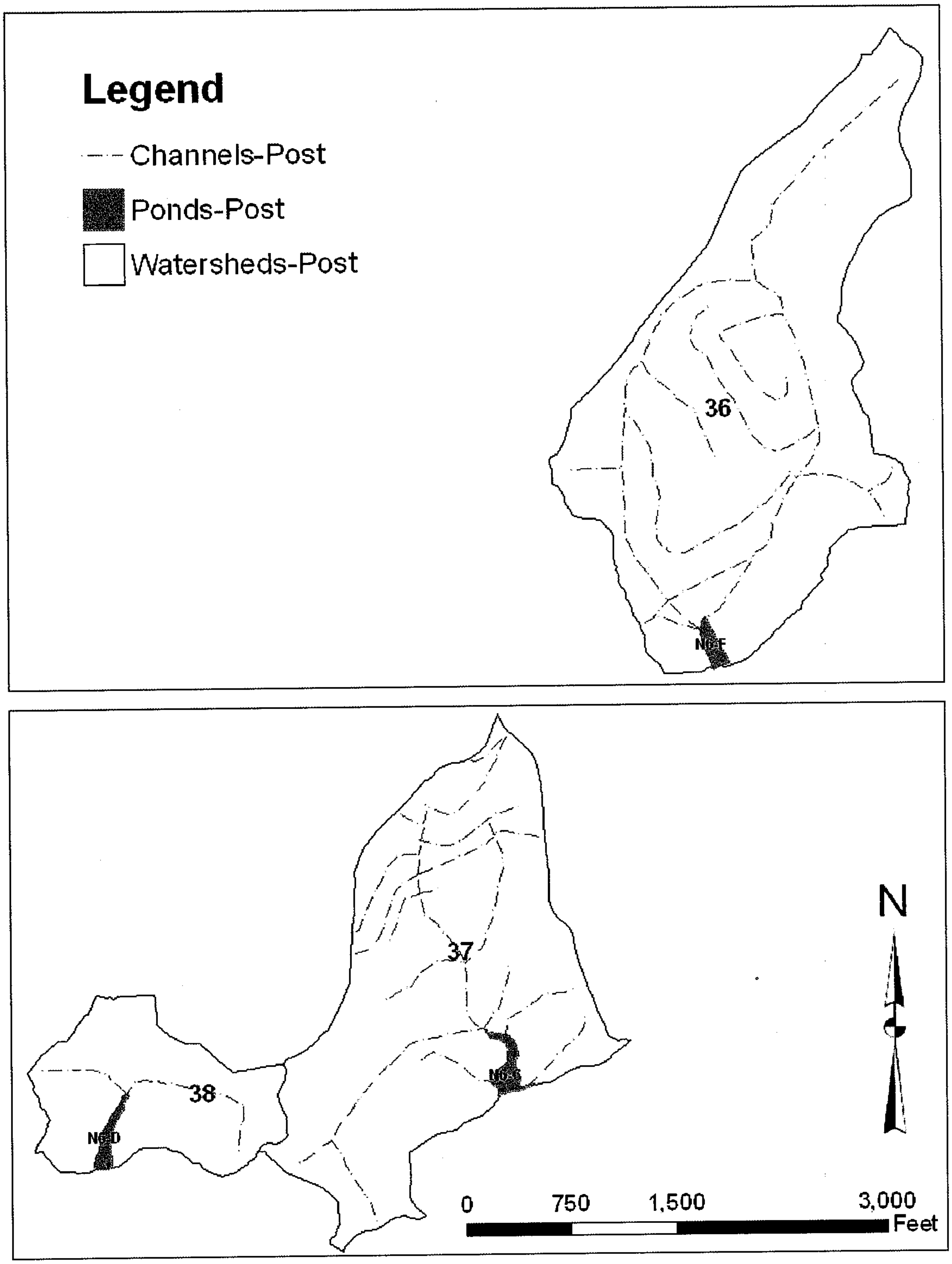

Figure 1.3. N6-C, N6-D, and N6-F postmine basins.

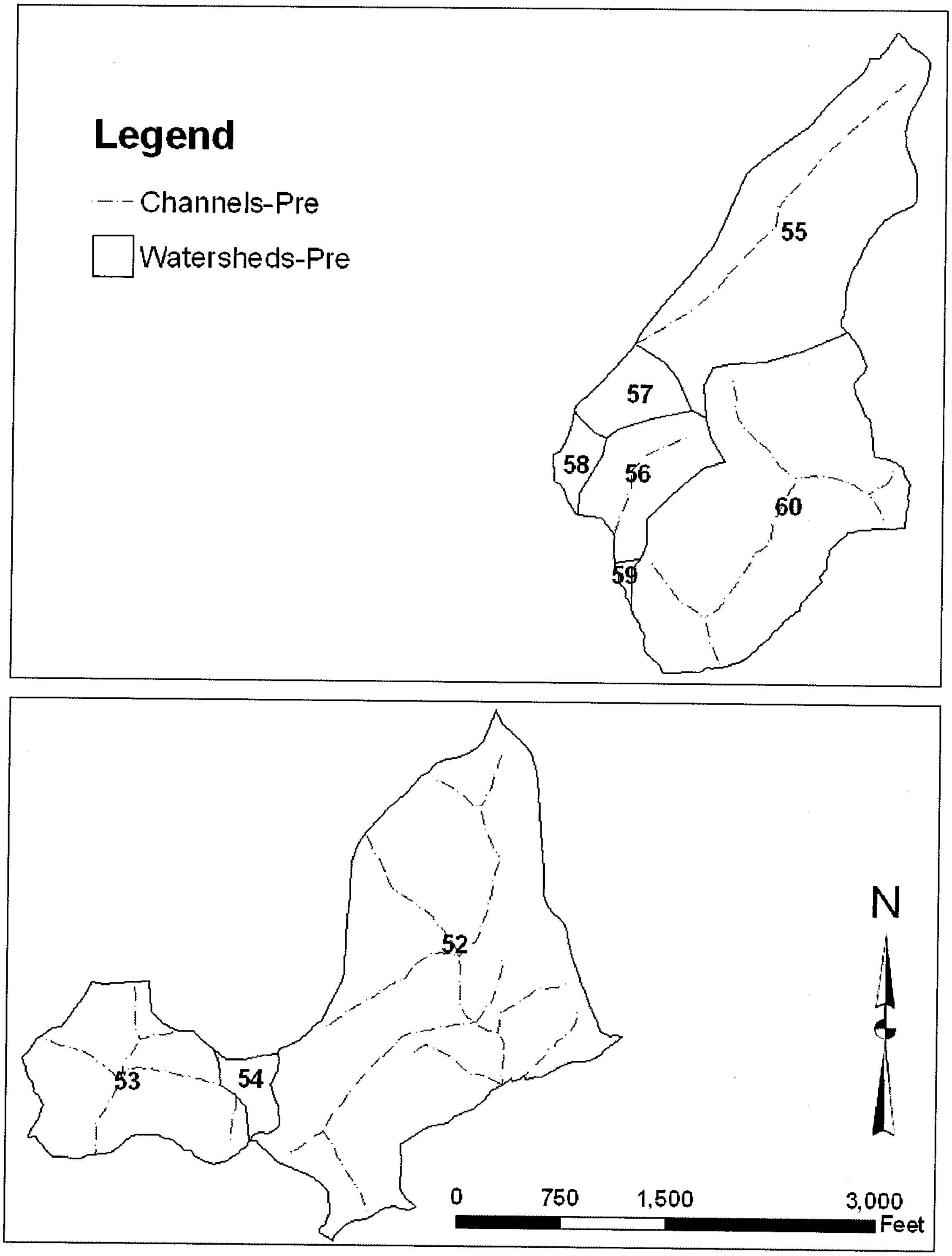

Figure 1.4. N6-C, N6-D, and N6-F premine basins.

1.4.1 Synthetic Rainfall

Synthetic storms of 2-, 5-, 10-, 25-, 50-, and 100-year return periods were used as input to the EASI model. Actual hyetographs were taken from the previous study (RCE 1993) and are based on both local data collection and the NOAA Atlas (Miller et al. 1973).

1.4.2 Computation of Average Runoff and Sediment Yield

The EASI model was used to evaluate runoff and sediment yield from a series of storm events having recurrence intervals of 2-, 5-, 10-, 25-, 50-, and 100 years. To define average annual conditions, the average annual runoff and sediment yield generated from storm events were computed using the commonly used equation of Lagasse et al. (1985).

1.5 Results

Figures 1.3 and 1.4 show the post- and premine basin delineations. Since the individual subareas differ in number, acreage and outlet locations, a direct comparison is not possible on a subarea basis. Therefore, the best way to compare the results is on an average basis for the WA. **Table 1.4** shows pre- and postmine drainage area, runoff, and sediment yield for the N6 WA. To consider the situation of pond removal for the postmine condition, the EASI model replaces a sediment pond with a channel, which lies near the location of the pond and discharges to the basin outlet. The channel is assumed to have a length equal to the pond's length and a slope similar to the outlet's natural slope. Runoff is defined as the total volume of water leaving the WA on an average annual basis and, therefore, does not include water stored in depression areas and ponds. For the premine condition, this is equal to the amount of water that drains off the hillslopes and subwatersheds because there are no ponds or significant depressions. For the postmine condition, this is equal to the amount of hillslope runoff less the amount stored in ponds. No ponds or significant depressions exist within the reclaimed N6 WA that was modeled. Similarly, the sediment yield is the amount of eroded material that leaves the WA on an average annual basis computed using the equation of Lagasse et al. (1985). The sediment yield is the production from the hillslope areas and erosion from the channels. The amount of erosion is the sediment yield from the hillslopes and subwatersheds only and does not include channel erosion, channel deposition or sediment trapped in ponds. Sediment yield can be greater or less than erosion, depending on the amount of channel erosion and the capacity of the channel network to convey sediment off the leasehold.

Table 1.4. Average Runoff and Sediment Yield Results.

Area	Condition	Drainage Area (ac)	Runoff (in)	Sediment Yield (t/ac/yr)
N6 WA	Premine	284.0	0.42	3.12
N6 WA	Postmine	280.9	0.42	2.51
N6-C	Premine	105.6	0.42	3.65
N6-C	Postmine	104.4	0.42	3.33
N6-D	Premine	36.1	0.42	1.76
N6-D	Postmine	35.1	0.42	1.07
N6-F	Premine	142.4	0.42	3.07
N6-F	Postmine	141.5	0.42	2.25

For the postmine condition, the overall sediment yield is less than those in the premine condition. Sediment yield is approximately 80% of the premine amount, and runoff is the same as the premine amount. The reduction of sediment yield is primarily due to the channel erosion control measures (BMP's) for the postmine condition.

Table 1.4 also shows pre- and postmine drainage area, runoff, and sediment yield for three individual watersheds (N6-C, N6-D, and N6-F) within the N6 WA. Modeling results of individual watersheds are similar to the overall N6 WA.

1.6 Discussion

Table 1.5 gives an overview of the geometric properties of the pre- and postmine disturbed areas. Premine hillslopes are generally longer than postmine hillslopes, postmine channels are not as steep as premine channels, and the drainage density of the postmine condition is greater than that of the premine condition. These properties agree with the postmine versus premine topography: the greater drainage density and shorter hillslopes of the postmine condition are due to the terracing of the land to allow less sediment erosion and transport. Generally, in a natural setting, a greater drainage density would be equated with higher sediment yields. However, the terraces are not "natural" channels as they are designed to segment long hillslopes into shorter lengths and the terrace channels are designed with low gradients to reduce erosion and sediment transport. A high drainage density in a natural setting would result in a short time of concentration and higher peak flows but a high drainage density due to terracing would increase time of concentration and decrease peak flows. Such differences in pre- and postmine topography make it difficult to generalize about sediment yield from pre- and postmine areas. This shows the value of modeling. One generalization that can be made, however, is that the significantly shorter hillslope lengths are the cause of lower erosion rates.

Table 1.5. Average Physical Properties of the N6 WA.

	Premine	Postmine
Total Area (ac)	284.0	280.9
Total Channel Length (ft)	21583	32108
Mean Channel Slope	0.0619	0.0529
Drainage Density (mi/mi^2)	9.2	13.9
Mean Hillslope Length (ft)	234	212
Mean Hillslope Gradient	0.1192	0.1150

2. COMPARISONS WITH MEASURED SEDIMENT TRANSPORT

As discussed in Section 1, PWCC has monitored flow and sediment on the main channels, principal tributaries and small watersheds within the leasehold. These data, along with the runoff plots, were used to calibrate the EASI model soil erodibility and infiltration input variables. **Figures 2.1** and **2.2** show sediment transport and sediment concentration versus discharge for measured unmined (background), measured reclaimed, WA N6's modeled unmined (premine) and modeled reclaimed (postmine) data. Although there is significant scatter shown in the data (as is expected with any sediment transport conditions), there are several conclusions that can be drawn from this data.

The open symbols in both figures depict measured data and whether the data were collected from reclaimed areas (the small watershed study) or from unmined or background surface water monitoring stations. The range of flows is generally greater for the background data but there is significant overlap between the two data sets between 0.1 and 100 cfs. This is because the reclaimed data are from small watersheds and the unmined data are from channels draining larger basins. These data show the same trend for sediment transport and sediment concentration over the entire range of flows and very close agreement in the area of discharge overlap. This, in itself, is strong evidence that (1) the sediment yields are channel transport capacity limited, (2) overlap of model predictions for both pre- and postmine conditions with measured data strongly indicate that EASI model predictions are representative and reasonable, and (3) sediment yields from reclaimed areas will not be additive to yields on the receiving streams.

The closed symbols depict data from WA N6's pre- and postmine EASI model runs. They represent data generated by EASI for both subwatersheds and channels for peak discharges resulting from 2-, 5-, 10-, 25-, 50-, and 100-year storms. Using the peak flows from extreme events results in discharges that generally exceed 10 cfs. The trend of the model-derived data is similar and the ranges of concentration and sediment transport are similar to the measured data and between pre- and postmine conditions.

The sediment discharge plot (Figure 2.1) shows a stronger trend because it is plotting discharge (sediment) against discharge (flow). This is expected because the sediment discharge does depend on flow discharge. The concentration plot (Figure 2.2) shows the two separate variables and, therefore, a less significant trend. PWCC believes that data measurement may have some influence on the scatter (outliers were removed), but the process variability is probably the major influence. The majority of the data, however, fall in a group centered on 100 cfs and 100,000 mg/l, both in the observed data and in the model results. These plots support the use of the EASI model, the results of the modeling, the conclusion that sediment yields from reclaimed areas are not additive to receiving stream sediment loads, and that sediment impacts to the prevailing hydrologic balance have been minimized.

From Figures 2.1 and 2.2 it is apparent that sediment loads and concentrations are dependent on the channel sediment transport capacity for both pre- and postmine conditions. Channel sources of sediment in this arid environment are virtually unlimited. Therefore, channel transport capacity and channel derived sediment limits and governs sediment yields from the small tributaries, large channels and the WA as a whole. The similarity of sediment discharge (or concentration) between pre- and postmine conditions appears to be inconsistent with the lower rates of sediment yield shown in Table 1.4.

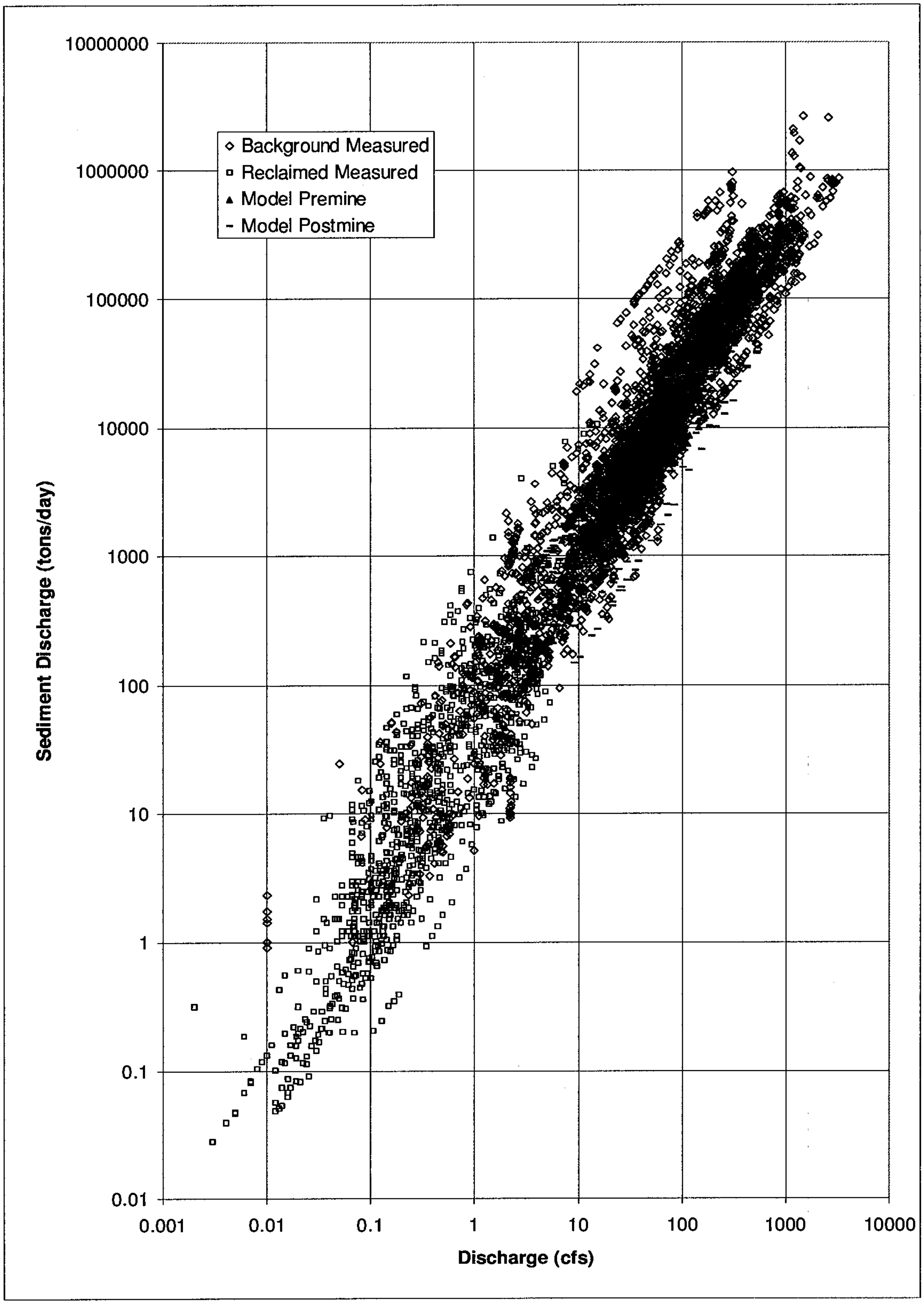

Figure 2.1. Observed and modeled sediment and water discharge.

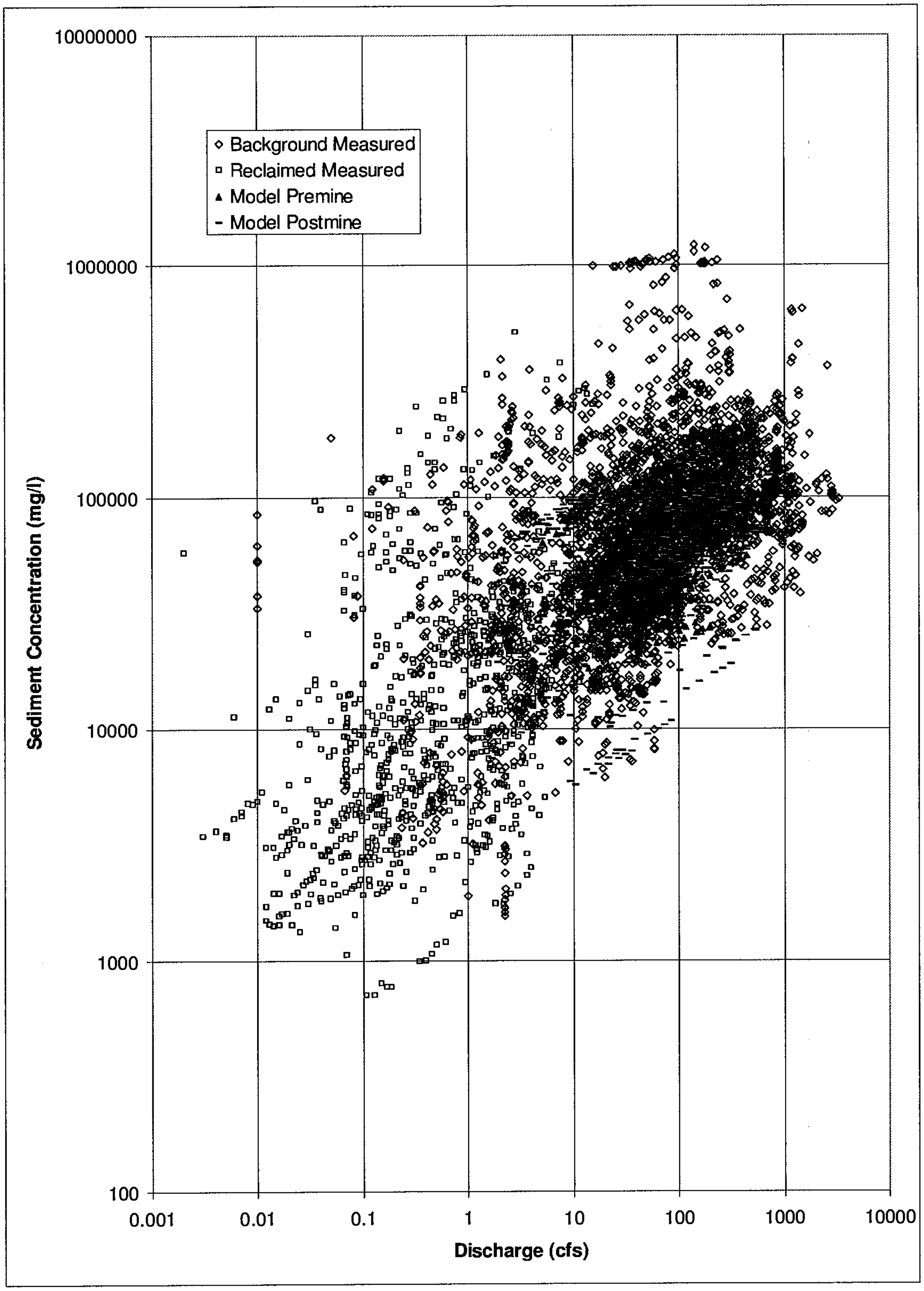

Figure 2.2. Observed versus modeled sediment concentration and discharge.

However, the sediment yield shown in Table 1.4 is the average annual amount of sediment leaving the N6 WA whereas the sediment discharge shown in Figure 2.1 is the peak rate of sediment in transport occurring in any channel represented by the data, whether the channel is located upstream or downstream of a pond. Therefore, it should be concluded that with or without a pond left in the postmine landscape that traps sediment or stores water, the mine reclamation is not contributing additional sediment to the receiving streams and sediment impacts to the prevailing hydrologic balance have been minimized.

Smith and Best (2000) analyzed the measured data (background and reclaimed) shown in Figure 2.1 to develop an approach that can be used to determine if channels in reclaimed areas have similar sediment transport characteristics as background channels. The method that they used was to develop Sen lines (Sen 1968) and confidence intervals around the data. The slope of the Sen line is a non-parametric statistic computed as the median slope of all possible slopes determined from pairing all the data points. The Sen line is drawn through the median coordinate of the data. Smith and Best first showed that the large channel flume data (background) and the small watershed background data could be combined. They concluded that since the data from one data set fall within the Sen line bounds of the other data set then the two data sets are merely extensions of each other and could be combined. Also, because the main channel and background small watershed site data could be combined, it indicated there is an unlimited supply of sediment and the channels are conveying sediment at (or near) capacity. The Sen line and bounds are shown with the background measured data in **Figure 2.3**.

They then plotted the reclaimed measured data (**Figure 2.4**) with the Sen line and bounds from the background data to show that the reclaimed data have the same characteristics even though the flow range of the measurements is lower. The data indicate that channel flows in this environment achieve the sediment transport capacity of the channel, whether in reclaimed or background conditions.

Using the same approach with the modeled data generated for the N6 WA, **Figures 2.5 and 2.6** show the pre- and postmine computed sediment transport rates with the Sen lines and bounds. One difference between the plots is that the measured data occur throughout the flow hydrograph whereas the modeled data are tabulated at the peak of the simulation flow hydrograph. The premine data plot (Figure 2.5) shows the data grouped around the Sen line and well within the bounds. Similarly, the postmine data (Figure 2.6) plot around the Sen line.

Several conclusions can be drawn from these data plots: (1) EASI model well replicates erosion and sediment transport processes at the mine site for background and reclaimed conditions, (2) all data show similar trends and are within the same bounds, (3) data trends indicate that channels are transporting sediment at or near capacity, and (4) amounts of sediment leaving the WA for postmine conditions are similar to premine conditions and within the range expected for the background conditions. Therefore, the overall conclusion is that the postmine reclaimed condition in N6 WA is not contributing additional suspended solids to receiving streams, and related impacts to the hydrologic balance have been minimized.

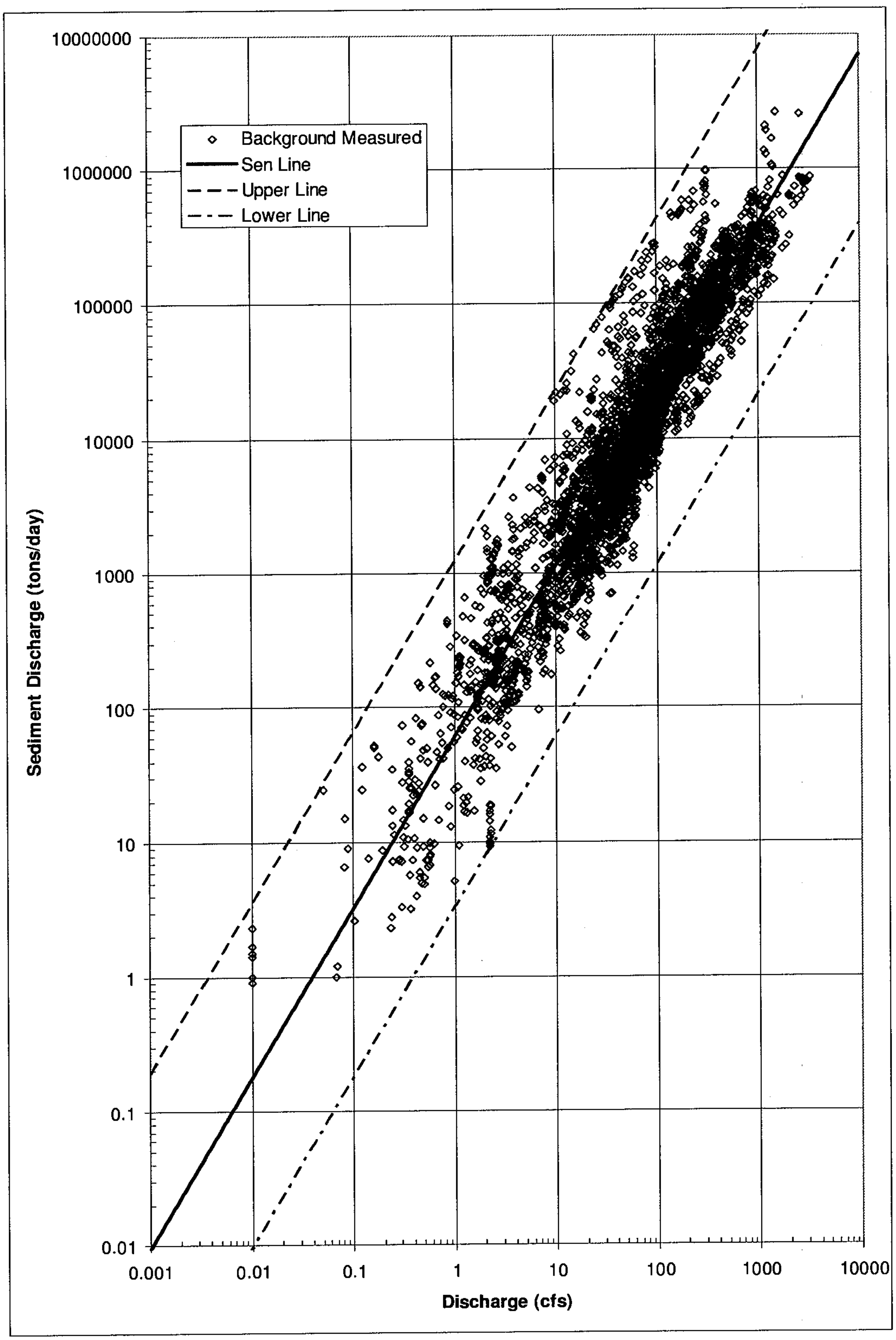

Figure 2.3. Background measured sediment and water discharge with Sen lines.

