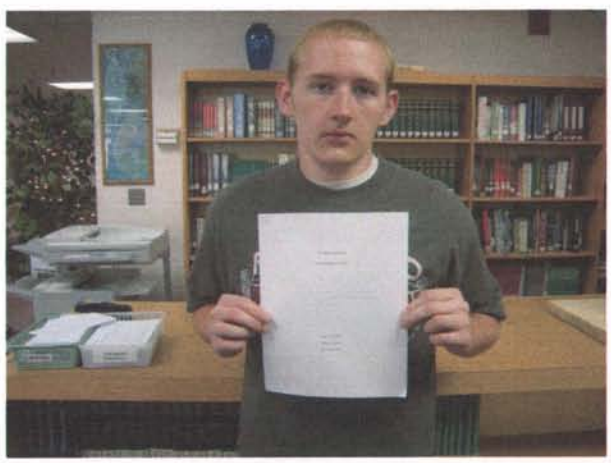
Social Studies

Researching Underground Coal Mining

English

Working on English Paper

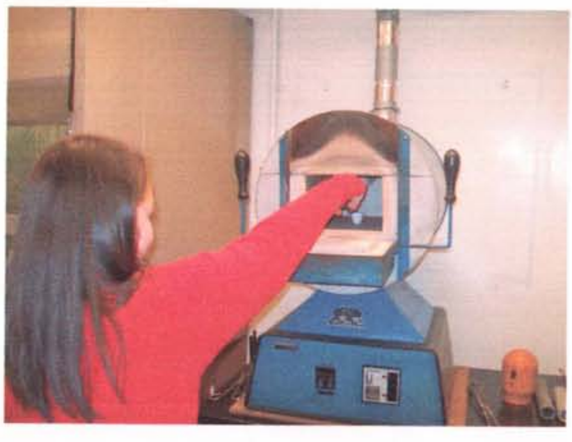


Completed English Paper

Science

Setting Up the Wind Tunnel

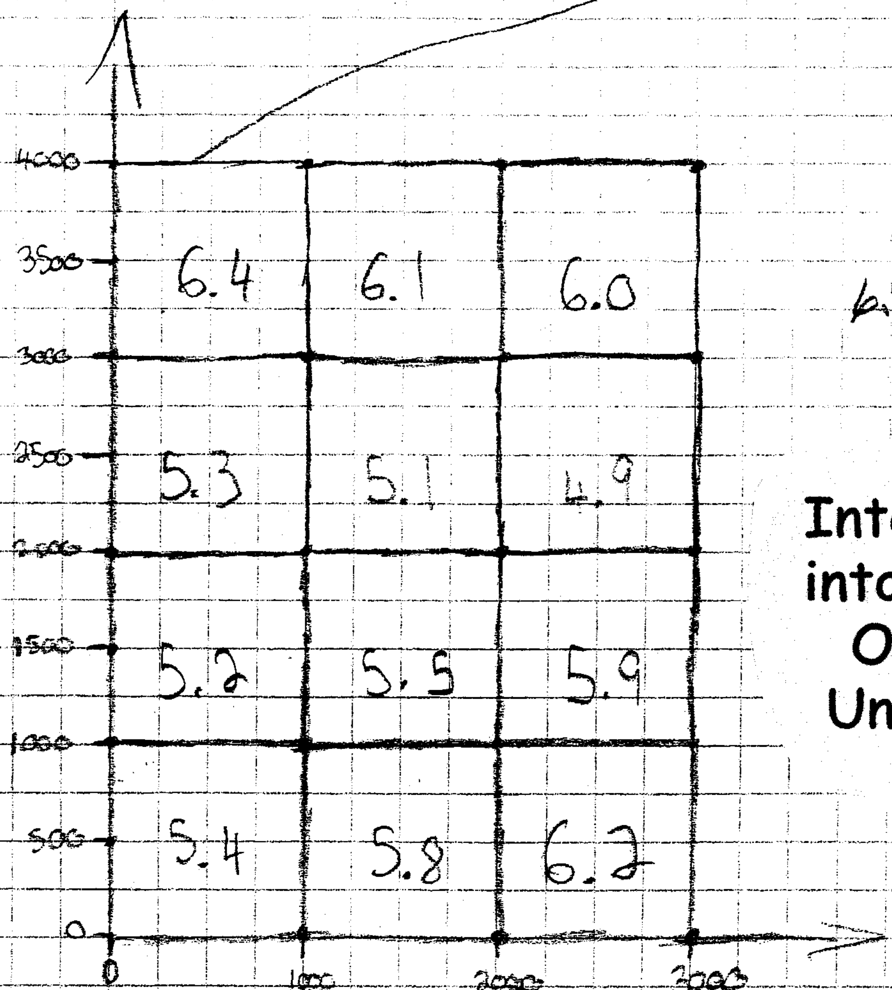
Checking the Air Pressure

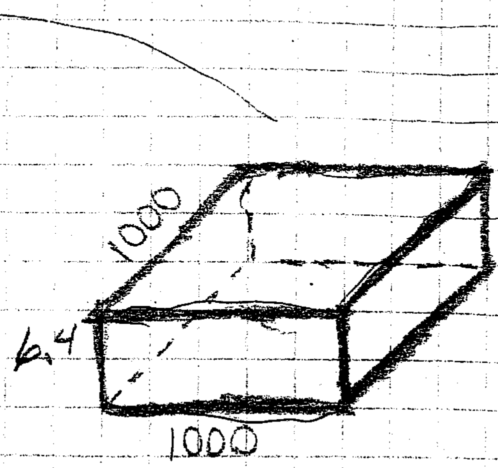


Coal Analysis

Judging the Culminating Projects

Evaluating the Culminating Projects





Integrating Safety into the Design and Operation of an Underground Coal Mine

Price of coal = 72.80

+
6400000
6100000
6000000
5300000
5100000
4900000
5200000
5500000
5900000
5400000
5800000
6200000
66,800,000 total sq ft

66,800,000
X .04
2672000 tons

2672000
X 72.80
194521600 $
total price of coal

Integrating Safety into the Design and Operation of an Underground Coalmine

I. INTRODUCTION

I began the search for a topic for this year's coal study unit by discussing several different mining concepts with the students in my classes. The discussions began with my AP Calculus students. We talked about several different coal related topics and eventually began discussing the Upper Big branch mine explosion from 2010. During the ensuing discussion one of my students asked the fateful question "how can the mines be designed so that they are safer for coal miners?" This question would become the guiding question of our coal study unit at our school.

At 10:30 am on October 11, 2010 