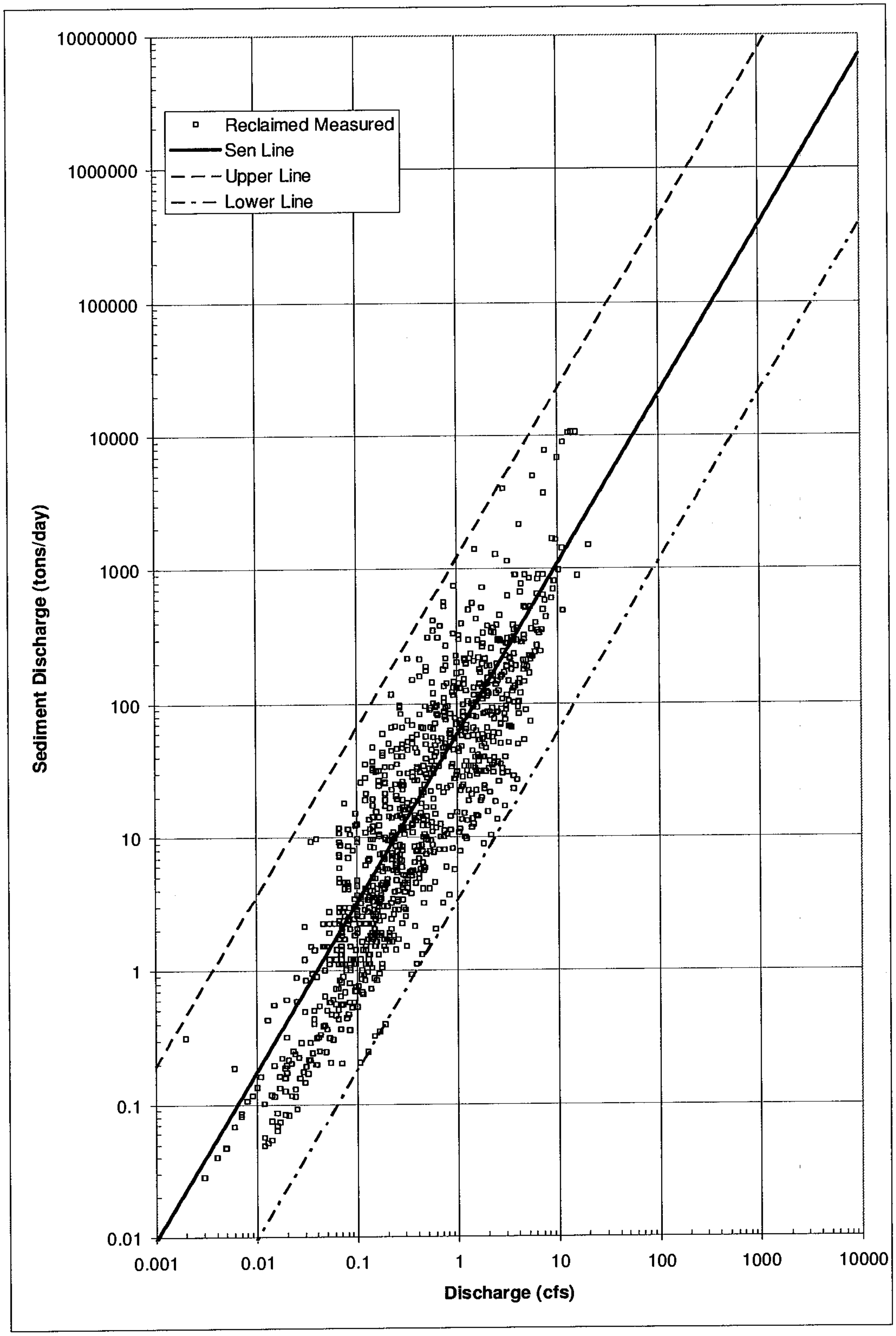

Figure 2.4. Reclaimed measured sediment and water discharge with Sen lines.

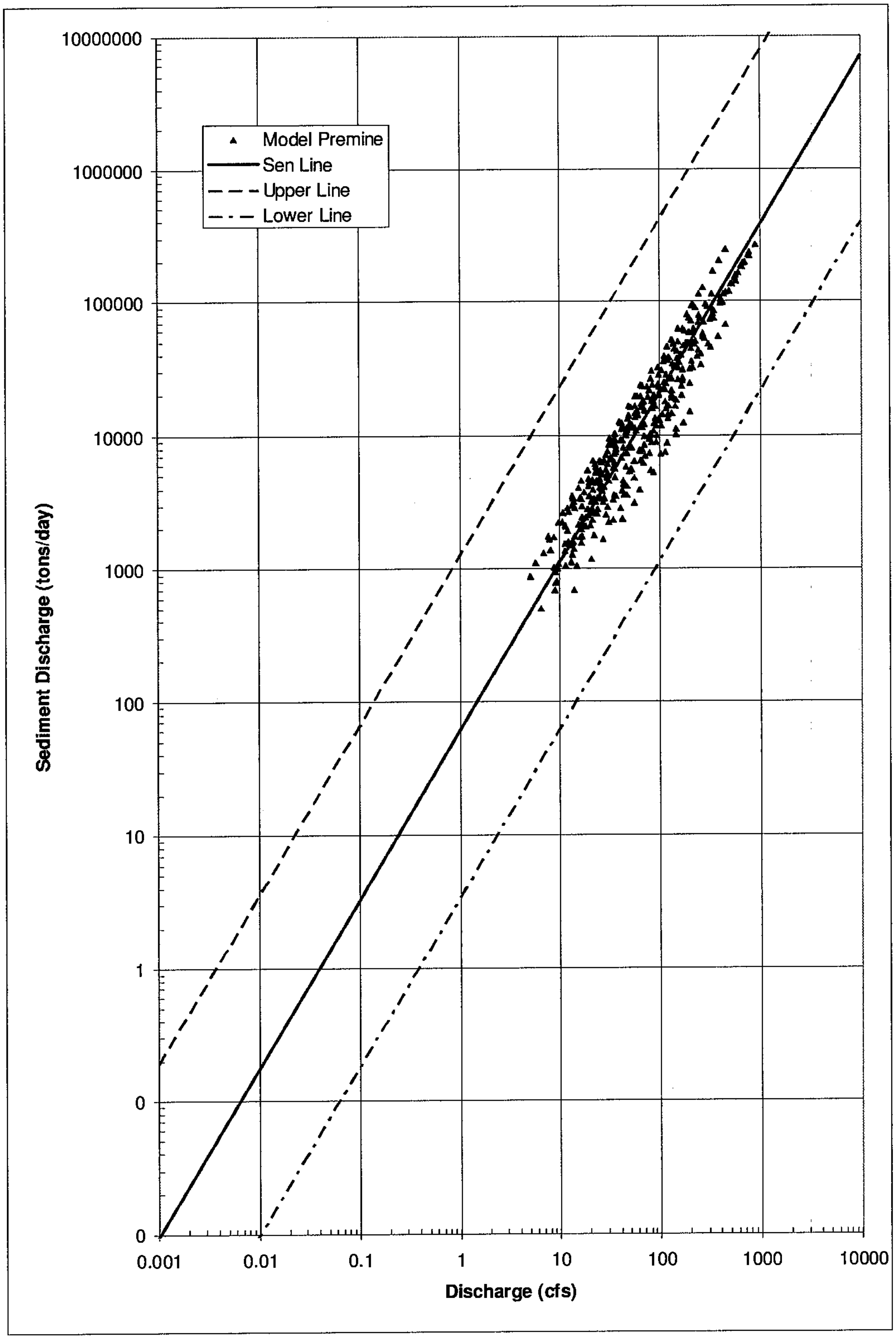

Figure 2.5. Modeled premine sediment and water discharge for the N6 WA with Sen lines.

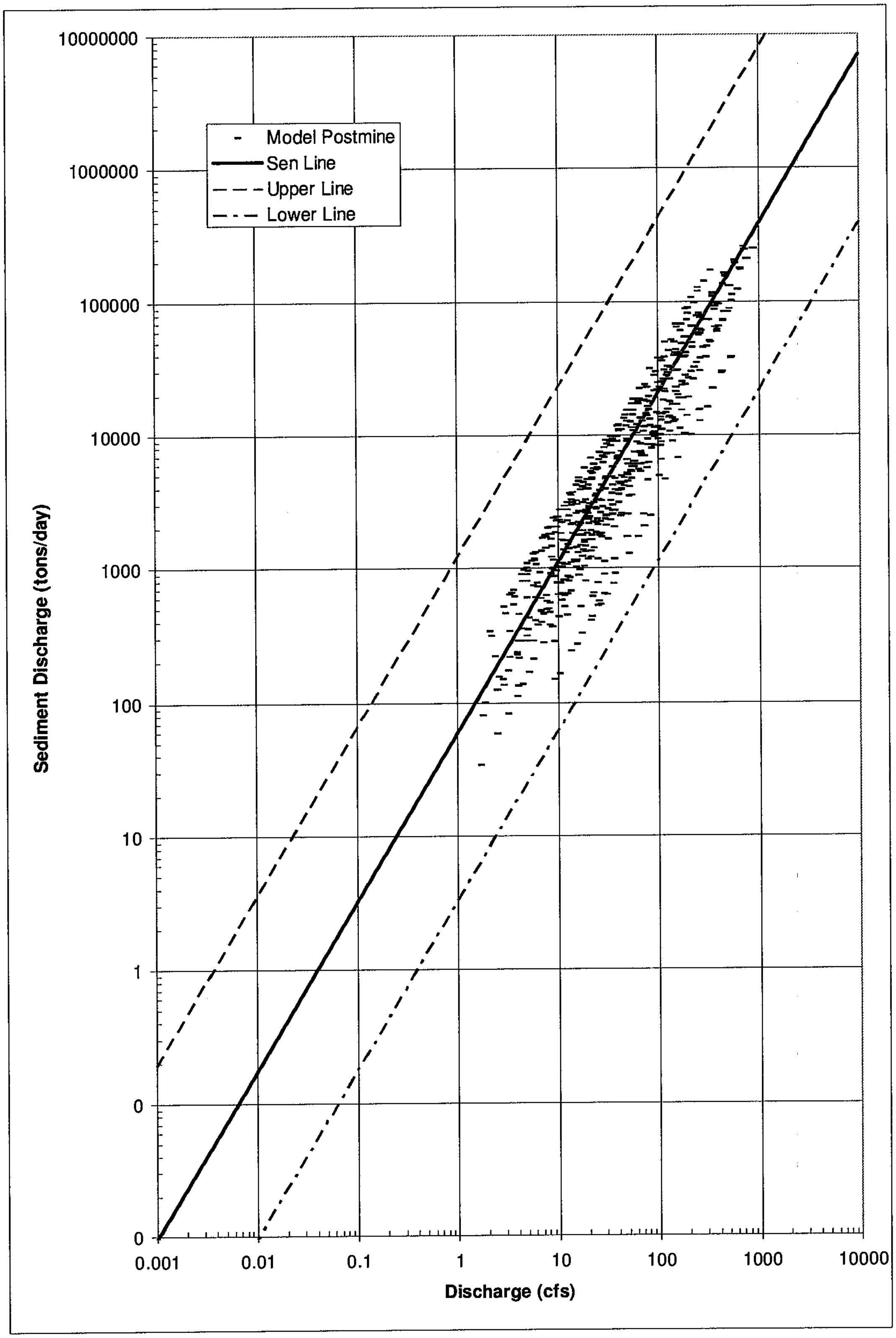

Figure 2.6. Modeled postmine sediment and water discharge for the N6 WA with Sen lines.

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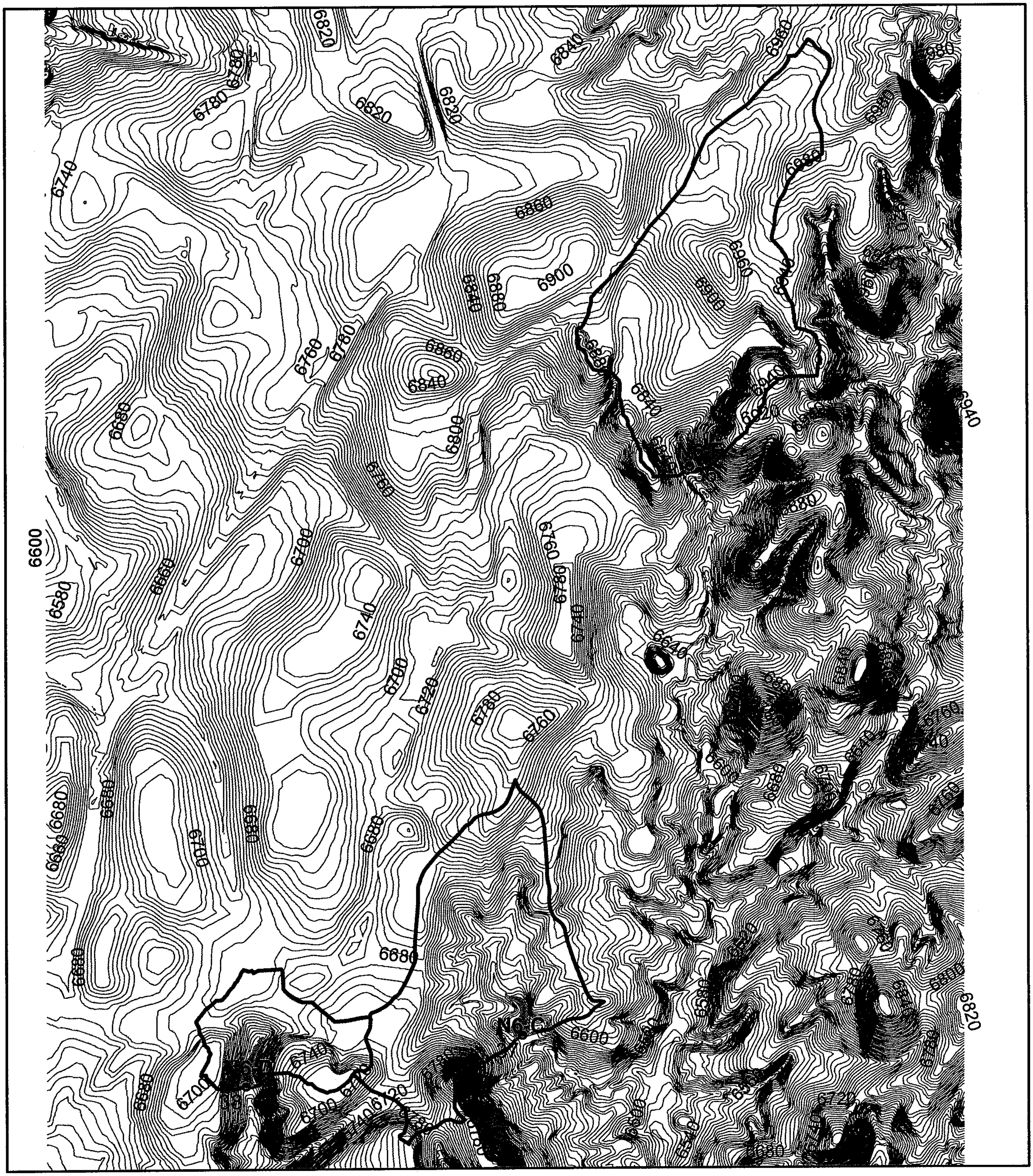
EXHIBIT 1
Postmine Topography



N

Legend

• End Points

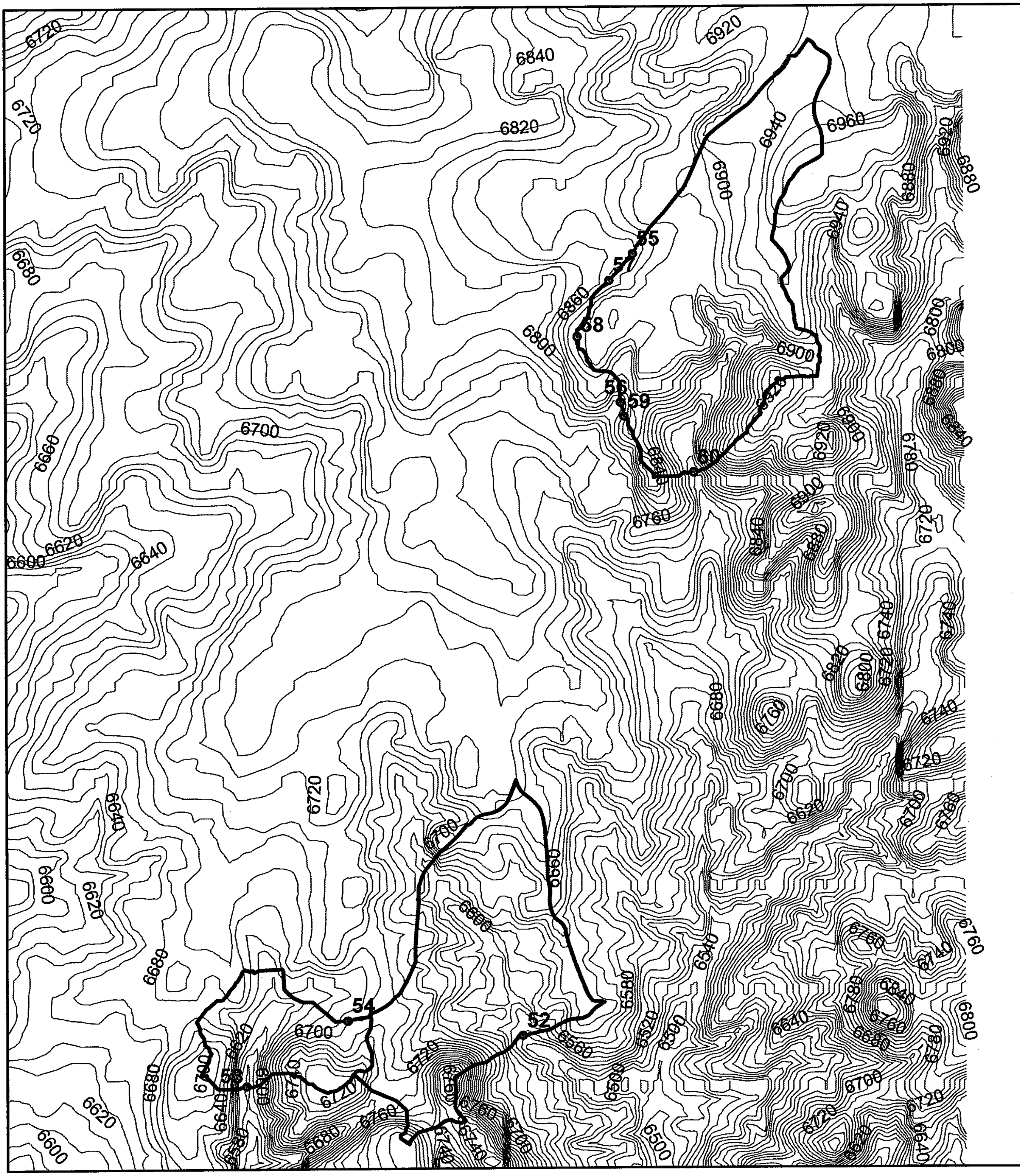
Ponds

Modeling Area

Feet
0 750 1,500 3,000 4,500

Exhibit 1. Postmine Topography

EXHIBIT 2
Premine Topography



N

Legend

- End Points

Modeling Area

Feet
0 750 1,500 3,000 4,500

Exhibit 2. Premine Topography

Appendix 3

Surface Water Modeling of the Reclaimed J16-E and J16-F Watershed Area at Kayenta Mine

SURFACE WATER MODELING OF THE RECLAIMED J16-E AND J16-F WATERSHED AREA AT KAYENTA MINE

Prepared for

Peabody Western Coal Co.
Highway 160, Navajo Route 41
Kayenta, Arizona 86033

AYRES ASSOCIATES

SURFACE WATER MODELING OF THE RECLAIMED J16-E AND J16-F WATERSHED AREA AT KAYENTA MINE

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The objective defined by PWCC for this project is to use a previously calibrated and validated runoff and erosion model (EASI, Zevenbergen et al. 1990; WET 1990) for the Black Mesa and Kayenta Mines to predict mean annual runoff and sediment yields from the reclaimed J16-E and J16-F watersheds. This objective included computation of runoff and sediment yields under premine conditions for the same area. All soils and rainfall input to the model are to be taken from models calibrated in the previous study (RCE 1993). The input variables that were calibrated to the mine areas and used in this study include soil infiltration parameters, erodibility parameters, and the grain size distribution. Parameters that are specific to this study are vegetative canopy and ground cover percentages from data collected on site.

The model calibration was conducted in a previous study (RCE 1993) using data obtained from instrumented watersheds and small hillslope plots collected under natural rainfall conditions. For a detailed discussion of data collection and model calibration, please refer to the previous study (RCE 1993).

1.2 Background

The J16-E and J16-F Watershed Area (WA) that is the focus of this project was reclaimed between 1984 and 2002. The fundamental purpose of this study was to quantify the expected behavior and hydrologic response of the reclaimed areas above each pond relative to the conditions that existed prior to the occurrence of mining activities.

Runoff and sediment yield response from the reclaimed lands should be managed by implementing Best Management Practices (BMP's) in conjunction with an OSM approved sediment control plan in order to not adversely impact the prevailing hydrologic balance and to limit additional contributions of suspended sediment to streamflow or runoff outside the mine permit areas. BMP's include regrading, replacing salvaged topsoil, revegetation, and other controls such as riprapped channel bottoms, check dams, and where practicable, contour terraces. The natural watersheds on the mesa contribute significant quantities of sediment to the channel system. It is expected that the postmine condition will also produce comparable amounts of sediment without adverse impact on the hydrologic balance.

This section describes the data and procedures used to evaluate the J16 WA. This area was modeled to determine the average annual hydrologic response following the completion of reclamation activities taking into account BMP's implemented as part of the reclamation process. Infiltration, runoff, and erosion processes from both hillslopes and channels within the J16 WA were modeled using EASI. Results were determined for concentration points at the outlets of the reclaimed watersheds, which correspond to the embankments associated with Ponds J16-E and J16-F. The locations of these points are shown in **Exhibit 1**. Modeling was also conducted to determine hydrologic response under premine conditions based on the topography, soils, cover, and other conditions that typified the undisturbed watersheds draining to each concentration point. **Exhibit 2** shows the modeling endpoints for the premine J16 WA.

1.3 Data

1.3.1 Soils

Soils data used for the current study (J16 WA) were based on data developed from the calibration of models used in the previous study for Coal Resource Areas (CRAs) N1/N2 and J27 (RCE 1993). The composition of postmine soil in the current study is depicted along with the composition of postmine soils from the previous study in **Figure 1.1**. This figure shows that the soil composition of WA J16 is very similar to soils evaluated during model calibration. Therefore, the soil properties developed in the previous study are valid for this modeling project. These properties include calibrated parameters, such as infiltration and erodibility coefficients, and measured soil size distributions. **Table 1.1** lists the premine and postmine soils data used during EASI modeling of WA J16.

1.3.2 Vegetation

Vegetative cover data representative of both pre- and postmine conditions in WA J16 were supplied by PWCC. For the premine condition, land was characterized as being covered by sagebrush or pinon juniper. The spatial distribution of vegetative cover for the J16 WA premine condition appears in **Figure 1.2**. Average cover properties for CRAs N1/N2 and J27 of the previous study and WA J16 of the current study appear in **Table 1.2**. For the postmine condition, the reclaimed area was assigned the postmine cover type and the unmined area was assigned the same cover type as the premine condition. **Table 1.3** lists the pre- and postmine vegetative cover data used in the EASI model runs generated for the J16 WA. Note that if a unit contained significant portions of both sagebrush and pinon juniper cover types, it was classified as half pinon juniper and half sagebrush.

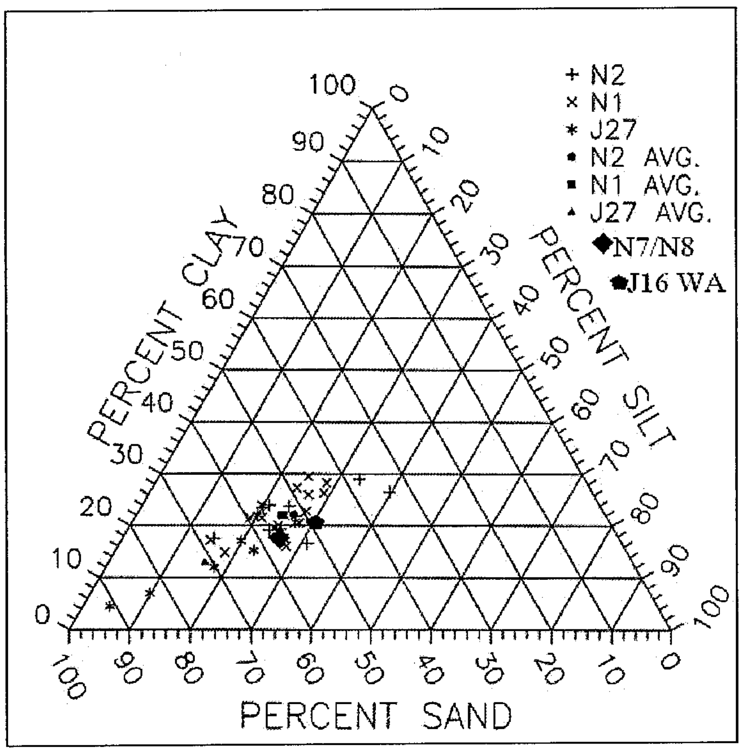

Figure 1.1. Reclaimed area soils trilinear graph.

Table 1.1. Soils Data.			
Condition	Premine	Postmine	Rock Chutes
Rainfall detachment	0.005	0.005	0
Overland flow detachment	0.44	0.44	0
Channel flow detachment	0.5	0.5	0
Initial soil moisture, %	70	70	70
Final soil moisture, %	90	90	90
Soil porosity, %	45	45	46
Temperature, *F	70	70	70
Hydraulic conductivity, in/hr	0.23	0.29	0.3
Capillary suction, in	3.7	2.6	2.6
	Particle Size Distribution (all conditions)		
	Size, mm	% Finer	
	0.001	0	
	0.004	18.0	
	0.016	27.4	
	0.062	36.6	
	0.125	56.2	
	0.250	64.3	
	0.500	72.4	
	1.000	80.5	
	2.000	88.6	
	4.000	92.4	
	16.000	100	

1.3.3 Topography

Pre- and postmine topography was supplied by PWCC in the form of ArcGIS geodatabase. Basin delineations, hillslope delineations, subwatershed delineations, as well as areas, slopes, and lengths of all units of the study area were defined and calculated using ArcGIS software. **Figures 1.3 and 1.4** show the watershed delineation and numbers assigned to the basins used in the EASI model for the post- and premine conditions, respectively. Channel dimensions input to EASI were based on the topography supplied and limited field observations.

1.4 Methodology

Runoff and sediment yield in the semiarid western United States is largely governed by the occurrence of high-intensity, short-duration rainstorms of limited areal extent (Renard and Simaton 1975). Research has indicated that relatively few events may produce the greatest erosion (e.g., Hjelmfelt et al. 1986 reported that only 3 to 4% of rainfall events accounted for 50% of long-term sediment yields). Although there is perhaps a relatively limited physical basis for definition of an "average annual" runoff or sediment yield in a semiarid environment due to the extreme variability in response and importance of single infrequent events, such a term does provide a useful basis for long-term comparison between reclaimed and undisturbed conditions.

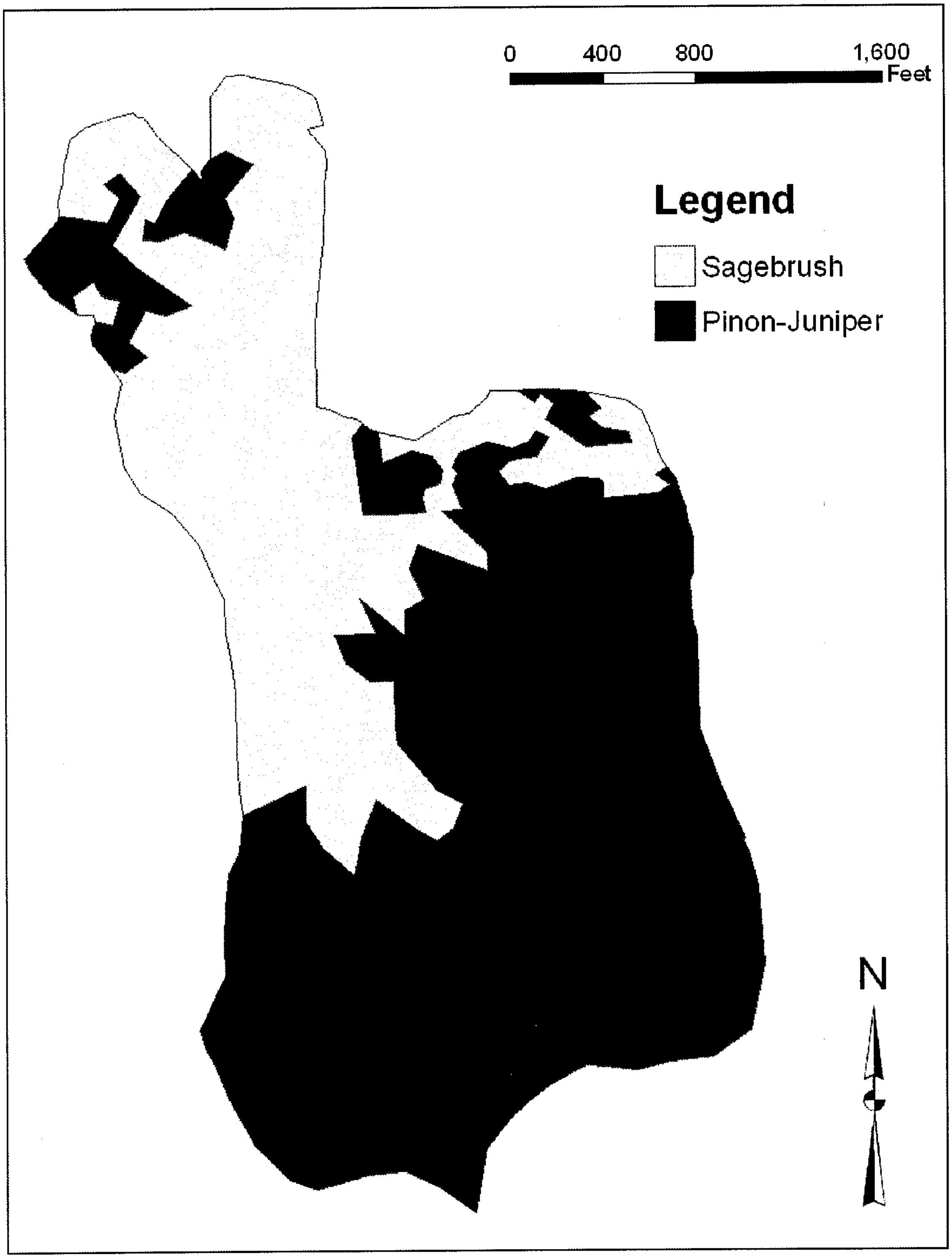

Figure 1.2. Spatial distribution of vegetative cover types for WA J16 premine condition.

Table 1.2. Cover Sampling Data.								
Area	Condition	Cover Type	Nonstratified Vegetation Cover (%)	Vegetation Canopy Cover (%)	Vegetation Ground Cover (%)	Litter* (%)	Rock (%)	Total Ground Cover (%)
N1/N2	Postmine	Postmine	25.6	1.4	24.2	13.6	4.2	41.9
J16 WA	Postmine	Postmine		0.3	34.7	20.2	6.1	61.0
N1/N2/J27	Premine	Pinon Juniper	32.7	31.1	3.0	44.0	19.7	66.7
J16 WA	Premine	Pinon Juniper		16.8	3.9	28.8	16.7	49.3
N1/N2	Premine	Sagebrush	25.1	16.0	10.3	25.3	18.1	53.7
J27	Premine	Sagebrush	30.6	9.7	22.0	24.0	1.6	47.6
J16 WA	Premine	Sagebrush		1.7	15.5	30.6	1.7	47.8
*Including standing dead litter								

Table 1.3. Cover Data for J16-E and J16-F Watersheds.				
Condition	Pinon Juniper	Sagebrush	Half Pinon Juniper-Half Sagebrush	Postmine
Canopy cover, %	16.8	1.7	9.3	0.3
Ground cover, %	49.3	47.8	48.5	61
Canopy storage, in	0.05	0.05	0.05	0.05
Ground storage, in	0.05	0.05	0.05	0.05
Depression storage, in	0.03	0.03	0.03	0.03
Impervious area, %	0	0	0	0
Manning n	0.07	0.07	0.07	0.05

To make comparisons between reclaimed lands and associated undisturbed lands at the Black Mesa Mining Complex on the basis of average annual sediment yield, a procedure was used that considers the importance of infrequent storm events in defining sediment yield in the semiarid west. First, however, the site-specific rainfall data available for the Black Mesa Mining Complex were used to evaluate the frequency and magnitude of the measured events relative to existing predictions for rainfall depth-duration (Miller et al. 1973). The analysis of the rainfall data was performed as part of a previous study of the N1/N2 and J27 CRAs (Resource Consultants and Engineers 1993).

Comparisons between runoff and sediment yield from undisturbed and reclaimed areas in WA J16 were developed for specific modeling endpoints shown in Exhibits 1 and 2. Mining and reclamation activities did not exactly replicate the topography, drainage network, or drainage areas that existed prior to mining. Consequently, direct comparisons of total runoff and sediment yield cannot be made between undisturbed and reclaimed response at a given point in a watershed. Comparisons were made on the basis of unit rates of runoff (inches) and sediment yield (tons/acre) at the various modeling computation endpoints. Although the same disturbance boundary was used to model extents for both pre- and postmine conditions, the topographic differences that resulted after mining and reclamation occurred in the J16 WA dictated that some small areas would be included or excluded from the modeling. The total area modeled (combined area for both J16-E and J16-F watersheds) for premine conditions is 179.2 acres and for postmine conditions is 148.5 acres. The difference in area results from the sediment ponds in postmine conditions and the extension of J16F's premine basin. The area bounded by the disturbance limits identified by PWCC as shown in Exhibit 1 is 150.2 acres.

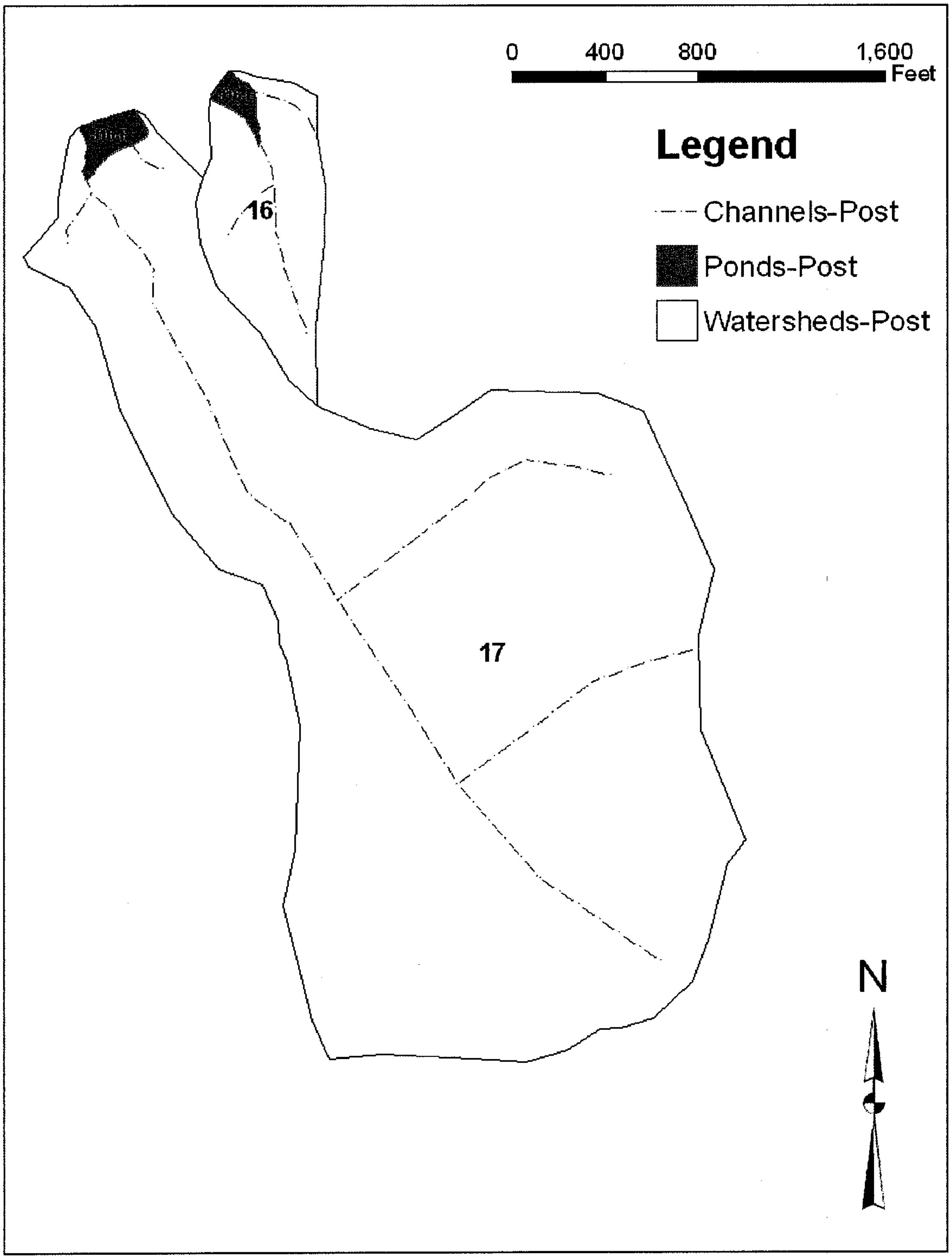

Figure 1.3. J16-E and J16-F postmine basins.

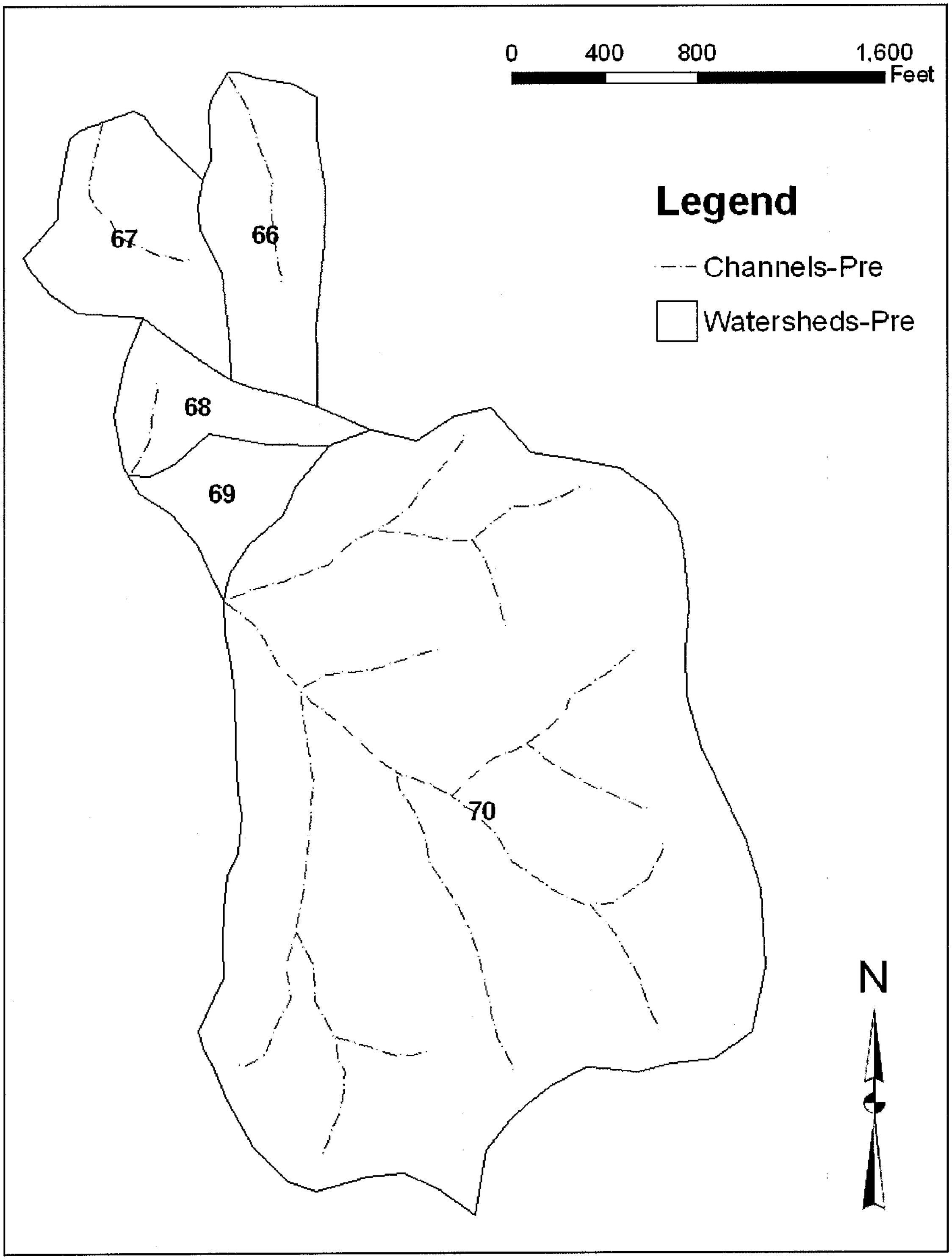

Figure 1.4. J16-E and J16-F premine basins.

1.4.1 Synthetic Rainfall

Synthetic storms of 2-, 5-, 10-, 25-, 50-, and 100-year return periods were used as input to the EASI model. Actual hyetographs were taken from the previous study (RCE 1993) and are based on both local data collection and the NOAA Atlas (Miller et al. 1973).

1.4.2 Computation of Average Runoff and Sediment Yield

The EASI model was used to evaluate runoff and sediment yield from a series of storm events having recurrence intervals of 2-, 5-, 10-, 25-, 50-, and 100 years. To define average annual conditions, the average annual runoff and sediment yield generated from storm events were computed using the commonly used equation of Lagasse et al. (1985).

1.5 Results

Figures 1.3 and 1.4 show the post- and premine basin delineations. Since the individual subareas differ in number, acreage and outlet locations, a direct comparison is not possible on a subarea basis. Therefore, the best way to compare the results is on an average basis for the WA. **Table 1.4** shows pre- and postmine drainage area, runoff, and sediment yield for the J16 WA. Runoff is defined as the total volume of water leaving the WA on an average annual basis and, therefore, does not include water stored in depression areas and ponds. For the premine condition, this is equal to the amount of water that drains off the hillslopes and subwatersheds because there are no ponds or significant depressions. For the postmine condition, this is equal to the amount of hillslope runoff less the amount stored in ponds. No ponds or significant depressions exist within the reclaimed J16 WA that was modeled. Similarly, the sediment yield is the amount of eroded material that leaves the WA on an average annual basis computed using the equation of Lagasse et al. (1985). The sediment yield is the production from the hillslope areas and erosion from the channels. The amount of erosion is the sediment yield from the hillslopes and subwatersheds only and does not include channel erosion, channel deposition or sediment trapped in ponds. Sediment yield can be greater or less than erosion, depending on the amount of channel erosion and the capacity of the channel network to convey sediment off the leasehold.

Table 1.4. Average Runoff and Sediment Yield Results.

Area	Condition	Drainage Area (ac)	Runoff (in)	Sediment Yield (t/ac/yr)
J16 WA	Premine	179.2	0.42	2.28
J16 WA	Postmine	148.5	0.42	1.14
J16-E	Premine	13.8	0.42	1.50
J16-E	Postmine	11.9	0.42	1.07
J16-F	Premine	165.4	0.42	2.34
J16-F	Postmine	136.6	0.42	1.15

For the postmine condition, the overall sediment yield is less than those in the premine condition. Sediment yield is approximately one-half of the premine amount, and runoff is the same as the premine amount. The reduction of sediment yield is primarily due to the channel erosion control measures (BMP's) for the postmine condition.

Table 1.4 also shows pre- and postmine drainage area, runoff, and sediment yield for two individual watersheds (J16-E and J16-F) within the J16 WA. Modeling results of individual watersheds are similar to the overall J16 WA.

1.6 Discussion

Table 1.5 gives an overview of the geometric properties of the pre- and postmine disturbed areas. Premine hillslopes are generally longer than postmine hillslopes, and postmine channels are not as steep as premine channels. The drainage density of the postmine condition is smaller than that of the premine condition, because the postmine topography has simple geometric characteristics and the premine topography is highly dissected.

Table 1.5. Average Physical Properties of the J16 WA.

	Premine	Postmine
Total Area (ac)	179.2	148.5
Total Channel Length (ft)	14773	8715
Mean Channel Slope	0.0733	0.0594
Drainage Density (mi/mi^2)	10.0	7.1
Mean Hillslope Length (ft)	257	248
Mean Hillslope Gradient	0.1354	0.0702

2. COMPARISONS WITH MEASURED SEDIMENT TRANSPORT

As discussed in Section 1, PWCC has monitored flow and sediment on the main channels, principal tributaries and small watersheds within the leasehold. These data, along with the runoff plots, were used to calibrate the EASI model soil erodibility and infiltration input variables. **Figures 2.1** and **2.2** show sediment transport and sediment concentration versus discharge for measured unmined (background), measured reclaimed, WA J16's modeled unmined (premine) and modeled reclaimed (postmine) data. Although there is significant scatter shown in the data (as is expected with any sediment transport conditions), there are several conclusions that can be drawn from this data.

The open symbols in both figures depict measured data and whether the data were collected from reclaimed areas (the small watershed study) or from unmined or background surface water monitoring stations. The range of flows is generally greater for the background data but there is significant overlap between the two data sets between 0.1 and 100 cfs. This is because the reclaimed data are from small watersheds and the unmined data are from channels draining larger basins. These data show the same trend for sediment transport and sediment concentration over the entire range of flows and very close agreement in the area of discharge overlap. This, in itself, is strong evidence that (1) the sediment yields are channel transport capacity limited, (2) overlap of model predictions for both pre- and postmine conditions with measured data strongly indicate that EASI model predictions are representative and reasonable, and (3) sediment yields from reclaimed areas will not be additive to yields on the receiving streams.

The closed symbols depict data from WA J16's pre- and postmine EASI model runs. They represent data generated by EASI for both subwatersheds and channels for peak discharges resulting from 2-, 5-, 10-, 25-, 50-, and 100-year storms. Using the peak flows from extreme events results in discharges that generally exceed 10 cfs. The trend of the model-derived data is similar and the ranges of concentration and sediment transport are similar to the measured data and between pre- and postmine conditions.

The sediment discharge plot (Figure 2.1) shows a stronger trend because it is plotting discharge (sediment) against discharge (flow). This is expected because the sediment discharge does depend on flow discharge. The concentration plot (Figure 2.2) shows the two separate variables and, therefore, a less significant trend. PWCC believes that data measurement may have some influence on the scatter (outliers were removed), but the process variability is probably the major influence. The majority of the data, however, fall in a group centered on 100 cfs and 100,000 mg/l, both in the observed data and in the model results. These plots support the use of the EASI model, the results of the modeling, the conclusion that sediment yields from reclaimed areas are not additive to receiving stream sediment loads, and that sediment impacts to the prevailing hydrologic balance have been minimized.

From Figures 2.1 and 2.2 it is apparent that sediment loads and concentrations are dependent on the channel sediment transport capacity for both pre- and postmine conditions. Channel sources of sediment in this arid environment are virtually unlimited. Therefore, channel transport capacity and channel derived sediment limits and governs sediment yields from the small tributaries, large channels and the WA as a whole. The similarity of sediment discharge (or concentration) between pre- and postmine conditions appears to be inconsistent with the lower rates of sediment yield shown in Table 1.4.

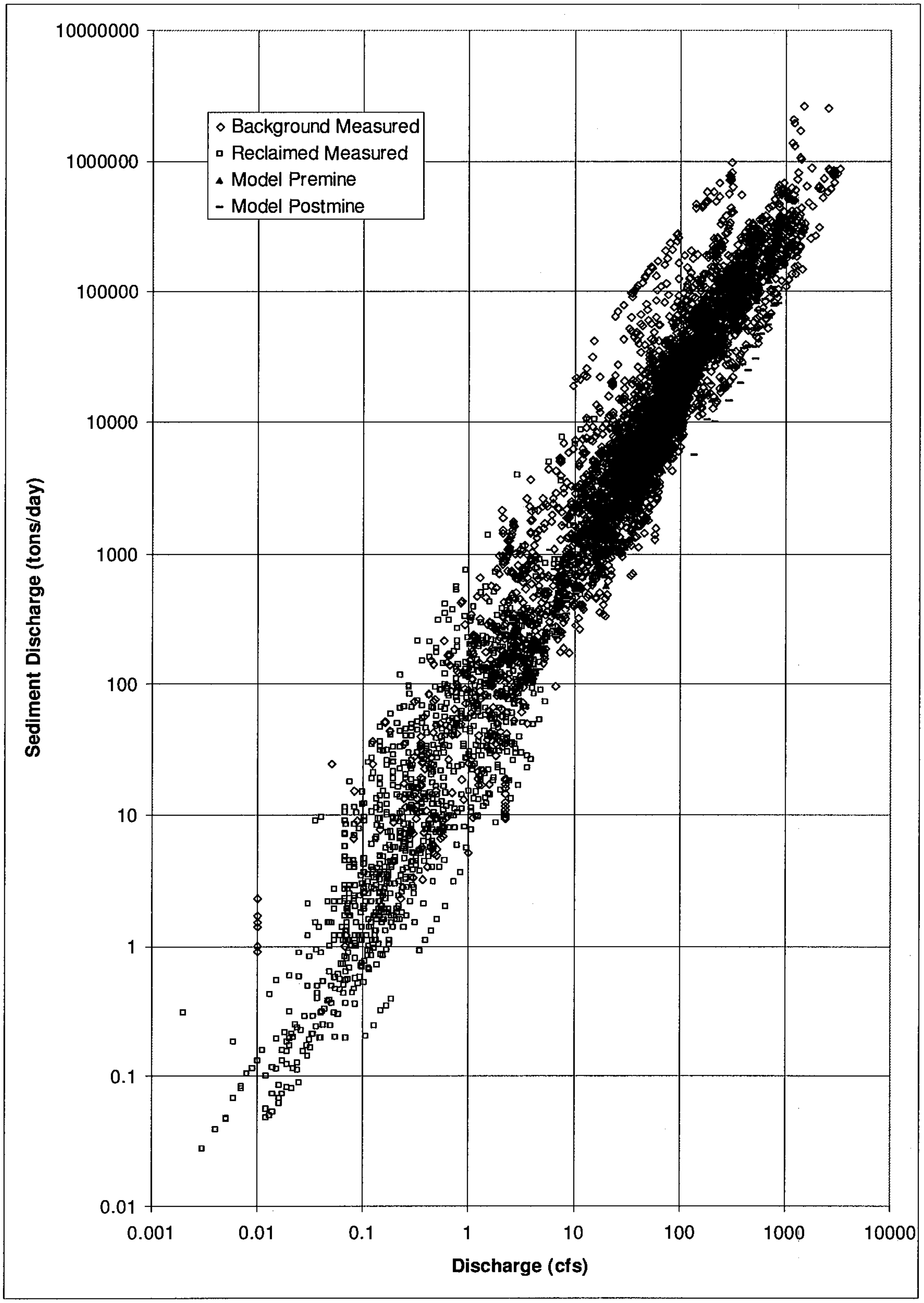

Figure 2.1. Observed and modeled sediment and water discharge.

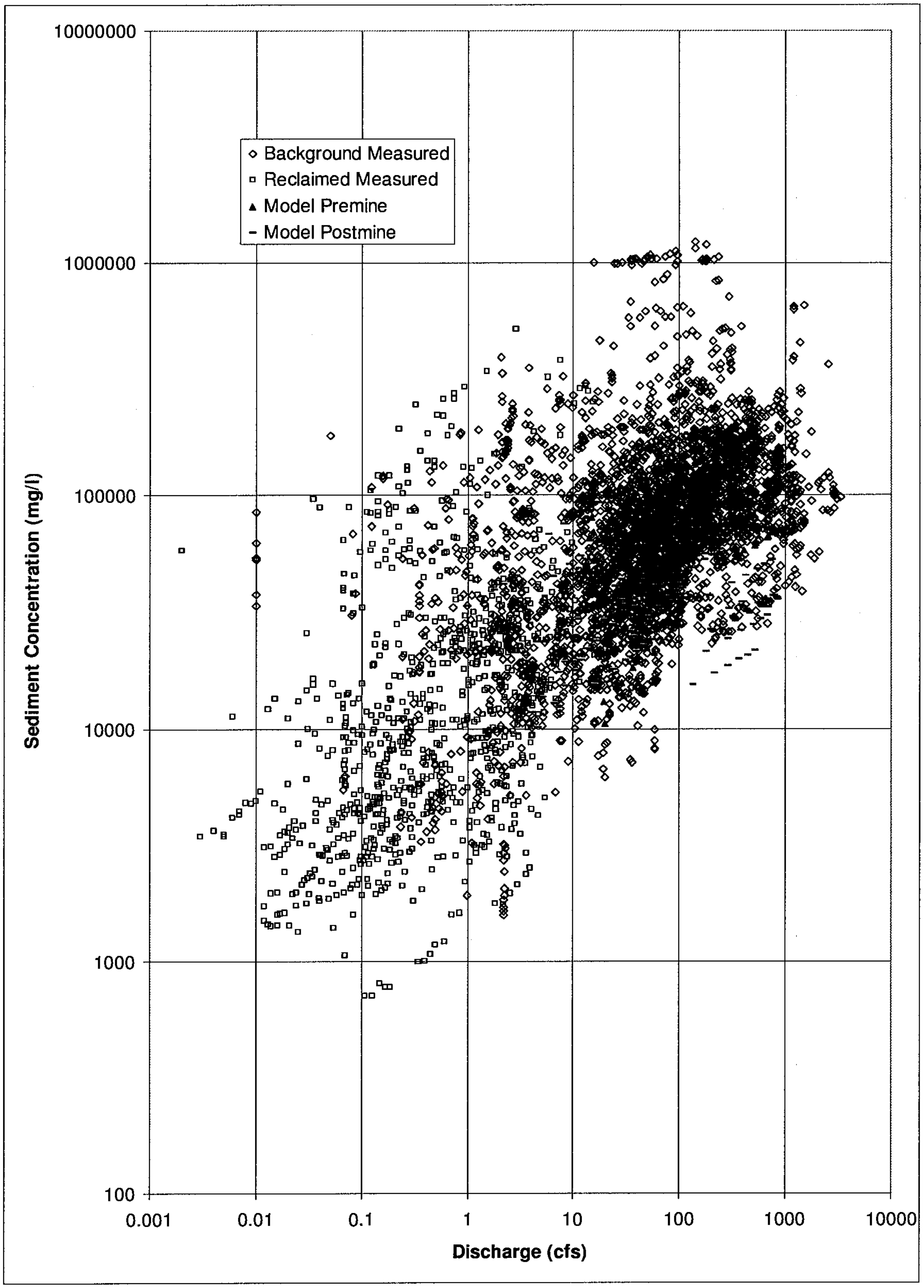

Figure 2.2. Observed versus modeled sediment concentration and discharge.

However, the sediment yield shown in Table 1.4 is the average annual amount of sediment leaving the J16 WA whereas the sediment discharge shown in Figure 2.1 is the peak rate of sediment in transport occurring in any channel represented by the data, whether the channel is located upstream or downstream of a pond. Therefore, it should be concluded that with or without a pond left in the postmine landscape that traps sediment or stores water, the mine reclamation is not contributing additional sediment to the receiving streams and sediment impacts to the prevailing hydrologic balance have been minimized.

Smith and Best (2000) analyzed the measured data (background and reclaimed) shown in Figure 2.1 to develop an approach that can be used to determine if channels in reclaimed areas have similar sediment transport characteristics as background channels. The method that they used was to develop Sen lines (Sen 1968) and confidence intervals around the data. The slope of the Sen line is a non-parametric statistic computed as the median slope of all possible slopes determined from pairing all the data points. The Sen line is drawn through the median coordinate of the data. Smith and Best first showed that the large channel flume data (background) and the small watershed background data could be combined. They concluded that since the data from one data set fall within the Sen line bounds of the other data set then the two data sets are merely extensions of each other and could be combined. Also, because the main channel and background small watershed site data could be combined, it indicated there is an unlimited supply of sediment and the channels are conveying sediment at (or near) capacity. The Sen line and bounds are shown with the background measured data in **Figure 2.3**.

They then plotted the reclaimed measured data (**Figure 2.4**) with the Sen line and bounds from the background data to show that the reclaimed data have the same characteristics even though the flow range of the measurements is lower. The data indicate that channel flows in this environment achieve the sediment transport capacity of the channel, whether in reclaimed or background conditions.

Using the same approach with the modeled data generated for the J16 WA, **Figures 2.5 and 2.6** show the pre- and postmine computed sediment transport rates with the Sen lines and bounds. One difference between the plots is that the measured data occur throughout the flow hydrograph whereas the modeled data are tabulated at the peak of the simulation flow hydrograph. The premine data plot (Figure 2.5) shows the data grouped around the Sen line and well within the bounds. The postmine data (Figure 2.6) plot most densely below the Sen line and are more scattered. On these graphs data plotting below the lines indicate that there is less sediment in transport for a given discharge. The lower sediment transport rates in the reclaimed data is probably the result of low gradient channels while low gradient channels in the premine condition are rare.

Several conclusions can be drawn from these data plots: (1) EASI model well replicates erosion and sediment transport processes at the mine site for background and reclaimed conditions, (2) all data show similar trends and are within the same bounds, (3) data trends indicate that channels are transporting sediment at or near capacity, and (4) amounts of sediment leaving the WA for postmine conditions are similar to premine conditions and within the range expected for the background conditions. Therefore, the overall conclusion is that the postmine reclaimed condition in J16 WA is not contributing additional suspended solids to receiving streams, and related impacts to the hydrologic balance have been minimized.

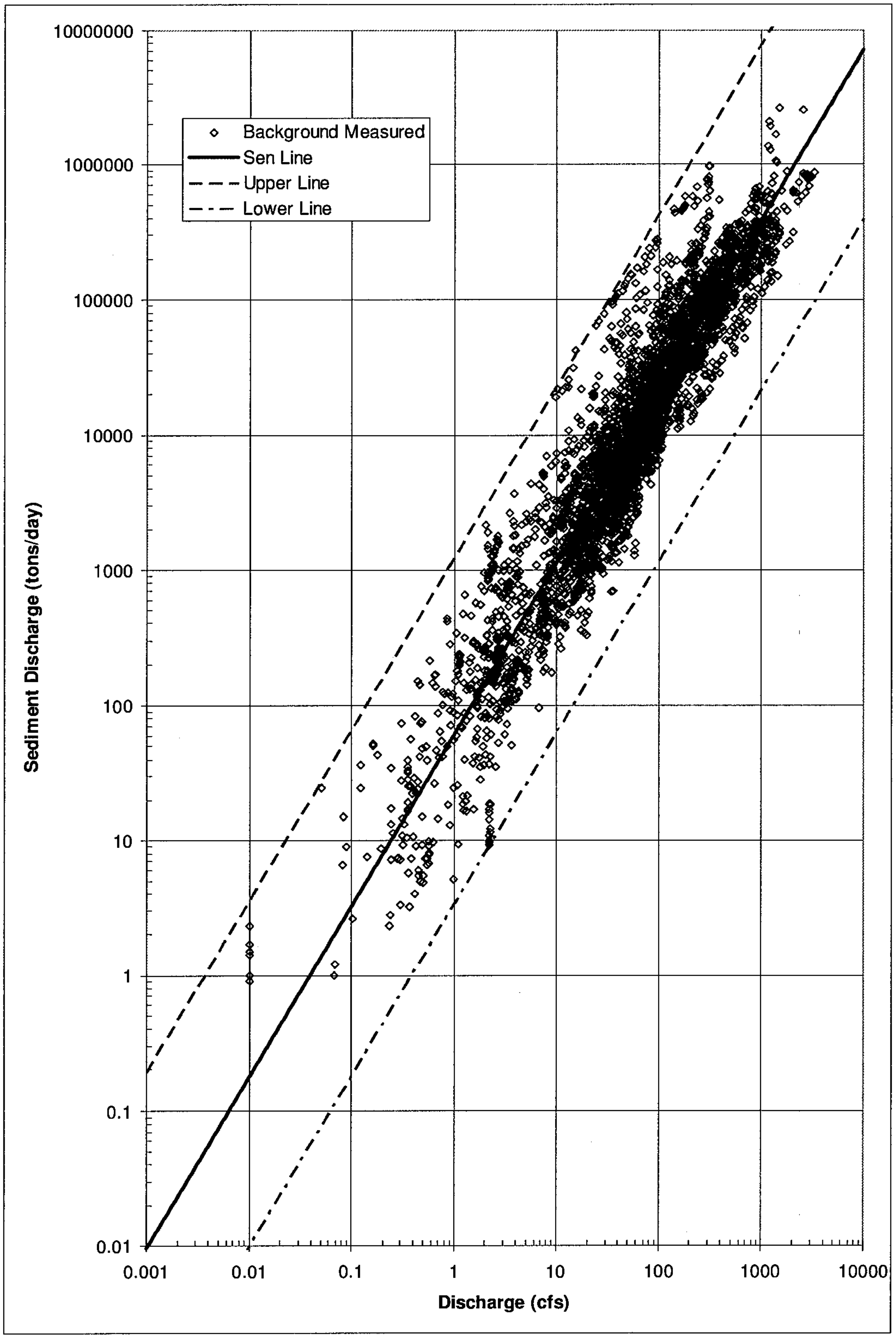

Figure 2.3. Background measured sediment and water discharge with Sen lines.

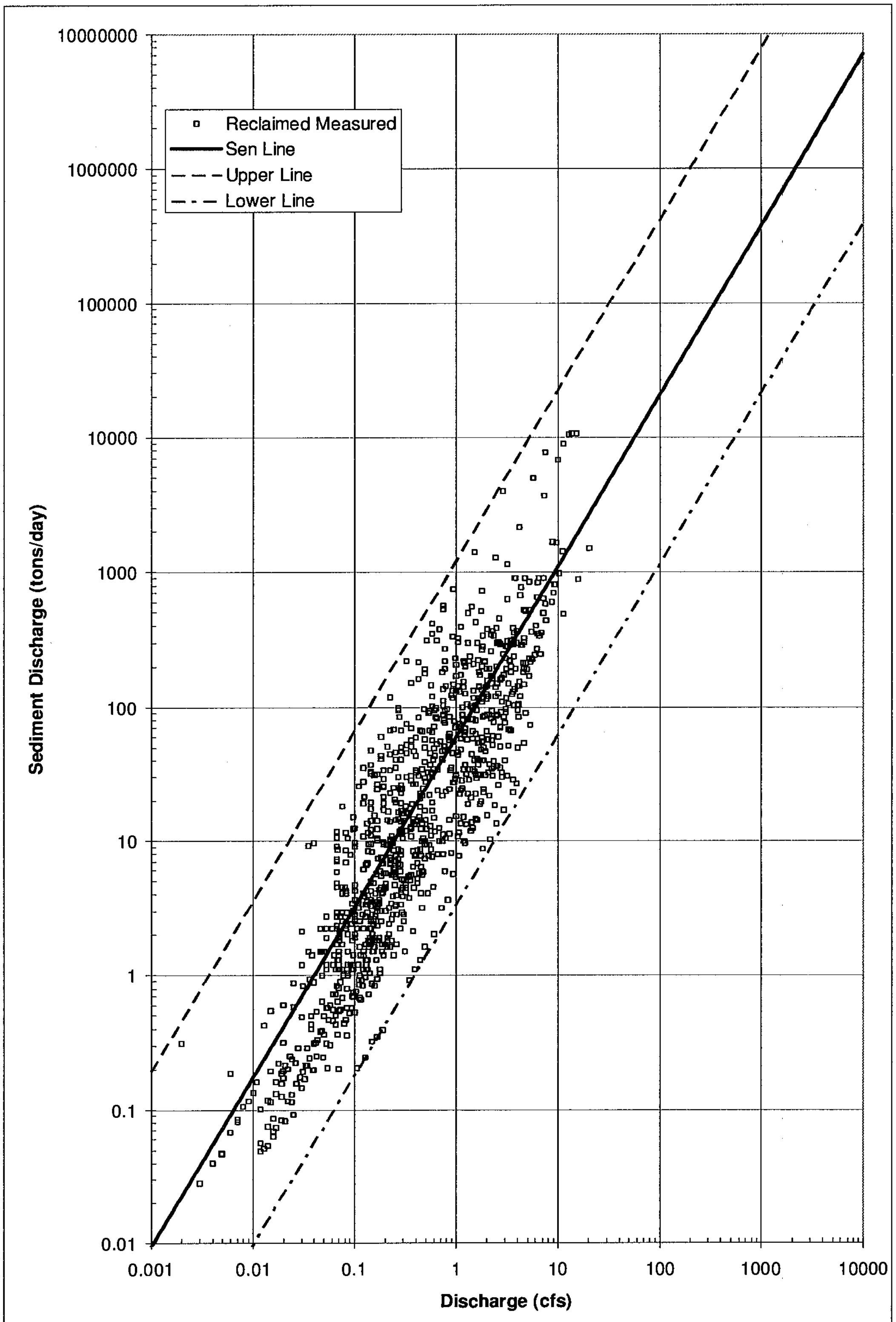

Figure 2.4. Reclaimed measured sediment and water discharge with Sen lines.

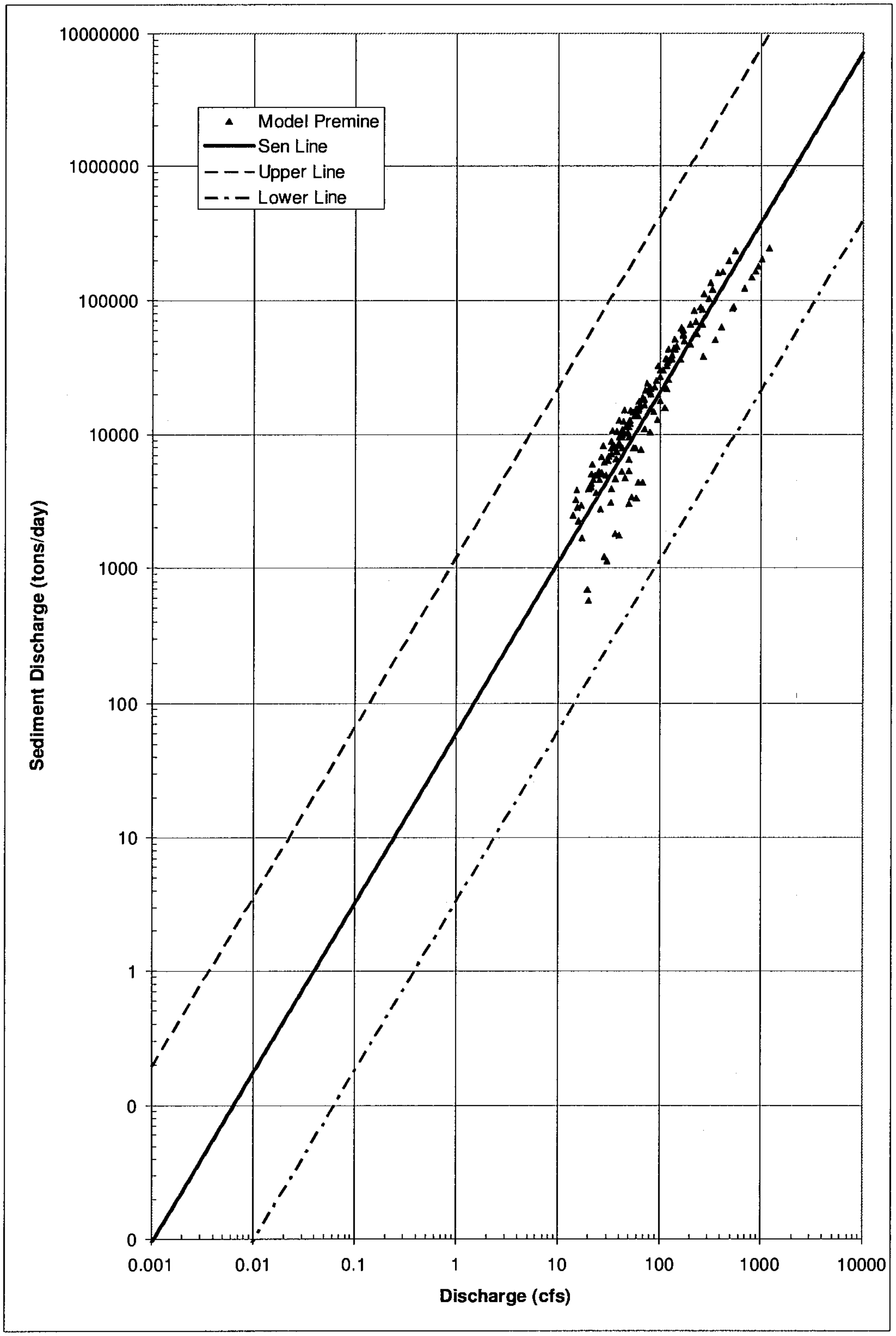

Figure 2.5. Modeled premine sediment and water discharge for the J16 WA with Sen lines.

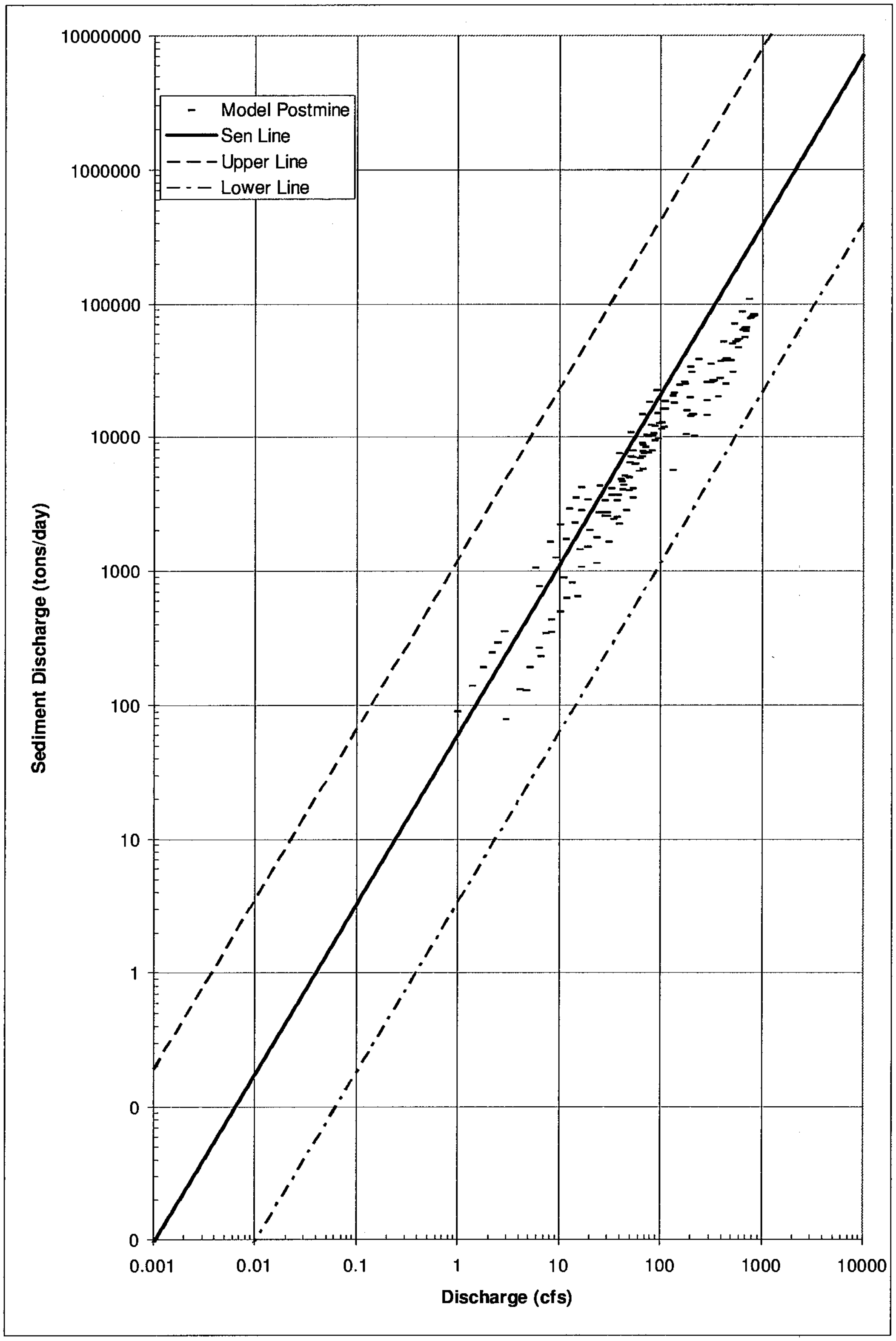

Figure 2.6. Modeled postmine sediment and water discharge for the J16 WA with Sen lines.

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EXHIBIT 1
Postmine Topography

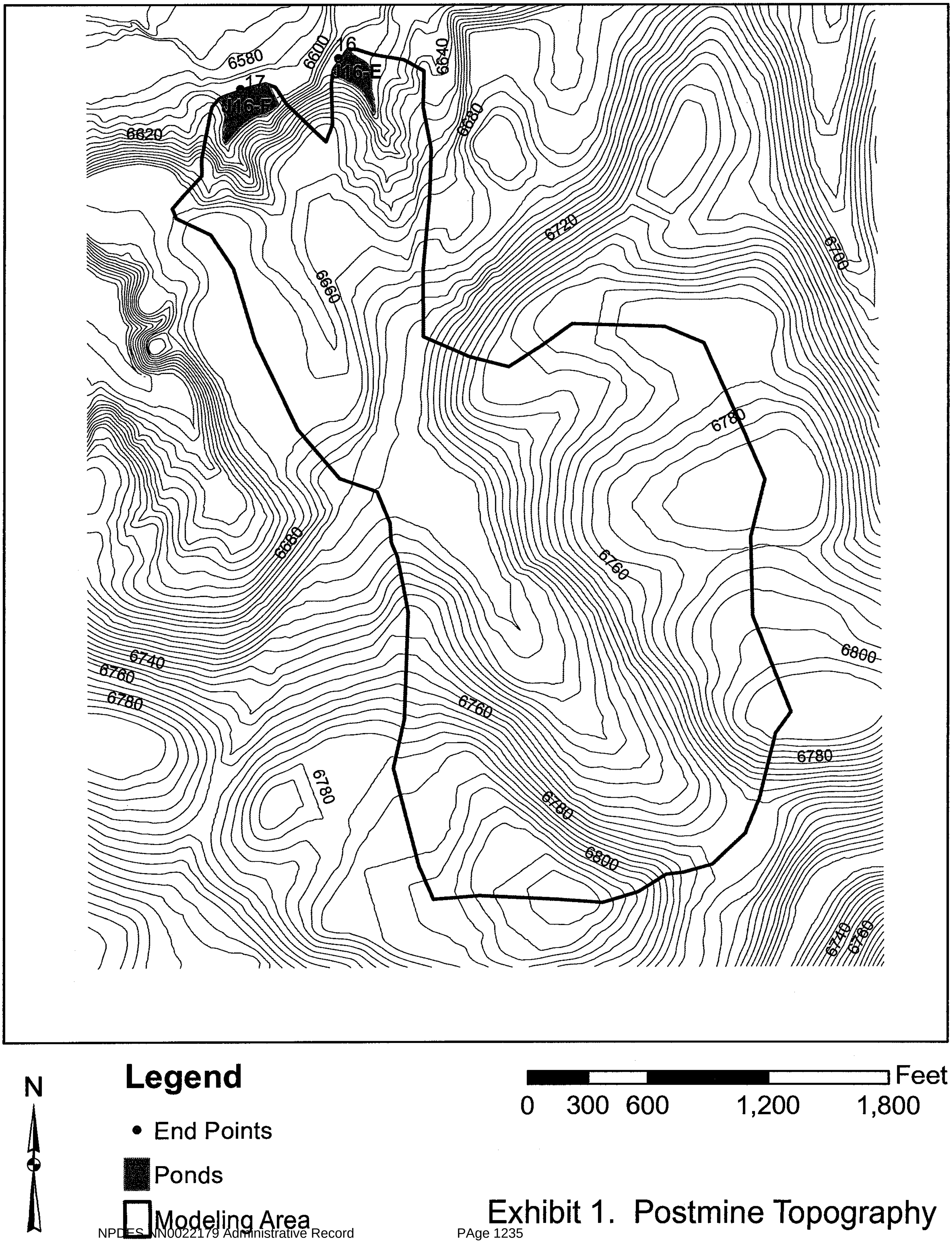
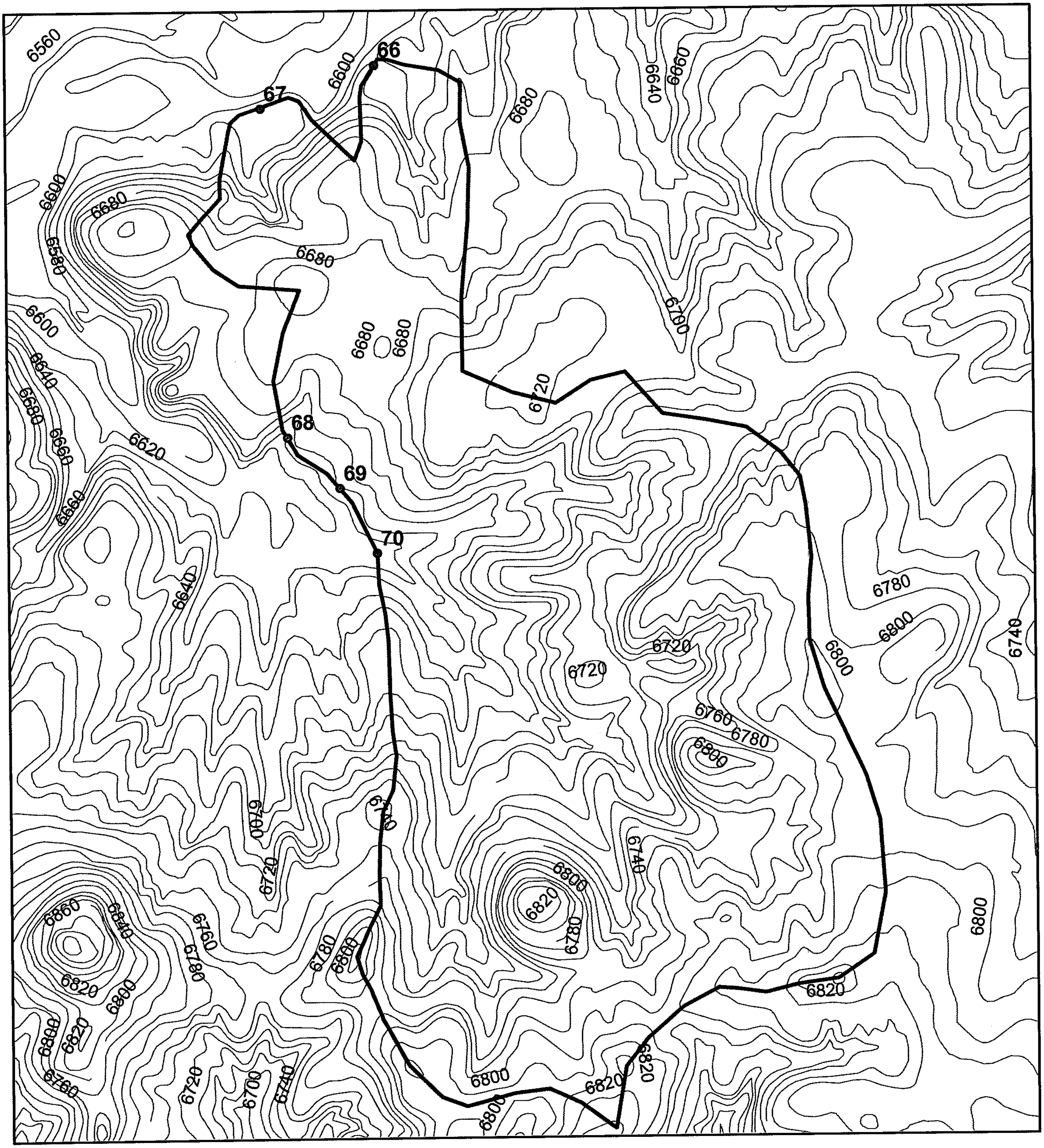


Exhibit 1. Postmine Topography

EXHIBIT 2
Premine Topography



N

0 300 600 1,200 1,800 Feet

Legend

- End Points
- Modeling Area

Exhibit 2. Premine Topography

Appendix 4

Surface Water Modeling of the Reclaimed J21-D and J21-E Watershed Area at Kayenta Mine

SURFACE WATER MODELING OF THE RECLAIMED J21-D AND J21-E WATERSHED AREA AT KAYENTA MINE

Prepared for

Peabody Western Coal Co.
Highway 160, Navajo Route 41
Kayenta, Arizona 86033

AYRES ASSOCIATES

SURFACE WATER MODELING OF THE RECLAIMED J21-D AND J21-E WATERSHED AREA AT KAYENTA MINE

Prepared for

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Highway 160, Navajo Route 41
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Ayres Project No. 32-1304.00
PEAB-J21.DOC

August 2008

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1. RECLAIMED PARCEL MODELING

1.1 Introduction

The objective defined by PWCC for this project is to use a previously calibrated and validated runoff and erosion model (EASI, Zevenbergen et al. 1990; WET 1990) for the Black Mesa and Kayenta Mines to predict mean annual runoff and sediment yields from the reclaimed J21-D and J21-E watersheds. This objective included computation of runoff and sediment yields under premine conditions for the same area. All soils and rainfall input to the model are to be taken from models calibrated in the previous study (RCE 1993). The input variables that were calibrated to the mine areas and used in this study include soil infiltration parameters, erodibility parameters, and the grain size distribution. Parameters that are specific to this study are vegetative canopy and ground cover percentages from data collected on site.

The model calibration was conducted in a previous study (RCE 1993) using data obtained from instrumented watersheds and small hillslope plots collected under natural rainfall conditions. For a detailed discussion of data collection and model calibration, please refer to the previous study (RCE 1993).

1.2 Background

The J21-D and J21-E Watershed Area (WA) that is the focus of this project was reclaimed in 2002. The fundamental purpose of this study was to quantify the expected behavior and hydrologic response of the reclaimed areas above each pond relative to the conditions that existed prior to the occurrence of mining activities.

Runoff and sediment yield response from the reclaimed lands should be managed by implementing Best Management Practices (BMP's) in conjunction with an OSM approved sediment control plan in order to not adversely impact the prevailing hydrologic balance and to limit additional contributions of suspended sediment to streamflow or runoff outside the mine permit areas. BMP's include regrading, replacing salvaged topsoil, revegetation, and other controls such as riprapped channel bottoms, check dams, and where practicable, contour terraces. The natural watersheds on the mesa contribute significant quantities of sediment to the channel system. It is expected that the postmine condition will also produce comparable amounts of sediment without adverse impact on the hydrologic balance.

This section describes the data and procedures used to evaluate the J21 WA. This area was modeled to determine the average annual hydrologic response following the completion of reclamation activities taking into account BMP's implemented as part of the reclamation process. Infiltration, runoff, and erosion processes from both hillslopes and channels within the J21 WA were modeled using EASI. Results were determined for concentration points at the outlets of the reclaimed watersheds, which correspond to the embankments associated with Ponds J21-D and J21-E. The locations of these points are shown in **Exhibit 1**. Modeling was also conducted to determine hydrologic response under premine conditions based on the topography, soils, cover, and other conditions that typified the undisturbed watersheds draining to each concentration point. **Exhibit 2** shows the modeling endpoints for the premine J21 WA.

1.3 Data

1.3.1 Soils

Soils data used for the current study (J21 WA) were based on data developed from the calibration of models used in the previous study for Coal Resource Areas (CRAs) N1/N2 and J27 (RCE 1993). The composition of postmine soil in the current study is depicted along with the composition of postmine soils from the previous study in **Figure 1.1**. This figure shows that the soil composition of WA J21 is very similar to soils evaluated during model calibration. Therefore, the soil properties developed in the previous study are valid for this modeling project. These properties include calibrated parameters, such as infiltration and erodibility coefficients, and measured soil size distributions. **Table 1.1** lists the premine and postmine soils data used during EASI modeling of WA J21.

1.3.2 Vegetation

Vegetative cover data representative of both pre- and postmine conditions in WA J21 were supplied by PWCC. For the premine condition, land was characterized as being covered by sagebrush or pinon juniper. The spatial distribution of vegetative cover for the J21 WA premine condition appears in **Figure 1.2**. Average cover properties for CRAs N1/N2 and J27 of the previous study and WA J21 of the current study appear in **Table 1.2**. For the postmine condition, the reclaimed area was assigned the postmine cover type and the unmined area was assigned the same cover type as the premine condition. **Table 1.3** lists the pre- and postmine vegetative cover data used in the EASI model runs generated for the J21 WA. Note that if a unit contained significant portions of both sagebrush and pinon juniper cover types, it was classified as half pinon juniper and half sagebrush.

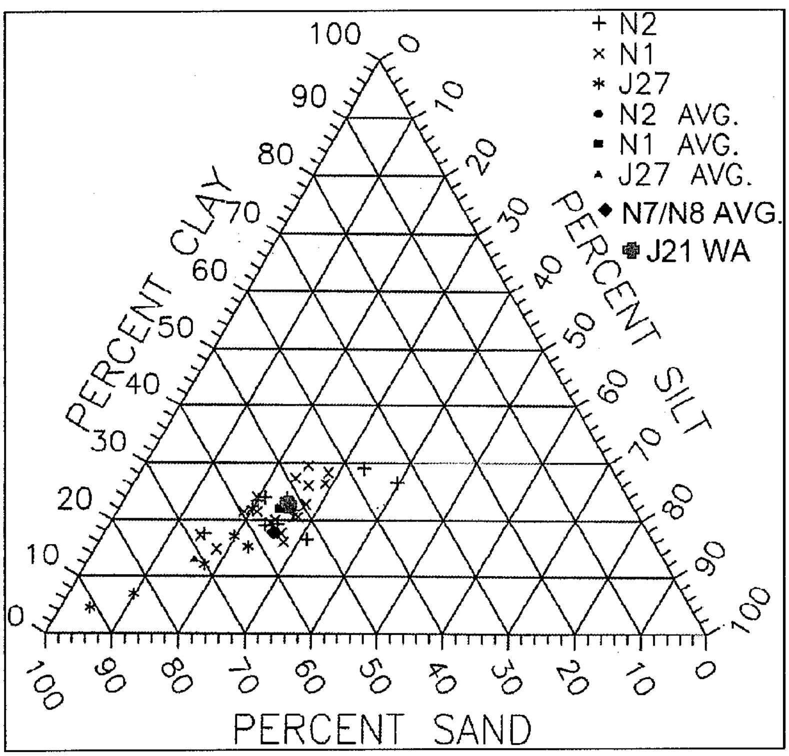

Figure 1.1. Reclaimed area soils trilinear graph.

Table 1.1. Soils Data.			
Condition	Premine	Postmine	Rock Chutes
Rainfall detachment	0.005	0.005	0
Overland flow detachment	0.44	0.44	0
Channel flow detachment	0.5	0.5	0
Initial soil moisture, %	70	70	70
Final soil moisture, %	90	90	90
Soil porosity, %	45	45	46
Temperature, *F	70	70	70
Hydraulic conductivity, in/hr	0.23	0.29	0.3
Capillary suction, in	3.7	2.6	2.6
	Particle Size Distribution (all conditions)		
	Size, mm	% Finer	
	0.001	0	
	0.004	18.0	
	0.016	27.4	
	0.062	36.6	
	0.125	56.2	
	0.250	64.3	
	0.500	72.4	
	1.000	80.5	
	2.000	88.6	
	4.000	92.4	
	16.000	100	

1.3.3 Topography

Pre- and postmine topography was supplied by PWCC in the form of ArcGIS geodatabase. Basin delineations, hillslope delineations, subwatershed delineations, as well as areas, slopes, and lengths of all units of the study area were defined and calculated using ArcGIS software. **Figures 1.3 and 1.4** show the watershed delineation and numbers assigned to the basins used in the EASI model for the post- and premine conditions, respectively. Channel dimensions input to EASI were based on the topography supplied and limited field observations.

1.4 Methodology

Runoff and sediment yield in the semiarid western United States is largely governed by the occurrence of high-intensity, short-duration rainstorms of limited areal extent (Renard and Simaton 1975). Research has indicated that relatively few events may produce the greatest erosion (e.g., Hjelmfelt et al. 1986 reported that only 3 to 4% of rainfall events accounted for 50% of long-term sediment yields). Although there is perhaps a relatively limited physical basis for definition of an "average annual" runoff or sediment yield in a semiarid environment due to the extreme variability in response and importance of single infrequent events, such a term does provide a useful basis for long-term comparison between reclaimed and undisturbed conditions.

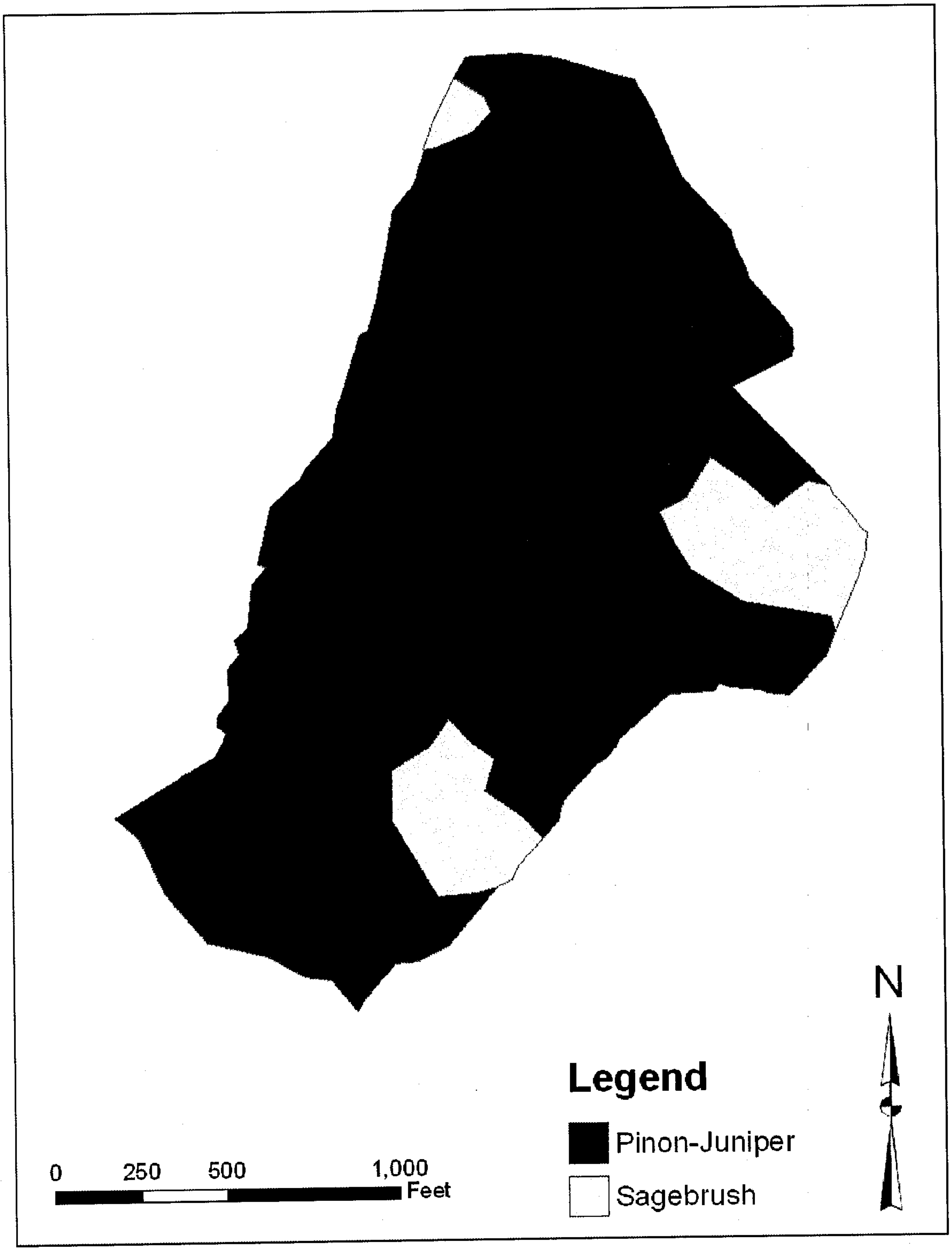

Figure 1.2. Spatial distribution of vegetative cover types for WA J21 premine condition.

Table 1.2. Cover Sampling Data.								
Area	Condition	Cover Type	Nonstratified Vegetation Cover (%)	Vegetation Canopy Cover (%)	Vegetation Ground Cover (%)	Litter* (%)	Rock (%)	Total Ground Cover (%)
N1/N2	Postmine	Postmine	25.6	1.4	24.2	13.6	4.2	41.9
J21 WA	Postmine	Postmine		0.3	33.2	19.1	13.4	65.6
N1/N2/J27	Premine	Pinon Juniper	32.7	31.1	3.0	44.0	19.7	66.7
J21 WA	Premine	Pinon Juniper		16.8	3.9	28.8	16.7	49.3
N1/N2	Premine	Sagebrush	25.1	16.0	10.3	25.3	18.1	53.7
J27	Premine	Sagebrush	30.6	9.7	22.0	24.0	1.6	47.6
J21 WA	Premine	Sagebrush		1.7	15.5	30.6	1.7	47.8

*Including standing dead litter

Table 1.3. Cover Data for J21-D and J21-E Watersheds.				
Condition	Pinon Juniper	Sagebrush	Half Pinon Juniper-Half Sagebrush	Postmine
Canopy cover, %	16.8	1.7	9.3	0.3
Ground cover, %	49.3	47.8	48.5	65.6
Canopy storage, in	0.05	0.05	0.05	0.05
Ground storage, in	0.05	0.05	0.05	0.05
Depression storage, in	0.03	0.03	0.03	0.03
Impervious area, %	0	0	0	0
Manning n	0.07	0.07	0.07	0.05

To make comparisons between reclaimed lands and associated undisturbed lands at the Black Mesa Mining Complex on the basis of average annual sediment yield, a procedure was used that considers the importance of infrequent storm events in defining sediment yield in the semiarid west. First, however, the site-specific rainfall data available for the Black Mesa Mining Complex were used to evaluate the frequency and magnitude of the measured events relative to existing predictions for rainfall depth-duration (Miller et al. 1973). The analysis of the rainfall data was performed as part of a previous study of the N1/N2 and J27 CRAs (Resource Consultants and Engineers 1993).

Comparisons between runoff and sediment yield from undisturbed and reclaimed areas in WA J21 were developed for specific modeling endpoints shown in Exhibits 1 and 2. Mining and reclamation activities did not exactly replicate the topography, drainage network, or drainage areas that existed prior to mining. Consequently, direct comparisons of total runoff and sediment yield cannot be made between undisturbed and reclaimed response at a given point in a watershed. Comparisons were made on the basis of unit rates of runoff (inches) and sediment yield (tons/acre) at the various modeling computation endpoints. Although the same disturbance boundary was used to model extents for both pre- and postmine conditions, the topographic differences that resulted after mining and reclamation occurred in the J21 WA dictated that some small areas would be included or excluded from the modeling. The total area modeled (combined area for both J21-D and J21-E watersheds) for premine conditions is 71.6 acres and for postmine conditions is 68.9 acres. The difference in area results from the sediment ponds in postmine conditions. The area bounded by the modeling boundary identified by PWCC as shown in Exhibits 1 and 2 is 71.6 acres.

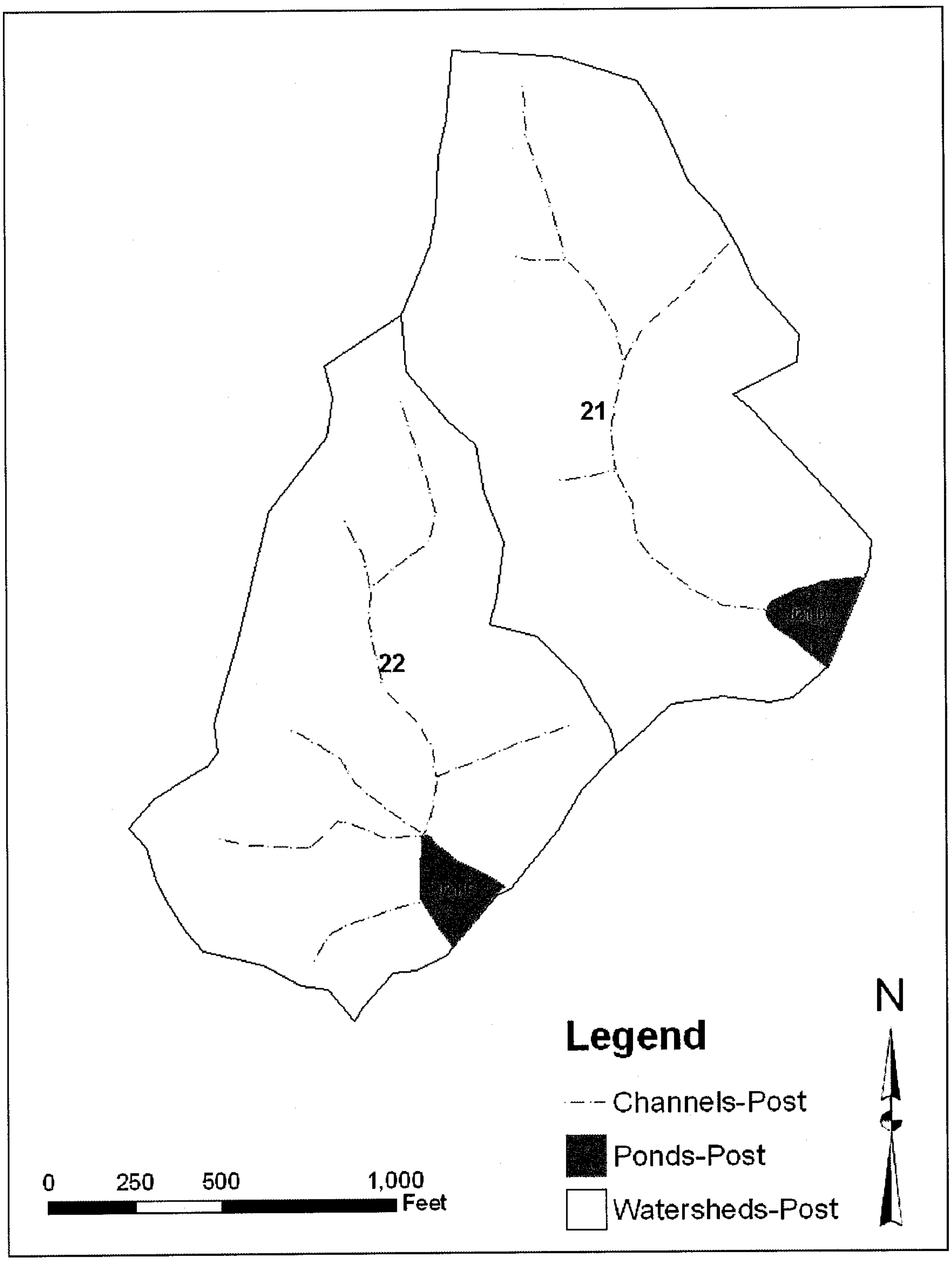

Figure 1.3. J21-D and J21-E postmine basins.

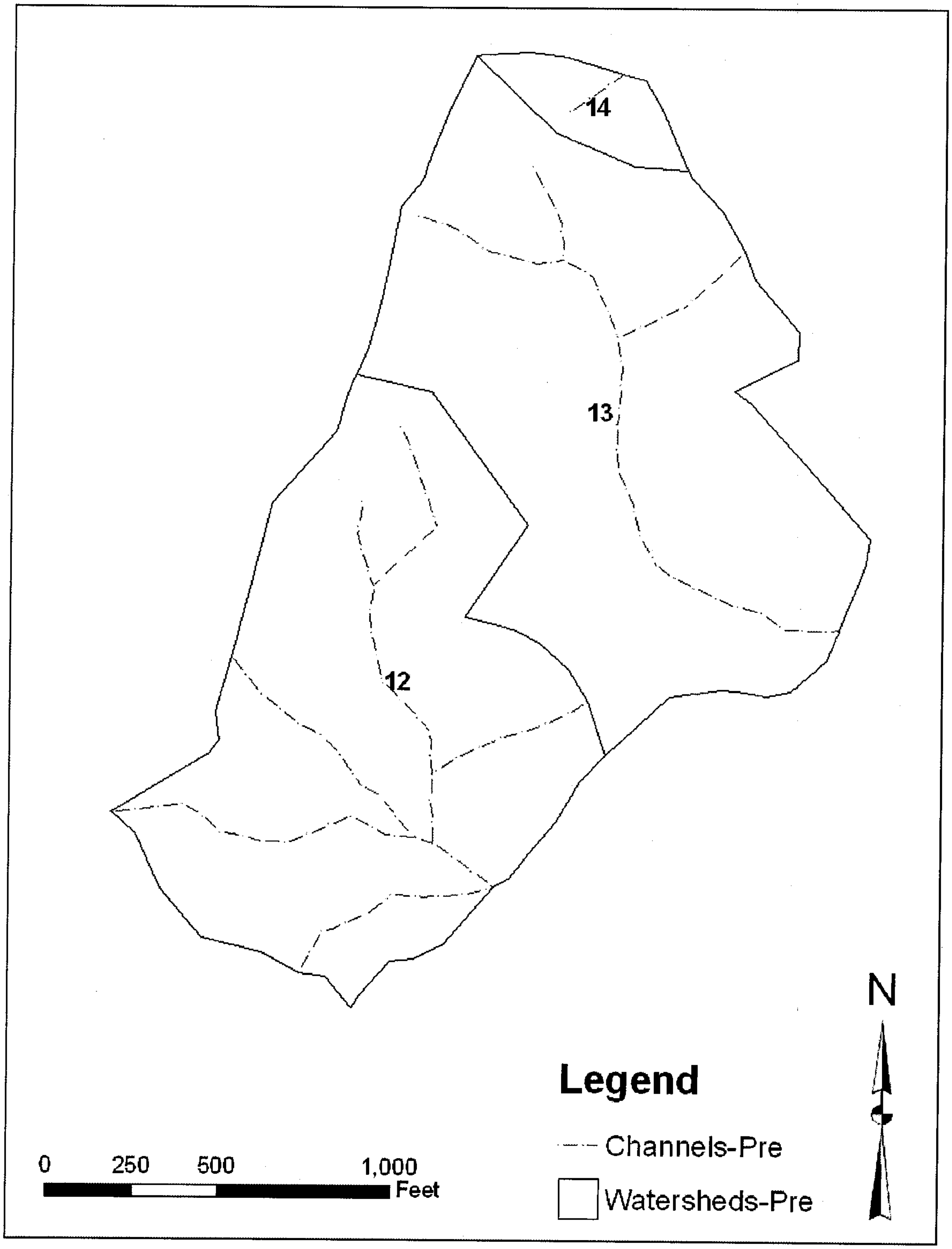

Figure 1.4. J21-D and J21-E premine basins.

1.4.1 Synthetic Rainfall

Synthetic storms of 2-, 5-, 10-, 25-, 50-, and 100-year return periods were used as input to the EASI model. Actual hyetographs were taken from the previous study (RCE 1993) and are based on both local data collection and the NOAA Atlas (Miller et al. 1973).

1.4.2 Computation of Average Runoff and Sediment Yield

The EASI model was used to evaluate runoff and sediment yield from a series of storm events having recurrence intervals of 2-, 5-, 10-, 25-, 50-, and 100 years. To define average annual conditions, the average annual runoff and sediment yield generated from storm events were computed using the commonly used equation of Lagasse et al. (1985).

1.5 Results

Figures 1.3 and 1.4 show the post- and premine basin delineations. Since the individual subareas differ in number, acreage and outlet locations, a direct comparison is not possible on a subarea basis. Therefore, the best way to compare the results is on an average basis for the WA. **Table 1.4** shows pre- and postmine drainage area, runoff, and sediment yield for the J21 WA. To consider the situation of pond removal for the postmine condition, the EASI model replaces a sediment pond with a channel, which lies near the location of the pond and discharges to the basin outlet. The channel is assumed to have a length equal to the pond's length and a slope similar to the outlet's natural slope. Runoff is defined as the total volume of water leaving the WA on an average annual basis and, therefore, does not include water stored in depression areas and ponds. For the premine condition, this is equal to the amount of water that drains off the hillslopes and subwatersheds because there are no ponds or significant depressions. For the postmine condition, this is equal to the amount of hillslope runoff less the amount stored in ponds. No ponds or significant depressions exist within the reclaimed J21 WA that was modeled. Similarly, the sediment yield is the amount of eroded material that leaves the WA on an average annual basis computed using the equation of Lagasse et al. (1985). The sediment yield is the production from the hillslope areas and erosion from the channels. The amount of erosion is the sediment yield from the hillslopes and subwatersheds only and does not include channel erosion, channel deposition or sediment trapped in ponds. Sediment yield can be greater or less than erosion, depending on the amount of channel erosion and the capacity of the channel network to convey sediment off the leasehold.

Table 1.4. Average Runoff and Sediment Yield Results.

Area	Condition	Drainage Area (ac)	Runoff (in)	Sediment Yield (t/ac/yr)
J21 WA	Premine	71.6	0.42	4.50
J21 WA	Postmine	68.9	0.42	4.12
J21-D	Premine	39.4	0.42	4.28
J21-D	Postmine	36.7	0.42	4.14
J21-E	Premine	32.2	0.42	4.77
J21-E	Postmine	32.2	0.42	4.10

For the postmine condition, the overall sediment yield is less than those in the premine condition. Sediment yield is slightly different from the premine amount, and runoff is the same as the premine amount. Only a small portion of J21 WA was disturbed, thus sediment yields for pre- and postmine conditions are close.

Table 1.4 also shows pre- and postmine drainage area, runoff, and sediment yield for two individual watersheds (J21-D and J21-E) within the J21 WA. Modeling results of individual watersheds are similar to the overall J21 WA.

1.6 Discussion

Table 1.5 gives an overview of the geometric properties of the pre- and postmine disturbed areas. Average properties for hillslopes and channels are similar because only a small portion of J21 WA was disturbed.

Table 1.5. Average Physical Properties of the J21 WA.

	Premine	Postmine
Total Area (ac)	71.6	68.9
Total Channel Length (ft)	7153	7066
Mean Channel Slope	0.1085	0.1200
Drainage Density (mi/mi^2)	12.1	12.4
Mean Hillslope Length (ft)	171	186
Mean Hillslope Gradient	0.1662	0.1703

2. COMPARISONS WITH MEASURED SEDIMENT TRANSPORT

As discussed in Section 1, PWCC has monitored flow and sediment on the main channels, principal tributaries and small watersheds within the leasehold. These data, along with the runoff plots, were used to calibrate the EASI model soil erodibility and infiltration input variables. **Figures 2.1** and **2.2** show sediment transport and sediment concentration versus discharge for measured unmined (background), measured reclaimed, WA J21's modeled unmined (premine) and modeled reclaimed (postmine) data. Although there is significant scatter shown in the data (as is expected with any sediment transport conditions), there are several conclusions that can be drawn from this data.

The open symbols in both figures depict measured data and whether the data were collected from reclaimed areas (the small watershed study) or from unmined or background surface water monitoring stations. The range of flows is generally greater for the background data but there is significant overlap between the two data sets between 0.1 and 100 cfs. This is because the reclaimed data are from small watersheds and the unmined data are from channels draining larger basins. These data show the same trend for sediment transport and sediment concentration over the entire range of flows and very close agreement in the area of discharge overlap. This, in itself, is strong evidence that (1) the sediment yields are channel transport capacity limited, (2) overlap of model predictions for both pre- and postmine conditions with measured data strongly indicate that EASI model predictions are representative and reasonable, and (3) sediment yields from reclaimed areas will not be additive to yields on the receiving streams.

The closed symbols depict data from WA J21's pre- and postmine EASI model runs. They represent data generated by EASI for both subwatersheds and channels for peak discharges resulting from 2-, 5-, 10-, 25-, 50-, and 100-year storms. Using the peak flows from extreme events results in discharges that generally exceed 10 cfs. The trend of the model-derived data is similar and the ranges of concentration and sediment transport are similar to the measured data and between pre- and postmine conditions.

The sediment discharge plot (Figure 2.1) shows a stronger trend because it is plotting discharge (sediment) against discharge (flow). This is expected because the sediment discharge does depend on flow discharge. The concentration plot (Figure 2.2) shows the two separate variables and, therefore, a less significant trend. PWCC believes that data measurement may have some influence on the scatter (outliers were removed), but the process variability is probably the major influence. The majority of the data, however, fall in a group centered on 100 cfs and 100,000 mg/l, both in the observed data and in the model results. These plots support the use of the EASI model, the results of the modeling, the conclusion that sediment yields from reclaimed areas are not additive to receiving stream sediment loads, and that sediment impacts to the prevailing hydrologic balance have been minimized.

From Figures 2.1 and 2.2 it is apparent that sediment loads and concentrations are dependent on the channel sediment transport capacity for both pre- and postmine conditions. Channel sources of sediment in this arid environment are virtually unlimited. Therefore, channel transport capacity and channel derived sediment limits and governs sediment yields from the small tributaries, large channels and the WA as a whole. The similarity of sediment discharge (or concentration) between pre- and postmine conditions appears to be inconsistent with the lower rates of sediment yield shown in Table 1.4.

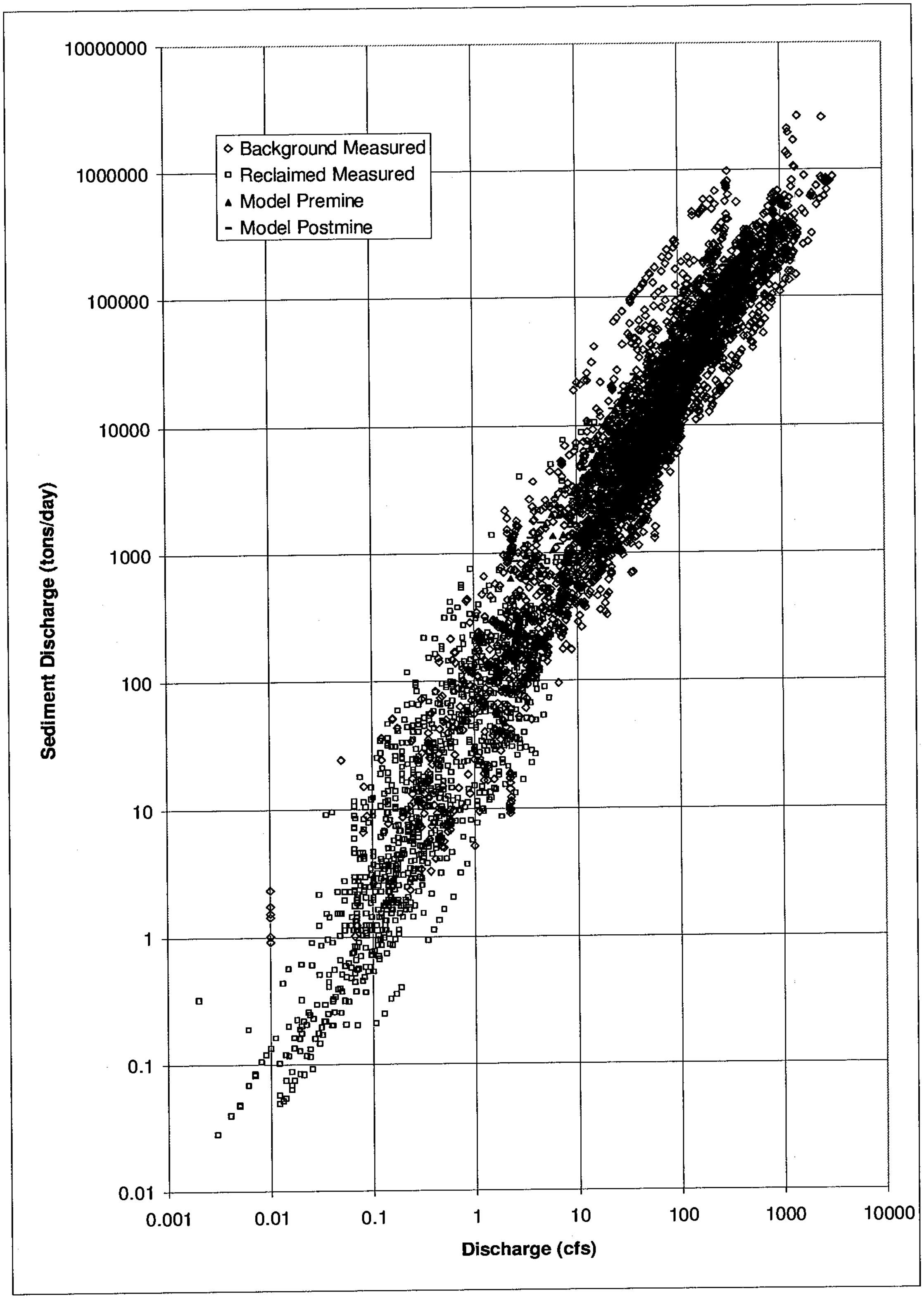

Figure 2.1. Observed and modeled sediment and water discharge.

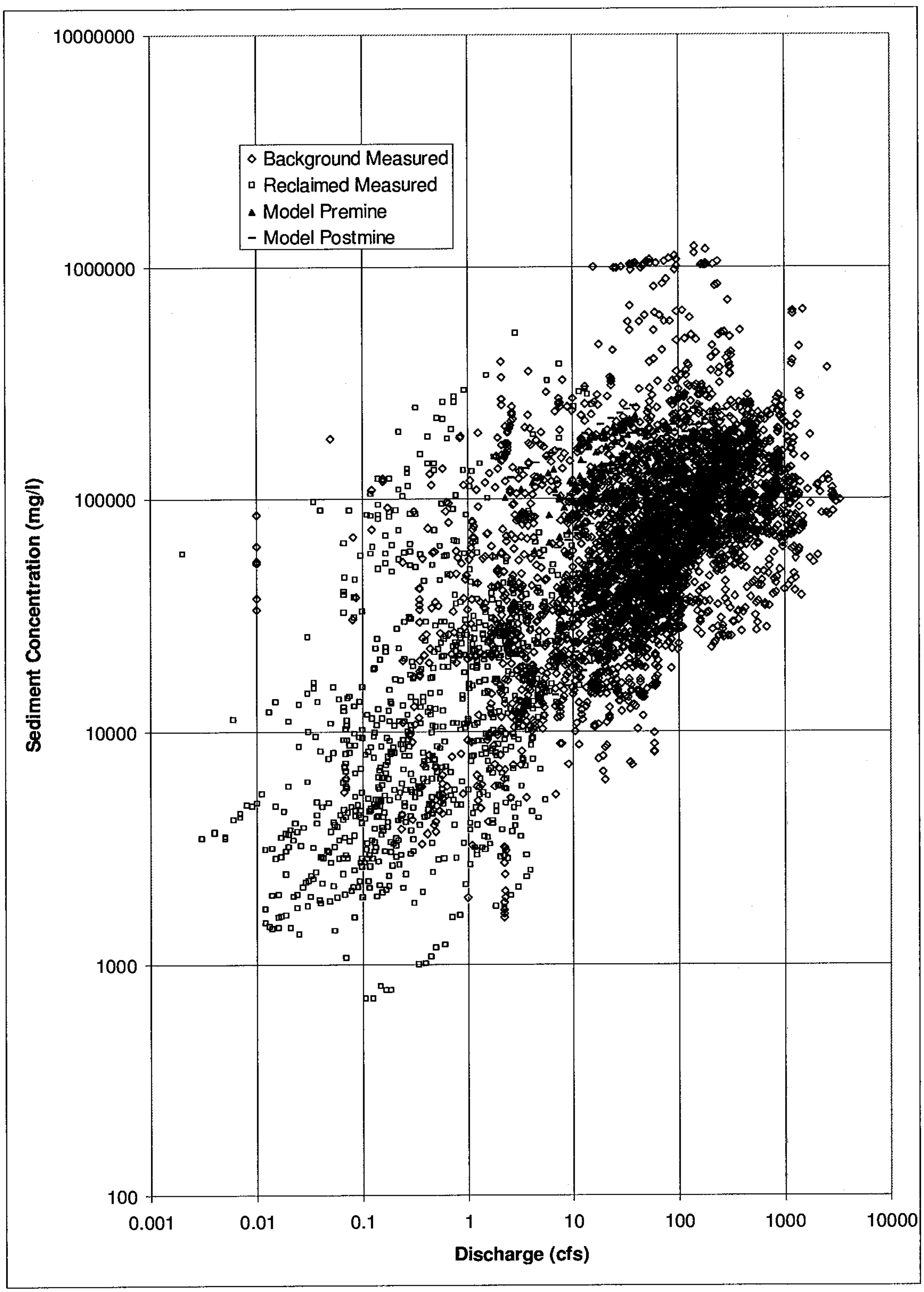

Figure 2.2. Observed versus modeled sediment concentration and discharge.

However, the sediment yield shown in Table 1.4 is the average annual amount of sediment leaving the J21 WA whereas the sediment discharge shown in Figure 2.1 is the peak rate of sediment in transport occurring in any channel represented by the data, whether the channel is located upstream or downstream of a pond. Therefore, it should be concluded that with or without a pond left in the postmine landscape that traps sediment or stores water, the mine reclamation is not contributing additional sediment to the receiving streams and sediment impacts to the prevailing hydrologic balance have been minimized.

Smith and Best (2000) analyzed the measured data (background and reclaimed) shown in Figure 2.1 to develop an approach that can be used to determine if channels in reclaimed areas have similar sediment transport characteristics as background channels. The method that they used was to develop Sen lines (Sen 1968) and confidence intervals around the data. The slope of the Sen line is a non-parametric statistic computed as the median slope of all possible slopes determined from pairing all the data points. The Sen line is drawn through the median coordinate of the data. Smith and Best first showed that the large channel flume data (background) and the small watershed background data could be combined. They concluded that since the data from one data set fall within the Sen line bounds of the other data set then the two data sets are merely extensions of each other and could be combined. Also, because the main channel and background small watershed site data could be combined, it indicated there is an unlimited supply of sediment and the channels are conveying sediment at (or near) capacity. The Sen line and bounds are shown with the background measured data in **Figure 2.3**.

They then plotted the reclaimed measured data (**Figure 2.4**) with the Sen line and bounds from the background data to show that the reclaimed data have the same characteristics even though the flow range of the measurements is lower. The data indicate that channel flows in this environment achieve the sediment transport capacity of the channel, whether in reclaimed or background conditions.

Using the same approach with the modeled data generated for the J21 WA, **Figures 2.5 and 2.6** show the pre- and postmine computed sediment transport rates with the Sen lines and bounds. One difference between the plots is that the measured data occur throughout the flow hydrograph whereas the modeled data are tabulated at the peak of the simulation flow hydrograph. The premine data plot (Figure 2.5) shows the data grouped above the Sen line and well within the bounds. The postmine data (Figure 2.6) plot most densely above the Sen line and are more scattered. On these graphs data plotting above the Sen line indicate that there is more sediment in transport for a given discharge.

Several conclusions can be drawn from these data plots: (1) EASI model well replicates erosion and sediment transport processes at the mine site for background and reclaimed conditions, (2) all data show similar trends and are within the same bounds, (3) data trends indicate that channels are transporting sediment at or near capacity, and (4) amounts of sediment leaving the WA for postmine conditions are similar to premine conditions and within the range expected for the background conditions. Therefore, the overall conclusion is that the postmine reclaimed condition in J21 WA is not contributing additional suspended solids to receiving streams, and related impacts to the hydrologic balance have been minimized.

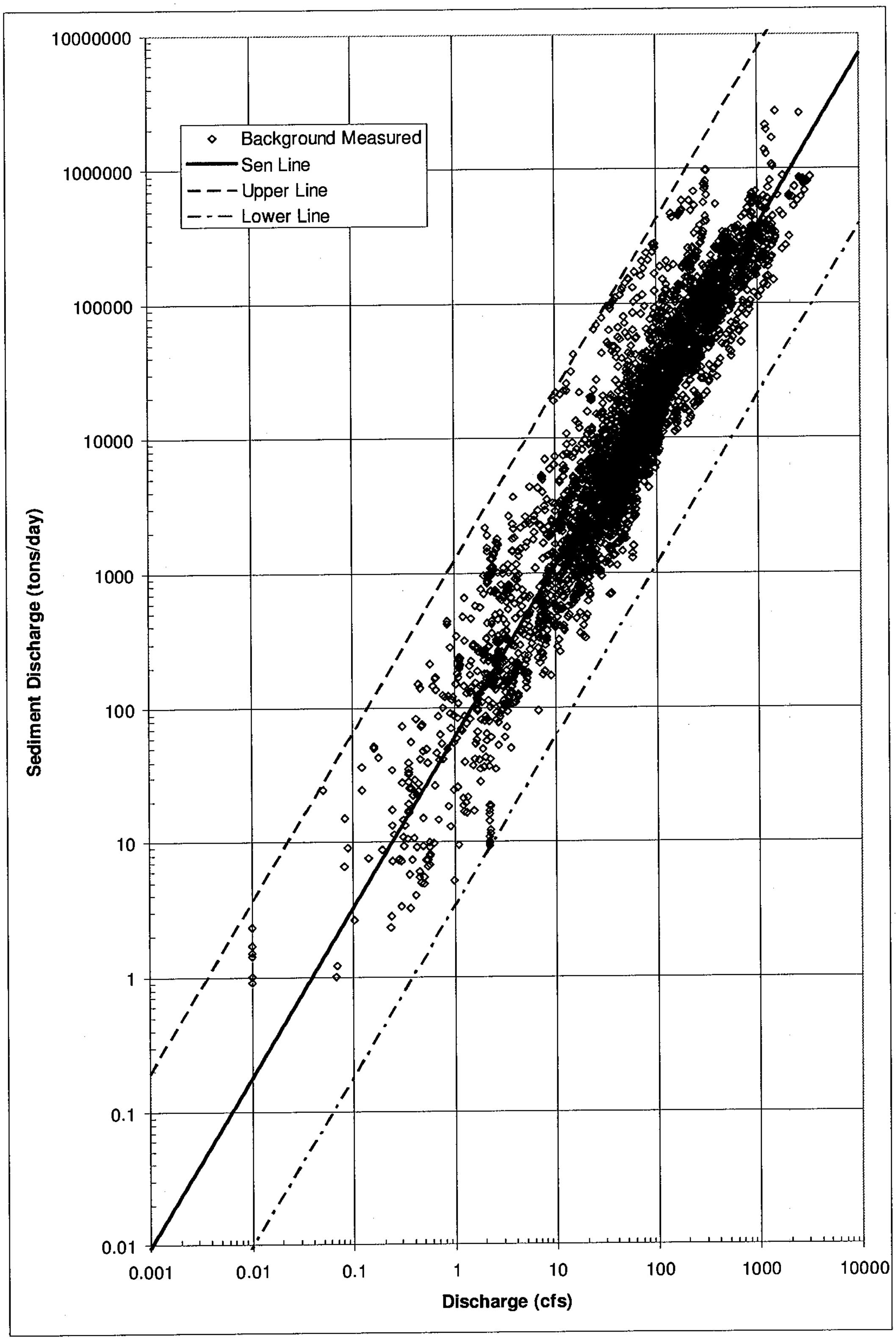

Figure 2.3. Background measured sediment and water discharge with Sen lines.

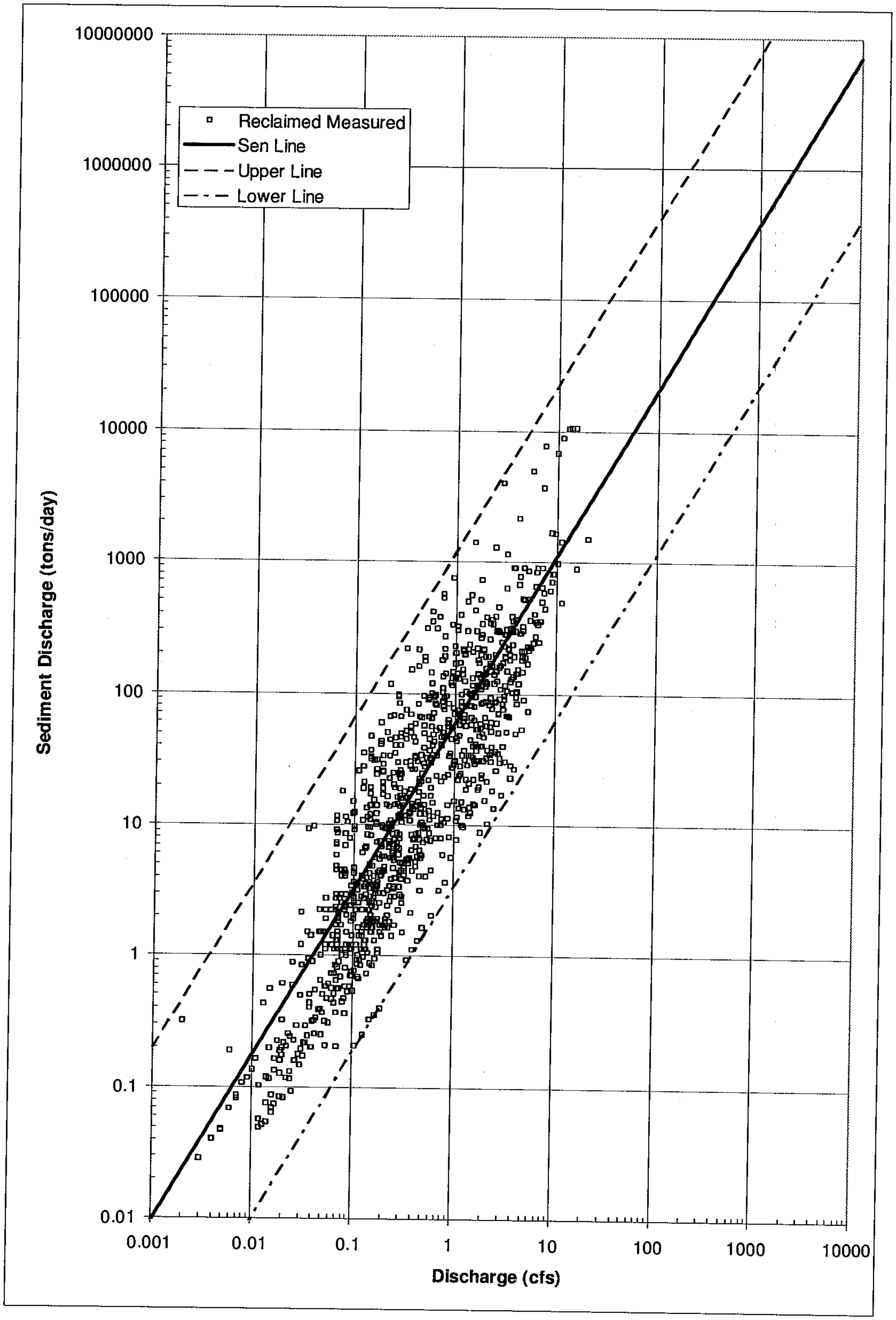

Figure 2.4. Reclaimed measured sediment and water discharge with Sen lines.

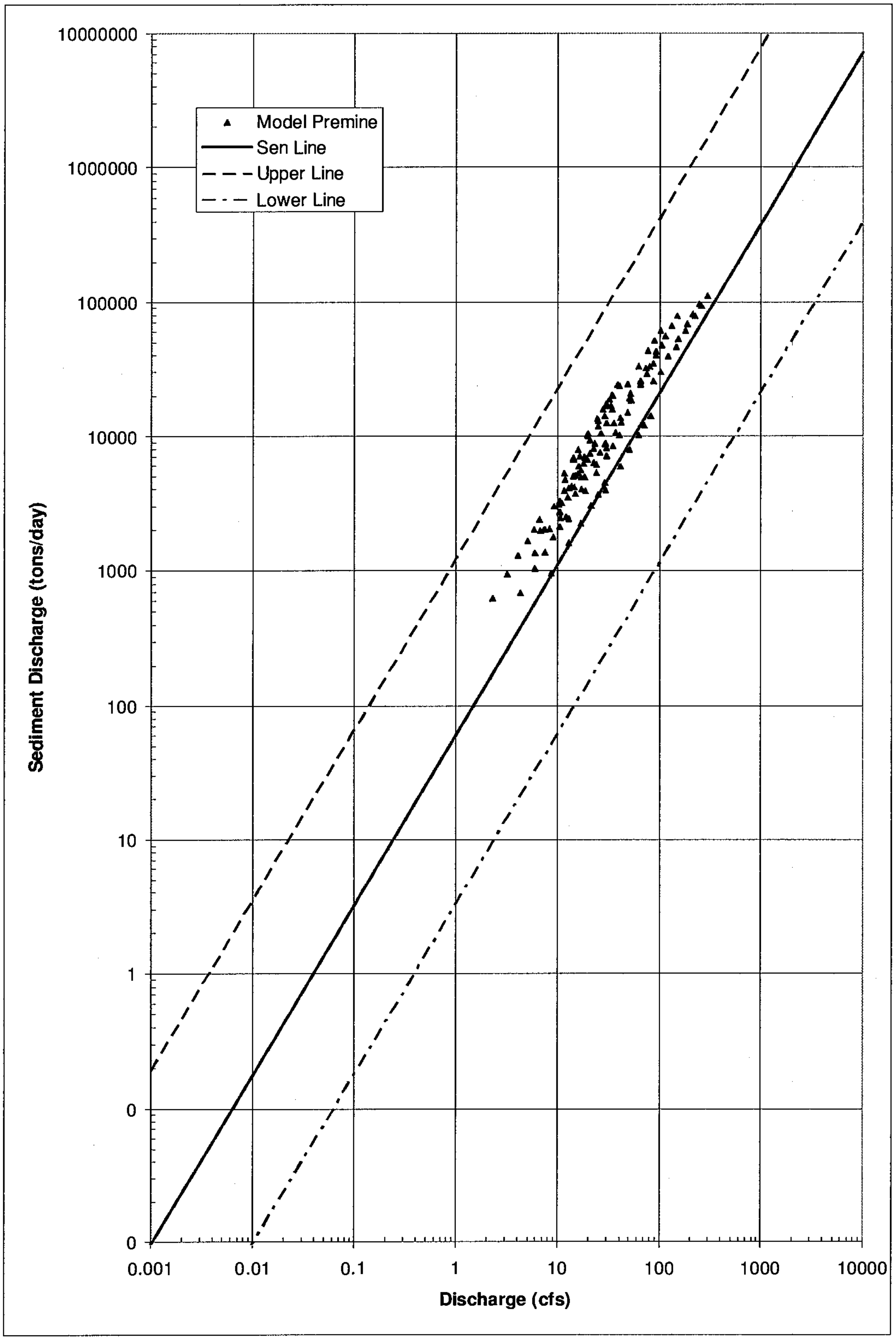

Figure 2.5. Modeled premine sediment and water discharge for the J21 WA with Sen lines.

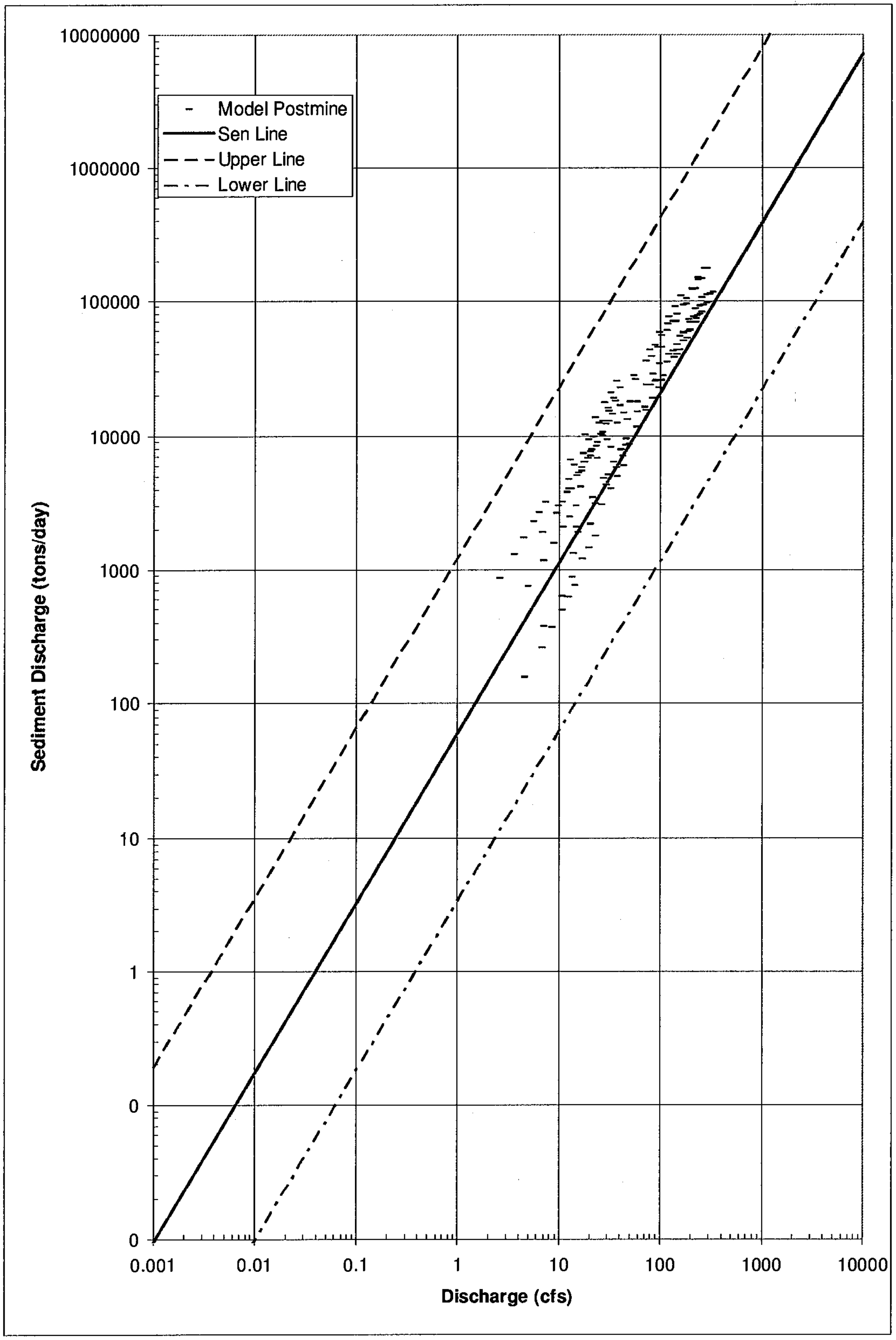

Figure 2.6. Modeled postmine sediment and water discharge for the J21 WA with Sen lines.

3. REFERENCES

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Zevenbergen, L.W., Peterson, M.R., and Watson, C.C., 1990. Computer simulation of watershed runoff and sedimentation processes, Proceedings of the Billings Symposium; Planning, Rehabilitation and Treatment of Disturbed Lands.

EXHIBIT 1
Postmine Topography

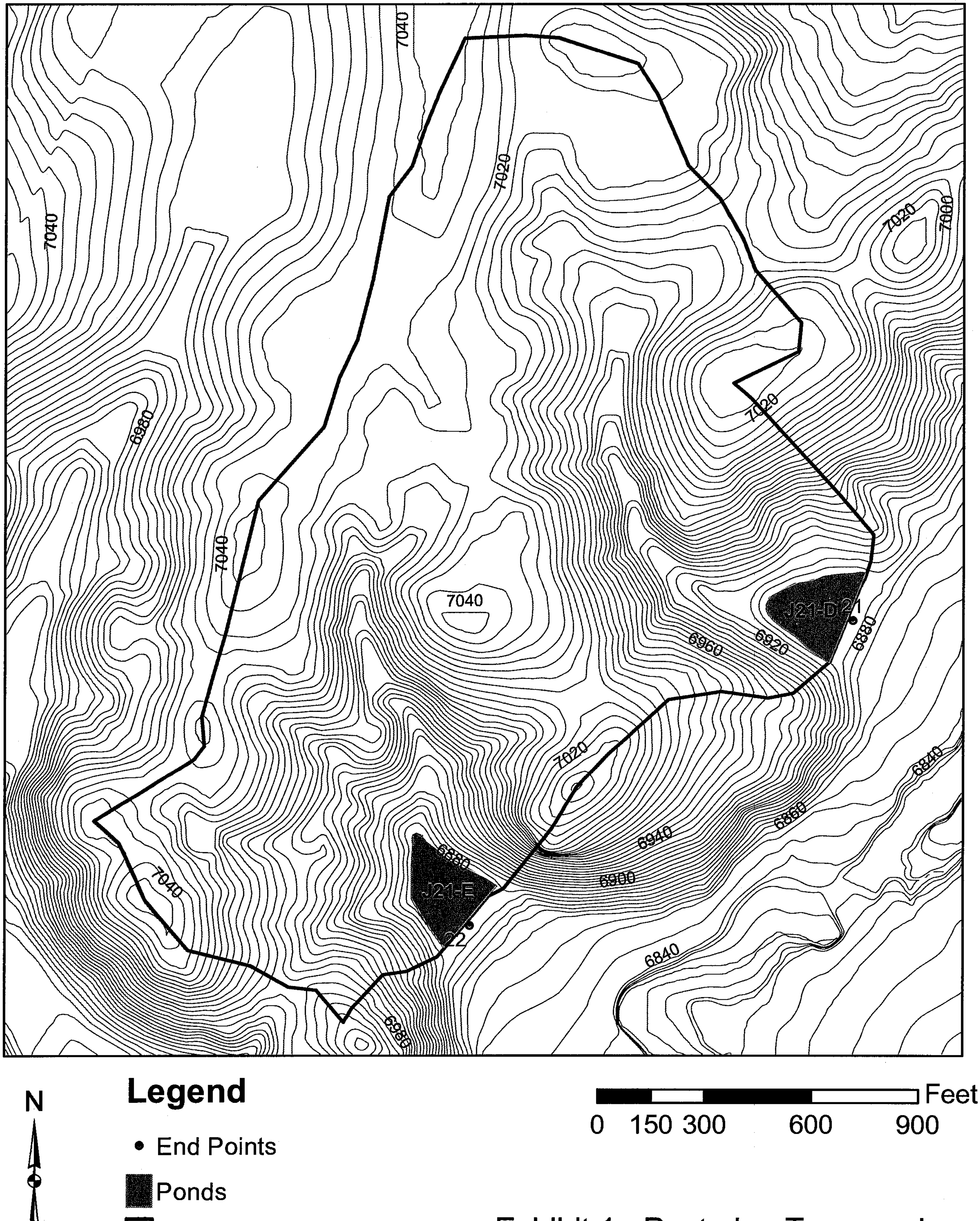
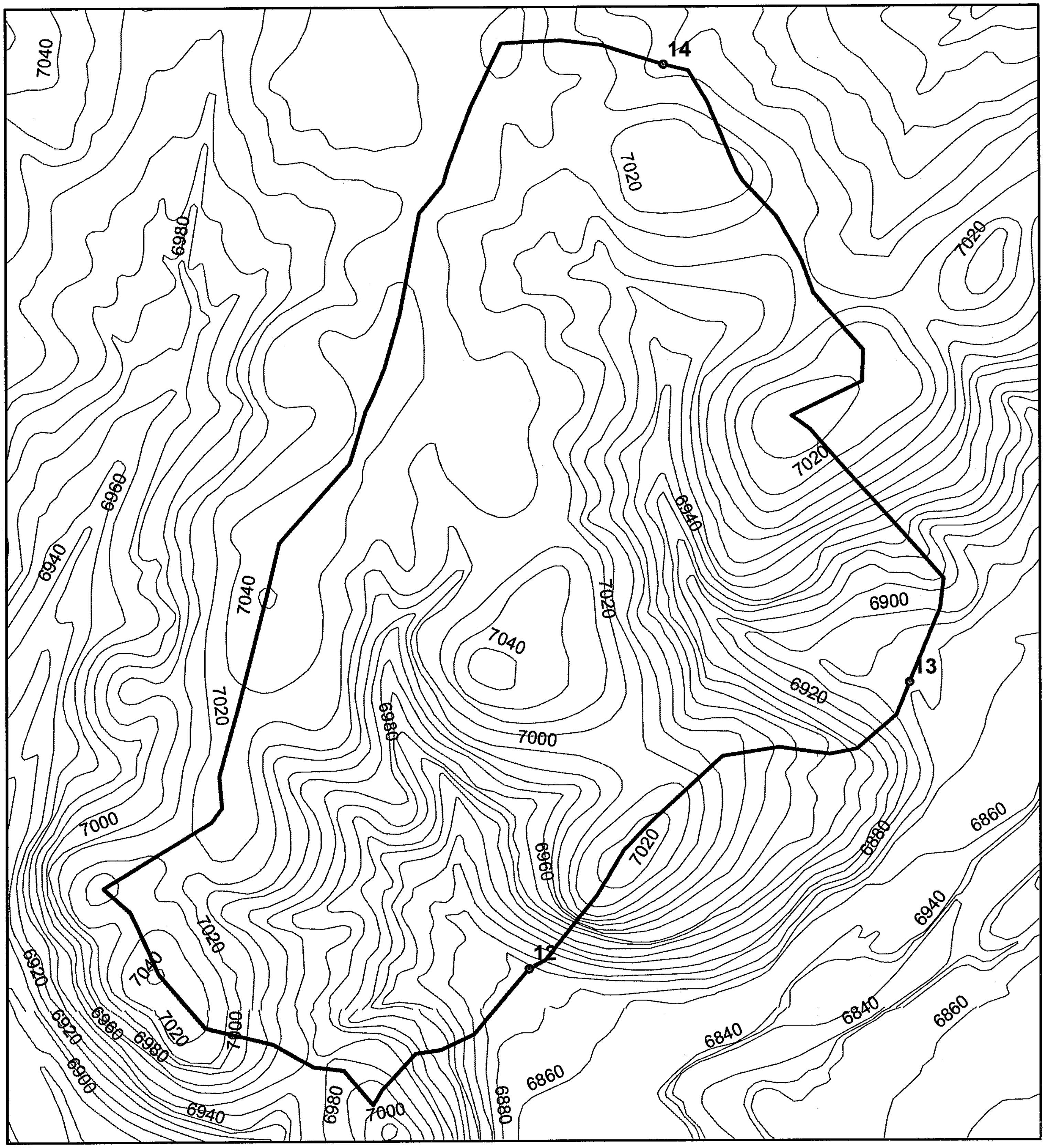


Exhibit 1. Postmine Topography

EXHIBIT 2
Premine Topography



Legend

• End Points

Modeling Area

Feet

0 150 300 600 900

Exhibit 2. Premine Topography

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
P.O. Box 46667
Denver, Colorado 80201-6667

IN REPLY REFER TO:

AZ-0001D

January 28, 2009

Gary W. Wendt, Manager
Environmental
Peabody Western Coal Company
P.O. Box 650
Navajo Route 41
Kayenta, Arizona 86033

Re: Black Mesa Complex – removal of sedimentation ponds in areas N6, J7, J16,and J21
Office of Surface Mining (OSM) project AZ-0001-D-J-58
OSM Administrative Records Management System (ARMS) No. 08/09/26-03

Dear Mr. Wendt:

The Office of Surface Mining (OSM) has completed a review of Peabody Western Coal Company's (PWCC's) September 24, 2008, permit revision application for the Black Mesa Complex (OSM project AZ-0001-D-J-58, ARMS No. 08/09/26-03).

In the application, PWCC requests under the Clean Water Act Western Alkaline Mine Drainage Category regulations at 40 CFR Part 434, Subpart H, to use best management practices in lieu of existing sedimentation ponds for 10 watersheds in areas N6, J7, J16, and J21. If OSM approves the application, PWCC would remove the sedimentation pond embankments. In so doing, PWCC would need to ensure that backfilling and grading of the pond areas approximates the original contour as required by 30 CFR 750.16 and 816.102(a).

OSM and EPA jointly reviewed the application under the procedures set forth in the December 19, 2003, memorandum of understanding (MOU) titled Process for Obtaining an NPDES Permit Under Subpart H – Western Alkaline Mine Drainage Category. A copy of the MOU is available for viewing on the OSM Western Region website at http://www.wrcc.osmre.gov/Guidances. With respect to the SMCRA application, OSM is processing it under the minor permit revision regulations at 30 CFR 750.12(c)(1)(ii) and 30 CFR Part 774.13.

For the reasons set forth in the enclosed technical evaluation documents, OSM finds that the proposal does not satisfy the applicable SMCRA permitting and performance standard regulations.

TAKE PRIDE® IN AMERICA

If you have any questions, please contact me by telephone at (303) 293-5048 or by e-mail at dwinterringer@osmre.gov.

Sincerely,

Dennis Winterringer

Dennis Winterringer, Leader
Black Mesa Complex Team

Enclosure

cc: BIA-Navajo Region
BIA-Western Region
Forest Lake Chapter House
Hopi Tribe Office of Mining & Mineral Resources
Hopi Tribe Office of Realty Services
Navajo Nation Minerals Department
OSM-Albuquerque Area Office
OSM-Farmington Area Office
John Tinger, EPA

TECHNICAL EVALUATION OF PERMIT REVISION
(Sediment Control Plan – NPDES 434 Outfalls/Ponds)

1. COMPANY: Peabody Western Coal Company (PWCC)

2. MINE/OPERATION: Kayenta Mine

3. TRACKING SYSTEM INFORMATION.

   A. **Mine Information Project Planning System (MIPPS)**: AZ-0001-D-J58
   B. **Workload Assignment Tracking System (WATS)**: FPD07968
   C. **Administrative Records Management System (ARMS)**: 08/09/26-03
   D. **Letterhead date of submittal**: September 24, 2008

4. TYPE OF APPLICATION/DOCUMENT REVIEWED.

   ☐ New permit application
   ☒ Permit revision application
   ☐ Permit renewal application
   ☐ Permit transfer, assignment, or rights sale application
   ☐ Other:

5. EVALUATION.

PWCC has submitted to the Office of Surface Mining Reclamation and Enforcement (OSM) and the U.S. Environmental Protection Agency (EPA) a Sediment Control Plan for ten outfalls contained in National Pollutant Discharge Elimination System (NPDES) Permit No. NN0022179, which covers the Black Mesa Complex. Under the Surface Mining Control and Reclamation Act and Clean Water Act, approval of this Plan would allow the 10 outfalls to be moved to the 40 CFR Part 434 Subpart H, Western Alkaline Coal Mining effluent limitations category, and subsequently allow PWCC to remove the 10 sedimentation ponds which currently exist at the outfall locations. The outfalls and associated ponds are:

OUTFALL:	049	050	051	021	022	037	031	032	174	175
POND:	J7-CD	J7-E	J7-F	N6-C	N6-D	N6-F	J16-E	J16-F	J21-D	J21-E

The NPDES permit is up for renewal, and PWCC proposes under the Western Alkaline Coal Mine Drainage Category regulations at 40 CFR Part 434, Subpart H, section 434.82 (a) through (c), that it be allowed to remove the pond embankments because its watershed modeling demonstrates that the use of best management practices, without the use of sediment ponds, in the postmining landscape will prevent an increase in the average annual sediment yield from premined, undisturbed conditions. Examples of best management practices are minimizing disturbance, backfilling, grading, topsoiling, establishing vegetation, terraces, and check dams.

OSM and EPA jointly reviewed the application under the procedures set forth in the December 19, 2003, memorandum of understanding titled Process for Obtaining an NPDES Permit Under Subpart H – Western Alkaline Mine Drainage Category.

As discussed below in section A(2)(b), OSM has concerns about water quality at Ponds J16-E and J16-F.

A. **<u>Part of application/document reviewed:</u>**

Proposed Sediment Control Plan;
Existing NPDES Permit No. 0022179;
Seepage Monitoring and Management Reports (PWCC – 1999, 2005, 2008).

(1) <u>Citation of applicable regulations</u>:

30 CFR 780.21 Hydrologic information.
30 CFR 780.25 Reclamation plan: Siltation structures, impoundments, et al.
30 CFR 816.42 Hydrologic balance: Water quality standards et al.
30 CFR 816.45 Hydrologic balance: Sediment control measures.
30 CFR 816.46 Hydrologic balance: Siltation structures.

(2) <u>Evaluation of compliance with the requirements of the applicable regulations</u>:

(a) <u>Evaluation of compliance with the permit application requirements (30 CFR Parts 777 through 784)</u>:

30 CFR 780.21(h) requires a plan, with maps and descriptions, and including the measures to be taken to prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow. 30 CFR 780.25(a)(3)(iv) says each detailed design plan shall describe the timetable and plans to remove each (sediment) structure, if appropriate. 40 CFR 434.82 allows for western alkaline coal mining operations to submit for reclamation areas, brushing and grubbing areas, topsoil stockpiling areas, and regraded areas a Sediment Control Plan that proposes use of best management practices other than sedimentation ponds to control sedimentation. 40 CFR 434.82(a) specifies that the operator must submit a site-specific Sediment Control Plan that is designed to prevent an increase in the average annual sediment yield from premined, undisturbed conditions. It further states that the plan must identify best management practices and describe design specifications, construction specifications, maintenance schedules, criteria for inspection, and performance and longevity of the best management practices.

In accordance with these regulations, PWCC has submitted a Sediment Control Plan which would become part of the overall hydrologic reclamation plan already in the permit. This Plan contains text, appendices, surface water modeling results for the applicable areas, methodology for pond removal, and sediment control maps. This complies with the requirements of 30 CFR 780.21(h) and 30 CFR 780.25(a)(3)(iv). In addition, the Plan includes the information required by EPA in 40 CFR 434.82(a) and thus complies with that regulation.

PWCC's surface water modeling studies were prepared by AYRES Associates using the EASI (Erosion And Sedimentation Impacts) watershed and surface water modeling program. This program has been previously used at Kayenta Mine. EASI accounts for factors such as: rainfall, soils, runoff, infiltration, slopes, flow routing, erosion, sediment transport, vegetation cover, and topography. Also contained in the report are: methodology; details on computations for runoff and sediment yield; tables/graphs of data and parameters; maps showing the affected areas, drainage basins, vegetation, premining topography, and postmining topography. There is also a detailed analysis of the modeling results. Results are discussed in section *(b)* below.

(b) Evaluation of compliance with the performance standards (30 CFR Parts 816 and 817):

30 CFR 816.45(a)(1) states that appropriate sediment control measures shall be used to prevent, to the extent possible, additional contributions of sediment to streamflow or to runoff outside the permit area. 30 CFR 816.46(b)(5) requires that siltation structures shall be maintained until removal is authorized by the regulatory authority and the disturbed area has been stabilized and revegetated. 40 CFR 434.82 allows for western alkaline coal mining operations to submit for reclamation areas, brushing and grubbing areas, topsoil stockpiling areas, and regraded areas a Sediment Control Plan that uses best management practices other than sedimentation ponds to control sedimentation. 40 CFR 434.82(b) specifies that, using watershed models, the operator must demonstrate that implementation of the Sediment Control Plan will result in average annual sediment yields that will not be greater than the sediment yield levels from premined, undisturbed conditions.

The AYRES study ran the EASI model for the applicable portions of areas J-7, N-6, J-16, and J-21 incorporating all BMP's except sediment ponds. Examination of the study has found it to be sound. The results show that average annual sediment yield for the applicable portions of each watershed decreased from pre-mine to post-mine conditions as follows: J-7 (-18%), N-6 (-20%), J-16 (-50%), and J-21 (-8%). Because of this reduction in sediment yield and concurrent demonstration of land stability, compliance with 30 CFR 816.45(a)(1), 30 CFR 816.46(b)(5), and 40 CFR 434.82(b) has been achieved.

30 CFR 816.42 states that discharges of water from areas disturbed by surface mining activities shall be made in compliance with all applicable State and Federal water quality laws and regulations. However, Pond J16-E and Pond J16-F have water quality problems, explained as follows.

Pond J16-E persistently holds water. In addition, the hydrologic head created by the pond has caused two seeps, J16-E-S1 & J16-E-S2, to emerge and infrequently flow below the pond embankment. PWCC periodically dewaters Pond J16-E by pumping to Pond J16-F in order to maintain the required capacity to handle the applicable 10-yr/24-hr precipitation event. The source of most of this water is Spring 151, which is just upstream from Pond J16-E. PWCC has not submitted documentation that the spring existed prior to initiation of mining operations in Area J16 or, if the spring existed prior to mining, that the mining operation has not affected it.

Also, the spring has poor water quality, specifically a high selenium concentration. Subsequently, Pond J16-E and the two seeps are likewise high in selenium. PWCC's 2005 Seepage Monitoring and Management Report reports that all historic selenium data from the site exceed the Navajo Nation's livestock and wildlife drinking water standard of 50.0 ug/l (68-158 ug/l at the spring; 90-160 ug/l at the pond; and 69-160 ug/l at the seeps). Pond J16-F is of course also affected, and the bottom sediment in both Ponds J16-E and J16-F may be contaminated with selenium. Monitoring of baseflow below the ponds and alluvial wells in Moenkopi Wash has not detected high selenium concentrations although some dilution has probably occurred.

(3) On the basis of the preceding evaluation, I conclude that:

☐ This part of the application/document complies with the requirements of the applicable regulations.

☒ This part of the application/document does not comply with the requirements of the applicable regulations. To bring the document into compliance, PWCC needs to:

- **Provide documentation that the spring existed prior to mining operations in J16 and that the mining operation has not affected it, or**
- **Provide a written mitigation plan to deal with the selenium problem in the water at and around the spring.**

☐ The above evaluation concerns a proposed revision of the reclamation plan that affects reclamation costs.

6. PRIMARY & PEER REVIEWERS.

A. Primary reviewer:

Rick Pruszka

Rick Pruszka, Hydrologist

Jan. 28, 2009

Date

B. Peer reviewer:

Amy McGregor

Amy McGregor, Soil Scientist

1/28/09

Date

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
P. O. Box 46667
Denver, Colorado 80201-6667

IN REPLY REFER TO:

AZ-0001D

June 16, 2009

Gary W. Wendt, Manager
Environmental
Peabody Western Coal Company
P.O. Box 650
Navajo Route 41
Kayenta, Arizona 86033

Re: Black Mesa Complex – removal of sedimentation ponds in areas N6, J7, and J21
Office of Surface Mining (OSM) project AZ-0001-D-J-58
OSM Administrative Records Management System (ARMS) Nos. 08/09/26-03 and 09/04/27-06

Dear Mr. Wendt:

The Office of Surface Mining (OSM) has completed a review of Peabody Western Coal Company's (PWCC's) September 24, 2008, and April 24, 2009, proposed sediment control plan for the Black Mesa Complex (OSM project AZ-0001-D-J-58, ARMS Nos. 08/09/26-03 and 09/04/27-06).

PWCC requested under the Clean Water Act Western Alkaline Mine Drainage Category regulations at 40 CFR Part 434, Subpart H, to use best management practices in lieu of eight existing sedimentation ponds in areas N6, J7, and J21 (ponds 021 (N6-C), 022 (N6-D), 037 (N6-F), 049 (J7-CD), 050 (J7-E), 051 (J7-F), 174 (J21-D), and 175 (J21-E)).

OSM and the U.S. Environmental Protection Agency jointly reviewed the proposed plan under the procedures set forth in the December 19, 2003, memorandum of understanding (MOU) titled Process for Obtaining an NPDES Permit Under Subpart H – Western Alkaline Mine Drainage Category. A copy of the MOU is available for viewing on the OSM Western Region website at http://www.wrcc.osmre.gov/Guidances.

OSM processed the proposed sediment control plan under the minor permit revision regulations at 30 CFR 750.12(c)(1)(ii) and 30 CFR Part 774.13. For the reasons set forth in the enclosed technical evaluation document, OSM finds that the proposal satisfies the applicable SMCRA permitting and performance standard regulations. Therefore I approve the proposal.

In its April 24, 2009, letter, PWCC states that upon plan approval it will remove the eight sedimentation embankments in 2009 and 2010. As we discussed, PWCC will, as it removes the embankments, make any necessary revisions to the approved permit application and submit them to OSM for updating of the application and distribution to the agencies (e.g., revisions to

TAKE PRIDE IN AMERICA

Drawing Nos. 85405, Sediment and Water Control Structures, and 85406, Siltation and Impoundment Structure Data).

As set forth in the Indian Lands Program at 30 CFR 750.12(c)(1)(iii), Peabody, or any person with an interest which is or may be adversely affected, may appeal this decision under the procedures of 30 CFR Part 775 and 43 CFR Part 4.

If you have any questions, please contact me by telephone at (303) 293-5048 or by e-mail at dwinterringer@osmre.gov.

Sincerely,

Dennis Winterringer

Dennis Winterringer, Leader
Black Mesa Complex Team

Enclosures

cc: BIA-Navajo Region
BIA-Western Region
Forest Lake Chapter House
Hopi Tribe Office of Mining & Mineral Resources
Hopi Tribe Office of Realty Services
Navajo Nation Minerals Department
OSM-Albuquerque Area Office
OSM-Farmington Area Office
John Tinger, EPA

OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT (OSM)

Approval of Application for Minor Permit Revision
Project AZ-0001-D-J-58
Permit AZ0001D
Peabody Western Coal Company (PWCC)
Black Mesa Complex

On September 24, 2008, and April 24, 2009, PWCC submitted under the Indian Lands Program an application for minor revision of Black Mesa Complex permit AZ0001D (project AZ-0001-D-J-58). In the application, PWCC proposed a sediment control plan to use best management practices in lieu of existing sedimentation ponds for eight watersheds in areas N6, J7, and J21.

Based on its review of the permit revision application, OSM has determined that:

1. Reclamation as required by the Surface Mining Control and Reclamation Act of 1977, as amended, (SMCRA) and the Indian Lands Program at 30 CFR Chapter VII, Subchapter E can be accomplished under the reclamation plan contained in the permit application, as revised.

2. The revision application is accurate and complete, and the applicant has complied with all requirements of SMCRA and the Indian Lands Program for the permit revision.

3. No other approval requirements at 30 CFR 750.12(c)(3)(ii)(C) and 773.15 are applicable to this permit revision application.

4. Environmental Reevaluation and Finding of No Significant Impact Under the National Environmental Policy Act.

    a. The proposed permit revision would not result in any additional environmental impacts beyond those identified in OSM's June 1990 environmental impact statement for the Kayenta Mine permit approval.

    b. The June 1990 environmental impact statement adequately addresses the impacts of the mine.

    c. The approval of this permit revision application would not significantly impact the quality of the human environment under section 102(2)(C) of the National Environmental Policy Act of 1969, 42 U.S.C. 4332(2)(C). Therefore, an environmental impact statement is not required.

OSM provided copies of the September 24, 2008, and April 24, 2009, submissions to and solicited comments from the Bureau of Indian Affairs, Navajo and Western Regional Offices; Hopi Tribe, Office of Mining and Minerals Resources; Hopi Tribe, Office of Realty Services; Navajo Nation Minerals Department; and Forest Lake Chapter House of the Navajo Nation. It notified but did not provide application copies to the Bureau of Land Management, Arizona State

Office; U.S. Fish and Wildlife Service; Navajo Environmental Protection Agency; and Navajo Air Quality Control Program. In response to its request, OSM did not receive any comments on Peabody's application.

On the basis of the above determinations, I, in accordance with 30 CFR 750.12(c)(1)(ii) and 774.13(c), approve Peabody's proposed minor permit revision application for Kayenta Mine permit AZ0001D (project AZ-0001-D-J-58).

Dennis Winterringer

Dennis Winterringer, Leader
Black Mesa Complex Team
Western Region
OSM

June 16, 2009

June 16, 2009

TECHNICAL EVALUATION OF PERMIT REVISION APPLICATION
(Revised Sediment Control Plan – NPDES 434 Outfalls/Ponds)

1. **COMPANY**: Peabody Western Coal Company (PWCC)

2. **MINE/OPERATION**: Black Mesa Complex

3. **TRACKING SYSTEM INFORMATION.**

   A. **Mine Information Project Planning System (MIPPS)**: AZ-0001-D-J58
   B. **Workload Assignment Tracking System (WATS)**: FPD07968 & FPD08052
   C. **Administrative Records Management System (ARMS)**: 08/09/26-03 & 09/04/27-06
   D. **Letterhead date of submittal**: September 24, 2008 & April 24, 2009

4. **TYPE OF APPLICATION/DOCUMENT REVIEWED.**

   ☐ New permit application
   ☒ Permit revision application
   ☐ Permit renewal application
   ☐ Permit transfer, assignment, or rights sale application
   ☐ Other:

5. **EVALUATION.**

PWCC has submitted to the Office of Surface Mining Reclamation and Enforcement (OSM) and the U.S. Environmental Protection Agency (EPA) a revised Sediment Control Plan for eight outfalls contained in National Pollutant Discharge Elimination System (NPDES) Permit No. NN0022179, which covers the Black Mesa Complex. A previous Sediment Control Plan for ten outfalls was submitted to OSM on September 24, 2008 (ARMS # 08/09/26-03). PWCC has removed outfalls 031 (Pond J16-E) and 032 (Pond J16-F) from their original request; this was done in response to OSM concerns raised in its January 28, 2009 issue letter about high selenium water in Pond J16-E which PWCC manages by periodically pumping that water to Pond J16-F.

Under the Surface Mining Control and Reclamation Act and Clean Water Act, approval of this Plan would allow the eight outfalls to be moved to the 40 CFR Part 434 Subpart H, Western Alkaline Coal Mining effluent limitations category, and subsequently allow PWCC to remove the eight sedimentation ponds which currently exist at the outfall locations. The outfalls and associated ponds are:

OUTFALL:	049	050	051	021	022	037	174	175
POND:	J7-CD	J7-E	J7-F	N6-C	N6-D	N6-F	J21-D	J21-E

The NPDES permit is up for renewal, and PWCC proposes under the Western Alkaline Coal Mine Drainage Category regulations at 40 CFR Part 434, Subpart H, section 434.82 (a) through (c), that it be allowed to remove the pond embankments because its watershed modeling demonstrates that the use of best management practices, without the use of sediment ponds, in the postmining landscape will prevent an increase in the average annual sediment yield from premined, undisturbed conditions. Examples of best management practices are minimizing disturbance, backfilling, grading, topsoiling, establishing vegetation, terraces, and check dams.

OSM and EPA jointly reviewed the application under the procedures set forth in the December 19, 2003, memorandum of understanding titled "Process for Obtaining an NPDES Permit Under Subpart H – Western Alkaline Mine Drainage Category".

A. <u>Part of application/document reviewed</u>:

PWCC's September 24, 2008 Sediment Control Plan;
PWCC's April 24, 2009 Sediment Control Plan;
Existing NPDES Permit No. 0022179.

(1) <u>Citation of applicable regulations</u>:

30 CFR 780.21	Hydrologic information.
30 CFR 780.25	Reclamation plan: Siltation structures, impoundments, et al.
30 CFR 816.45	Hydrologic balance: Sediment control measures.
30 CFR 816.46	Hydrologic balance: Siltation structures.
40 CFR 434.82	Western Alkaline Coal Mining – Effluent limitations attainable by the application of the best practicable control technology currently available (BPT).

(2) <u>Evaluation of compliance with the requirements of the applicable regulations</u>:

(a) *<u>Evaluation of compliance with the permit application requirements (30 CFR Parts 777 through 784)</u>:*

30 CFR 780.21(h) requires a plan, with maps and descriptions, and including the measures to be taken to prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow. 30 CFR 780.25(a)(3)(iv) says each detailed design plan shall describe the timetable and plans to remove each (sediment) structure, if appropriate. 40 CFR 434.82 allows for western alkaline coal mining operations to submit for reclamation areas, brushing and grubbing areas, topsoil stockpiling areas, and regraded areas a Sediment Control Plan that proposes use of best management practices other than sedimentation ponds to control sedimentation. 40 CFR 434.82(a) specifies that the operator must submit a site-specific Sediment Control Plan that is designed to prevent an increase in the average annual sediment yield from premined, undisturbed conditions. It further states that the plan must identify best management practices and describe design specifications, construction specifications, maintenance schedules, criteria for inspection, and performance and longevity of the best management practices.

In accordance with these regulations, PWCC has submitted a Sediment Control Plan which will become part of the overall hydrologic reclamation plan already in the permit. This Plan contains text, appendices, surface water modeling results for the applicable areas, methodology for pond removal, and sediment control maps. This complies with the requirements of 30 CFR 780.21(h) and 30 CFR 780.25(a)(3)(iv). In addition, the Plan includes the information required by EPA in 40 CFR 434.82(a) and thus complies with that regulation.

PWCC's surface water modeling studies were prepared by AYRES Associates using the EASI (Erosion And Sedimentation Impacts) watershed and surface water modeling program. This program has been previously used at the Black Mesa Complex. EASI accounts for factors including rainfall, soils, runoff, infiltration, slopes, flow routing, erosion, sediment transport, vegetation cover, and topography. Also contained in the report are: methodology; details on computations for runoff and sediment yield; tables/graphs of data and parameters; maps showing the affected areas, drainage basins, vegetation, premining topography, and postmining topography. There is also a detailed analysis of the modeling results. Results are discussed in section *(b)* below.

(b) Evaluation of compliance with the performance standards (30 CFR Parts 816 and 817):

30 CFR 816.45(a)(1) states that appropriate sediment control measures shall be used to prevent, to the extent possible, additional contributions of sediment to streamflow or to runoff outside the permit area. 30 CFR 816.46(b)(5) requires that siltation structures shall be maintained until removal is authorized by the regulatory authority and the disturbed area has been stabilized and revegetated. 40 CFR 434.82 allows for western alkaline coal mining operations to submit for reclamation areas, brushing and grubbing areas, topsoil stockpiling areas, and regraded areas a Sediment Control Plan that uses best management practices other than sedimentation ponds to control sedimentation. 40 CFR 434.82(b) specifies that, using watershed models, the operator must demonstrate that implementation of the Sediment Control Plan will result in average annual sediment yields that will not be greater than the sediment yield levels from premined, undisturbed conditions.

The AYRES study ran the EASI model for the applicable portions of areas J-7, N-6, and J-21 incorporating all BMP's except sediment ponds. Examination of the study has found it to be sound. The results show that average annual sediment yield for the applicable portions of each watershed will decrease from pre-mine to post-mine conditions as follows: J-7 (-18%), N-6 (-20%), and J-21 (-8%). Because of this reduction in sediment yield and concurrent demonstration of land stability, compliance with 30 CFR 816.45(a)(1), 30 CFR 816.46(b)(5), and 40 CFR 434.82(b) has been achieved.

This evaluation finds PWCC's Sediment Control Plan for NPDES Permit No. NN0022179 to be acceptable.

(3) On the basis of the preceding evaluation, I conclude that:

☒ This part of the application/document complies with the requirements of the applicable regulations.

☐ This part of the application/document does not comply with the requirements of the applicable regulations. To bring the document into compliance, PWCC needs to:

☐ The above evaluation concerns a proposed revision of the reclamation plan that affects reclamation costs.

6. PRIMARY & PEER REVIEWERS.

A. Primary reviewer:

Rick Pruszka

Rick Pruszka, Hydrologist

06/08/2009

Date

B. Peer reviewer:

Paul Clark

Paul Clark, Hydrologist

6/9/09

Date

PEABODY WESTERN

Peabody Western Coal Company

April 24, 2009

Mr. Bob Postle
Office of Surface Mining
Reclamation and Enforcement
1999 Broadway, Suite 3320
Denver, CO 80202-5733

RE: Sediment Control Plan for NPDES Permit No. NN0022179

Dear Mr. Postle:

Enclosed please find Peabody Western Coal Company's (PWCC) Sediment Control Plan for eight outfalls contained in NPDES Permit No. NN0022179. The plan had been submitted previously on September 24, 2008 for ten outfalls; PWCC has removed outfalls 031 (J16-E) and 032 (J16-F) from the plan because these two ponds are still under evaluation. The outfalls are designations assigned to temporary sediment ponds constructed at PWCC's Black Mesa Complex. PWCC is submitting the Plan concurrently to the USEPA and the Office of Surface Mining Reclamation and Enforcement (OSMRE) for approval in order to move the eight outfalls to the 40 CFR Part 434 Subpart H, Western Alkaline Coal Mining effluent limitations in the soon to be renewed NPDES permit. The Sediment Control Plan provides information on the Best Management Practices (BMP's) PWCC has utilized to control sediment in reclaimed areas above the eight outfalls, includes 1"=400' scale maps of each outfall showing BMP's constructed in each outfall's watershed, and a section that describes inspection and maintenance criteria. In addition, the Plan includes surface water and sediment modeling demonstrations that indicate the BMP's are effective measures for controlling sediment. The model predictions show average annual sediment yields from the reclaimed watersheds above each outfall are less than the average annual sediment yields from the watersheds that existed above each outfall prior to mining. Ten CDs are enclosed with this submittal for distribution.

The eight outfalls and corresponding temporary sediment pond names are 049 (J7-CD), 050 (J7-E), 051 (J7-F), 021 (N6-C), 022 (N6-D), 037 (N6-F), 174 (J21-D) and 175 (J21-E). PWCC plans to remove the embankments at these outfalls during 2009 and 2010.

If you have any questions or need additional information please don't hesitate to call me at 928.677.5130, email me at gwendt@peabodyenergy.com, or write to me at the address below at your earliest convenience.

Respectfully,

Gary W. Wendt

Gary W. Wendt
Manager Environmental
Black Mesa Complex

GWW

Enclosure

Peabody Western Coal Company · P.O. Box 650 · Kayenta, Arizona 86033 · Telephone 928.677.5130 · Fax 928.677.5083

C: w/ CD enclosure

Mr. Patrick Antonio
Navajo Nation Environmental Protection Agency
NPDES Program
P.O. Box 339
Window Rock, AZ 86515

Mr. John Tinger
U.S. Environmental Protection Agency
Region IX, CWA Standards and Permits
75 Hawthorne Street
San Francisco, CA 94105

The Hopi Tribe
Water Resources Office
P.O. Box 123
Kykotsmovi, AZ 86039

John Cochran (PIC)

file

Sediment Control Plan

Peabody Western Coal Company

NPDES Permit No. NN0022179
Black Mesa Complex Mine Permit AZ-0001D

April 2009

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

Peabody Western Coal Company (PWCC) has been mining coal in two separate surface-mining operations on Black Mesa, within Navajo County, Arizona, since the 1970s. Mining takes place within the Black Mesa Complex, which is located on contiguous coal leases within the boundaries of the Hopi and Navajo Indian Reservations. The Kayenta Mine operated historically under the Office of Surface Mining Reclamation and Enforcement (OSMRE) Permanent Program Permit AZ-0001D in accordance with permanent program performance standards at 30 CFR Subchapter K Part 810. The Black Mesa Mine operated historically under an OSMRE initial regulatory program (30 CFR Subchapter B Part 710); however, mining operations are temporarily suspended at the Black Mesa Mine. The combined permit and lease area is referred to as the Black Mesa Complex.

OSM is charged with the regulation of surface coal mining and reclamation operations on Indian Lands, including the administration and enforcement of the performance standards as set forth in the 1977 Surface Mining Control and Reclamation Act (SMCRA). The performance standards include the General Hydrology Requirements for protecting the hydrologic balance at 30 CFR 816.41, and sediment control measures at 30 CFR 816.45. During mining at both the Kayenta and Black Mesa Mines, PWCC constructed numerous temporary sediment ponds around the perimeter of the mining areas to treat runoff from the disturbance area. Although the Black Mesa Mine was authorized to mine in accordance with the initial regulatory program rules, all temporary ponds built at both mines were designed, constructed and maintained in compliance with 30 CFR 816.42, 816.46, 816.47, and 816.49. The ponds collect runoff that drains from watersheds which are tributary to either Moenkopi Wash or Dinnebito Wash, which in turn both drain to the Little Colorado River.

1.1 Purpose and Need

30 CFR 816.45 requires that sediment control measures, including sediment ponds as best technology currently available (BTCA), be designed, constructed, and maintained to meet the more stringent of applicable state or federal effluent limitations. Consequently, PWCC obtained National Pollutant Discharge Elimination System (NPDES) Permit NN0022179 from the U.S. Environmental Protection Agency (USEPA). As part of the wastewater permitting process, USEPA assigned discharge monitoring locations or outfalls that coincide with the spillways at temporary sediment ponds constructed at the Black Mesa Complex where effluent must meet water quality criteria.

The effluent limitations at 40 CFR Part 434 for Subpart H, Western Alkaline Coal Mining are applicable to alkaline drainage from reclaimed areas at western coal mining operations, including permitted outfalls at the Black Mesa Complex that have eligible reclaimed areas. The portions of the watersheds that were mined above several temporary ponds have been regraded to achieve an acceptable post-mining topography. These regraded areas have been topsoiled using suitable salvaged topsoil in accordance with OSMRE requirements in the permanent program Permit AZ-

0001D or the initial regulatory program. These areas have also been seeded with a permanent seed mix as required in Permit AZ-0001D or the initial regulatory program and have an established vegetative cover at least two years old.

The following sections present the Sediment Control Plan (Plan) for eligible outfalls (temporary sediment ponds) in NPDES Permit No. NN0022179. The plan includes descriptions of the best management practices (BMP's) PWCC has implemented above the ponds to control sediment and erosion, and to minimize disturbance to the prevailing hydrologic balance. The plan also summarizes design specifications, construction specifications, inspection criteria, and maintenance schedules. The information summarized and referenced in the Plan is contained in the approved Black Mesa Complex permit application package (PAP) for Permit No. AZ-0001D.

Sediment yield demonstrations were conducted using the EASI computer model (Zevenbergen et al. 1990; WET 1990). This model was calibrated using site-specific data collected at the Black Mesa Complex over an eight-year period (RCE, 1993). EASI has been used to predict mean annual runoff and sediment yield from several large areas that were reclaimed under both the initial and permanent regulatory programs. These predictions have been reviewed and approved by OSMRE and other agencies in support of applications for Termination of Jurisdiction (N1/N2 and N7/N8 initial program areas), and in support of a recently submitted and approved Phase II performance bond release application (N14 permanent program reclamation) at the Black Mesa Complex. Therefore, PWCC believes the use of the model is appropriate.

Results of the modeling demonstrations for each temporary sediment pond are provided in separate modeling reports in the Appendices to the Plan. Each appendix also includes a 1"=400' scale map that shows outfall locations, current topography of the entire watershed, affected lands boundary within each pond's watershed, and the BMP's installed in each watershed above each outfall in order to control sediment. The modeling demonstrations show that average annual sediment yields predicted at each outfall location taking into account the postmining, or reclaimed mine-land conditions within the watershed are less than or equal to the average annual sediment yields for the premining, or undisturbed conditions. Average annual sediment yields are provided in each modeling report as tons/acre/yr, which are normalized values that account for differences between premining and postmining acreages and topography. The sediment yield data shows that the BMP's utilized by PWCC at the Black Mesa Complex are effective in minimizing erosion and sediment loads from reclaimed mine-lands, and ultimately, protecting the prevailing hydrologic balance.

2.0 BEST MANAGEMENT PRACTICES

PWCC has developed the Plan for temporary sediment ponds that are eligible for coverage under Subpart H (Western Alkaline Coal Mining) of the 40 CFR Part 434 effluent limitations guidelines to prevent an increase in the average annual sediment yield from areas disturbed by mining and reclamation operations. The Sediment Control Plan utilizes a variety of best management practices (BMP's) to control and minimize erosion and resulting sediment yield that includes, but is not limited to the following:

- Minimize the extent of the disturbance area;
- Stabilize the disturbance area by backfilling and grading to return the land surface to a postmining topography similar to the original landform;
- Develop a postmine drainage configuration that regulates runoff velocities and is designed for the long-term stability of the landscape;
- Regulate runoff velocities of water by collecting runoff in postmine drainage channels, and lining the drainage channels with erosion resistant materials including suitable spoil, as appropriate;
- Salvage and redistribute topsoil material to provide an adequate plant growth medium for revegetation;
- Till and prepare the seedbed to provide initial surface stabilization, prepare the topsoil material for seeding, and enhance seed germination and plant establishment;
- Design and plant reclamation seed mixtures that are permanent and sustainable for rapid and long-term surface stabilization that achieve the postmine land use; and,
- Design and construct sediment ponds to treat and control sediment from the disturbance area.

2.1 Limits of Disturbance

Mining and reclamation operations at the Black Mesa Complex were designed and implemented to minimize the extent of disturbance. The operations were designed to disturb only the land necessary to remove the coal resource. The extent of the disturbance area or affected lands includes the mined area, road right-of-ways, topsoil salvage and storage areas, facilities areas (e.g., temporary sediment ponds) and reclamation areas. Drawing No. 85360, Jurisdictional Permit and Affected Lands Map, contained in Volume 20 of the Black Mesa Complex Permit Application Package (PAP) show the affected lands boundary within the Black Mesa Complex permit areas.

Current watershed areas above each temporary sediment pond are shown on 1"=400' maps in each appendix to the plan. The current watershed areas may differ from the premining watershed areas due to the reclaimed topography. The affected lands boundary within the watershed disturbance boundary is also shown on each 1"=400' map.

The reclamation operations were designed to complete reclamation and revegetation activities as quickly as possible, site conditions and weather permitting, to restore the disturbed area to the postmine land use and minimize adverse impacts to the environment. The reclamation timetable at the Black Mesa Complex is summarized in Chapter 20, Reclamation Schedule of the PAP (Volume 11). The reclamation schedule outlines the sequence and timing of each major phase of the reclamation operations.

2.2 Postmining Topography

Following coal removal, the disturbed area is returned to a postmining topography that is similar to the original landform in accordance with 30 CFR 715.14, Backfilling and Grading, for initial program lands, and with 30 CFR 816.102, Backfilling and Grading: General Requirements, for permanent program lands. OSMRE approved the postmining landforms above the eligible temporary sediment ponds as part of the permit approval process for Permit AZ-0001D.

Chapter 21, Backfilling and Grading in Volume 11 of the PAP describes how PWCC developed the postmine landform. The design of the postmining topography required adjusting the original landform elevations for the removed coal seam and the swell of the overburden or spoil material. The postmine topography was designed to blend into the surrounding undisturbed hills and slopes. The approved postmining topography is shown on Drawing No. 85352, Estimated Postmining Topographic Map in Volume 29 of the PAP. PWCC also implemented a Surface Stabilization Program (SSP) in 1990 as outlined in Chapter 26 of the PAP (Volume 28) to develop the postmining landform for areas disturbed after 1990.

PWCC designed the backfilling and grading sequence to produce a postmining land surface similar to the original landform. Methods used to backfill and grade the mine spoils are also described in Chapter 21, Backfilling and Grading, of the PAP (Volume 11). As the mining sequence progressed, spoil materials from the "active" pit are used to backfill the previous pit. Backfilled materials were placed to minimize adverse affects on groundwater, minimize off-site effects, and to support the approved postmining land use.

Final grading of the spoil material was performed to create surface irregularities to minimize erosion, increase infiltration, improve soil moisture holding characteristics for the revegetation process, and improve range and wildlife habitat. The graded spoil is sampled to insure that there is a minimum of four feet of suitable plant growth material for revegetation.

2.3 Postmining Water Conveyance Features

The postmine drainage configurations for the reclaimed portions above the eligible temporary sediment ponds were developed during the backfilling and grading process to blend with undisturbed drainages above and below the disturbed area. The conveyances were included in the post-mining topography to provide drainage through the reclaimed areas, restore the premine drainage pattern where practicable, and minimize adverse impacts to the hydrologic balance.

The premining drainage network on Black Mesa typically features high drainage densities and deeply-incised ephemeral channels that convey large runoff events due to heavy localized thunderstorms and regional frontal storms. Most of the events feature supercritical flows that carry very high sediment loads. Utilization of the SSP as outlined in Chapter 26 of the PAP results in creating postmining drainage networks that develop characteristics similar to the premining drainage systems. In order to minimize deeply-incised channels within the postmining drainage network, PWCC utilizes topsoiled and revegetated swales in the flatter interior portions of reclaimed areas. Gradient terraces, reclamation downdrains and reclamation channels are utilized in steeper reclaimed areas such as outslopes from initial box cuts of the mine pits, and final pit areas. Reclamation channels are also utilized to convey runoff from reclaimed areas into the undisturbed receiving stream channels.

Gradient terraces are constructed on a positive grade in steeper reclaimed slopes to break up slope lengths and thereby minimize hillslope erosion, and to convey runoff to downdrains or reclaimed channels. Criteria for spacing gradient terraces on reclaimed hillslopes are provided in Attachment A (Terrace Spacing Justification) of Chapter 26 in the PAP (Volume 28). Design criteria for constructing gradient terraces are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

Reclamation downdrains are erosion-resistant grade control structures used to convey concentrated flow from steep areas into reclaimed channels. These structures are built with appropriate surface protection to limit velocities, trap sediment, and minimize erosion. Design criteria for constructing reclamation downdrains are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

Reclamation channels may vary in size depending on the drainage area. Reclamation channels that drain less than 640 acres are designed for the 10-year, 6-hour precipitation event, and reclamation channels that drain more than 1 square mile are designed for the 100-year, 6-hour event. The reclamation channels are not topsoiled. Rather, four feet of suitable plant growth spoil material form the bottom and sides of the channels. The spoil material is typically comprised of coarse rock fragments that form an armored surface, minimize erosion and enhance channel stability. In addition, no topsoil is placed for 15 feet on each side of the reclamation channel bottoms adequately containing high flows and confining low meandering flows within the channel area and away from the topsoiled and revegetated areas. Design criteria for the reclamation channels are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

2.4 Topsoil

PWCC developed an overburden/spoil handling plan to ensure a minimum of four feet of suitable growth material was placed on backfilled and graded lands prior to topsoiling activities. Overburden was tested to determine suitability as a plant growth material. Chapter 8, Soils

Resources and Overburden in the PAP (Volume 8) presents results of the overburden suitability assessment. Chapter 22, Minesoil Reconstruction in the PAP (Volume 11) presents the overburden and spoil handling plan.

Site-specific soil survey data (Chapter 8, Soils Resources and Overburden) were used to ensure the most suitable topsoil was salvaged. Chapter 22, Minesoil Reconstruction also describes topsoil redistribution operations. PWCC utilized direct hauling of topsoil material whenever possible. If direct hauling was not possible then the material was stored in approved stockpiles. Except where regraded materials were determined to be suitable as a surface plant growth material, topsoil was replaced after approved postmine contours were achieved, water conveyance structures were identified and preliminary construction initiated, and when no additional disturbance was anticipated. Residual soils with high levels of coarse rock fragments are used in limited areas to support the reestablishment of cultural and woody plants. OSM requires a minimum topsoil depth of 0.5 feet over initial program graded spoil. Assessments of overburden suitability and available topsoil salvaged from each mine pit area prior to mining indicate a minimum average of 1.0 feet of topsoil has been replaced over suitable graded spoil at permanent program areas of the Black Mesa Complex (Chapter 22, Minesoil Reconstruction). Upon completion of topsoiling activities, the areas were scarified to a minimum depth of 18 inches to enhance the rooting medium, increase infiltration, and reduce erosion. Following scarification, the replaced soil was disked on contour with a large furrowing disk.

2.5 Revegetation Practices

Following the completion of backfilling and grading activities and topsoil redistribution, the reclaimed areas were revegetated to support the proposed postmining land uses – livestock grazing and wildlife habitat. Chapter 23, Revegetation Plan in the PAP (Volume 11) contains detailed information on methods used to revegetate the postmining areas within the watersheds above the eligible temporary sediment ponds. Across the majority of the reclaimed lands at the Black Mesa Complex, the revegetation plan was developed with herbaceous production emphasized over development of large woody plants. Emphasizing herbaceous vegetation ensures the quick establishment of a vegetation community, enhances long-term stability, and minimizes erosion.

PWCC developed several seed mixes for permanent revegetation at the Black Mesa Complex. The most prevalent seed mix used for revegetation was a rangeland mix comprised primarily of grasses and forbs, but also includes fourwing saltbush. This mix establishes a permanent and sustainable vegetative cover that includes shrubs. Other seed mixes have been developed for providing temporary stabilization to minimize erosion, for repairing rills and gullies, and for key habitat areas along drainages and ridge lines. Seeding was generally accomplished by broadcasting or drilling on the contour. PWCC conducts both qualitative and quantitative revegetation monitoring in order to evaluate seeding success, determine the success of applied reclamation practices and collect data for termination of jurisdiction applications for interim program areas or bond release applications for permanent program areas (see Chapter 23, Revegetation Plan). Qualitative evaluations are carried out at least annually during the growing season, while quantitative measurements and evaluations are conducted on a more periodic basis during May and September of each year through bond release. Revegetation monitoring data is submitted to the OSM in the Annual Reclamation Status and Monitoring Reports. The 2007 Annual Revegetation Monitoring Report (ESCO, 2008) indicates the average total vegetative cover measured at various locations in the reclaimed mined-lands at the Black Mesa Complex was greater than the reference area, which represents the premine condition. The report also presents information regarding herbaceous production and species diversity, and indicates PWCC is successfully establishing vegetation on reclaimed mine-lands at the Black Mesa Complex that meet the postmine land use. The revegetation will enhance the long-term erosional stability of the site as the revegetated areas are effective and self-sustaining. RUSLE evaluations contained in Chapter 26 of the AZ-0001D PAP support these conclusions.

2.6 Sediment Ponds and Alternative Sediment Control Methodologies

PWCC designed and constructed numerous temporary sediment ponds in the drainages surrounding the affected lands at the Black Mesa Complex to treat disturbed area runoff and to minimize off-site adverse impacts to the hydrologic balance, The ponds were designed, constructed and maintained in compliance with 30 CFR 816.46, 816.47, and 816.49. The eligible temporary sediment ponds that are included with the Plan were designed in accordance with the aforementioned rules.

The 1"=400' maps that are included in each appendix to the plan show the location of the eligible temporary sediment ponds in relation to current topography. Drawing No. 85400, Drainage Area and Facilities Map in Volume 21, and Drawing No. 85405, Sediment and Water Control Structures Map in Volume 22 of the PAP shows the location of all temporary sediment ponds constructed at the Black Mesa Complex.

Chapter 6, Facilities in the PAP (Volumes 1 through 7F) contains design methodology and as-built certifications for all temporary sediment ponds constructed at the Black Mesa Complex, including regulatory requirements. In addition, individual design reports for the eligible temporary sediment ponds in this Plan can be found in Chapter 6, which include details on pond capacities and configurations, spillway designs, and pond-specific calculations of sediment trapping performance.

In addition to using sediment ponds to control sediment, PWCC uses alternative sediment control methodologies (ASCM) either in conjunction with the sediment ponds or individually. These ASCM's include straw dikes, filtration structures (silt fence), sediment traps, gabions, and check dams to reduce overland flow velocity, reduce runoff volume, or trap sediment. Most of these are temporary measures, but some may be left as permanent features in the reclaimed landscape. Design and construction specifications for the ASCM's are provided in Attachment B (Reclamation Surface Stabilization Design Handbook) of Chapter 26 in the PAP (Volume 28).

PWCC plans to eventually breach the embankments of the eligible temporary sediment ponds. Breaching will involve removing either a portion or all of each embankment to restore the natural stream channel course and gradient in the vicinity of the pond. Breaching involves less disturbance of established vegetation than complete removal of the entire embankment. The area disturbed by the breaching of the embankments will be graded to blend in with the surrounding topography, mechanically manipulated as needed, and seeded with an appropriate seed mix. ASCM's will be installed in the vicinity and downstream of the breached structure and will serve as BMP's. ASCM's will be installed in accordance with design and construction specifications contained in Chapter 26, Surface Stabilization Plan in the PAP (Volume 28). ASCM's that are temporary such as silt fences and/or straw bales may be removed once revegetation in the vicinity becomes established. The BMP's will be maintained until termination of jurisdiction is achieved for initial program lands or final bond release is granted for permanent program lands above each breached embankment. Modifications to this plan and other portions of the PAP to reflect PWCC's plans to breach the embankments will be submitted to OSMRE as a technical revision to Permit AZ-0001D in the near future.

3.0 CRITERIA FOR INSPECTIONS AND MAINTENANCE

As an active surface coal mine with ongoing reclamation operations, OSMRE conducts quarterly inspections of all areas of the Black Mesa Complex to assure compliance with the 30 CFR performance standards and the provisions of Permit AZ-0001D. The quarterly inspections include the BMP's that have been discussed in previous sections of this Plan, such as backfilling and grading to confirm the reclaimed land surface conforms to the approved postmine topography. Reclaimed areas in which topsoiling and revegetation activities have been completed are inspected to identify potential problem areas as indicated by rilling or gullying or other signs of instability or excess erosion. Postmine water conveyance structures and sediment ponds are also inspected to assure these structures are stable and retain the capacity of the approved design(s). If a problem is identified during an inspection, OSMRE may require an immediate fix, request a remedial plan, and/or they may issue a notice of violation which includes a specified time period to solve the problem depending upon the magnitude and severity.

In addition, PWCC is required by Permit AZ-0001D to conduct ongoing inspections of the reclaimed mine-lands including engineered structures to record and monitor the reclamation process and identify any potential problems. If problems are identified by either OSMRE or PWCC in the course of an inspection, then a remedial plan is developed and implemented. After the problem is fixed, the remedial work is monitored to assure the corrective action was successful.

PWCC is required to monitor the salvage, storage and redistribution of topsoil and spoil handling operations. Specific programs include determining final graded spoil suitability and verifying topsoil redistribution thickness. The topsoil and spoil handling monitoring data collected for each calendar year is reported to OSMRE in the Annual Reclamation Status and Monitoring Report.

PWCC conducts annual vegetation monitoring of permanently revegetated areas to document revegetation success. Revegetated areas are also surveyed for noxious weeds to evaluate potential adverse impacts to adjacent desirable vegetation. The revegetation monitoring data collected for each calendar year is reported to OSMRE in the Annual Reclamation Status and Monitoring Report.

PWCC is required to inspect all temporary sediment ponds on a quarterly basis for embankment stability, inlet and outlet conditions, and sediment storage capacities. The annual sediment pond inspection report is certified by a Professional Engineer and submitted to OSMRE.

Comprehensive Site Inspections and Reporting

PWCC will conduct comprehensive site inspections of the BMP's at the eligible temporary sediment ponds included with this Plan. The inspections will assess the following:

- The accuracy of the area covered by Plan,
- 1"=400' site maps are to be updated or otherwise modified to reflect current conditions,
- Effective implementation of the BMP's identified in the Plan,
- Necessity to maintain existing BMP's or install additional BMP's, and
- Necessity to revise the Plan.

Once the Plan becomes approved by OSMRE and USEPA, inspections will be conducted quarterly as part of OSMRE's quarterly inspections. If the comprehensive site inspection determines changes to the plan are warranted, PWCC will revise the Plan and submit the revisions to both OSMRE and USEPA for approval within 30 days.

PWCC will develop an Annual Compliance Evaluation Report and submit the report to OSMRE and USEPA by March 31st of each year for the preceding calendar year's inspections. The report will identify personnel making the inspections, dates of inspections, and summarize observations made and actions taken in accordance with the Plan. The report will identify any incidents of noncompliance, and where a report does not identify any incidents of noncompliance, the report will contain a certification that the facility is in compliance with the Plan. Annual Compliance Evaluation Reports will be retained with the Plan.

4.0 WATERSHED MODELING DEMONSTRATIONS

In accordance with 40 CFR Part 434.82, PWCC has prepared several watershed demonstrations that evaluate the performance of BMP's for controlling sediment in the reclaimed watersheds above eligible temporary sediment ponds at the Black Mesa Complex. The demonstrations involved using the EASI model to predict average annual sediment yields for the entire watershed area above each eligible temporary sediment pond. Sediment yields predicted for premining conditions reflect natural conditions in the watershed above each pond location prior to mining. Sediment yields predicted for postmining conditions reflect the BMP's that PWCC has implemented within the affected lands in the watershed above each sediment pond. The modeling demonstrations were conducted to show the BMP's result in average annual sediment yields from the postmining landscape that are less than or equal to the average annual sediment yields from the premining landscape.

The demonstrations are provided in modeling reports developed by Ayres Associates of Fort Collins, Colorado (Ayres). The reports were developed for eligible temporary sediment ponds (outfalls) that share adjacent watershed boundaries in which similar BMP's have been used for sediment control within the reclaimed portions of each watershed. The reports provide information on the EASI model development and reference previous EASI modeling reports developed for PWCC that were submitted to OSMRE in support of applications for termination of jurisdiction of initial program areas and bond release for permanent program areas. They also discuss data used to develop each model, modeling methodology, and model results. The model results are provided as average annual sediment yields on an acre-unit basis above each pond for both premine and postmine watershed condtions.

The following is a list of the temporary sediment ponds and corresponding NPDES Permit NN0022179 outfall designations at the Black Mesa Complex that have been evaluated for eligibility under the effluent limitations at 40 CFR Part 434 for Subpart H. The list also provides the Appendix to the Plan in which the modeling demonstration reports for each pond can be found. Each appendix also contains a 1"=400' scale map that shows pond locations, current topography of the entire watershed, affected lands boundary within each pond's watershed, and the BMP's installed in each watershed.

Pond ID	Outfall	Appendix No.
J7-CD	049	Appendix 1
J7-E	050	Appendix 1
J7-F	051	Appendix 1
N6-C	021	Appendix 2
N6-D	022	Appendix 2
N6-F	037	Appendix 2
J21-D	174	Appendix 3
J21-E	175	Appendix 3

5.0 SUMMARY AND CONCLUSIONS

The EASI modeling results indicate that the average annual sediment yield from the watersheds above the eligible temporary sediment ponds at the Black Mesa Complex, including the reclaimed areas above each pond, is less than or equal to the average annual sediment yield from the premining watershed that existed prior to building the pond. The sediment yield data demonstrates that the BMP's utilized by PWCC at the Black Mesa Complex are successful at minimizing erosion and sediment loads from the reclaimed mine-lands. The results also demonstrate that the ponds no longer serve as the best practicable control technology available for minimizing erosion and sediment, and the sediment ponds could be removed and reclaimed.

6.0 REFERENCES

ESCO Associates, Inc., 2008. "2007 Annual Revegetation Monitoring Report, Black Mesa and Kayenta Mines", Prepared for Peabody Western Coal Company, Kayenta, Arizona.

Resource Consultants & Engineers, Inc. (RCE), 1993. "Surface Water Modeling of Reclaimed Parcels at the Black Mesa Complex", Prepared for Peabody Western Coal Company.

Water Engineering & Technology, Inc. (WET), 1990. "Determination of Background Sediment Yield and Development of a Methodology for Assessing Alternative Sediment Control Technology at Surface Mines in the Semiarid West," Prepared for Office of Surface Mining and the National Coal Association, Fort Collins, CO.

Zevenbergen, L.W., Peterson, M.R., and Watson, C.C., 1990. "Computer Simulation of Watershed Runoff and Sedimentation Processes", Proceedings of the Billlings Symposium; Planning, Rehabililtation and Treatment of Disturbed Lands.

Appendix 1

Surface Water Modeling of the Reclaimed J7-CD, J7-E, and J7-F Watershed Area at the Black Mesa Complex

Appendix 2

Surface Water Modeling of the Reclaimed N6-C, N6-D, and N6-F Watershed Area at the Black Mesa Complex

Appendix 3

Surface Water Modeling of the Reclaimed J21-D and J21-E Watershed Area at the Black Mesa Complex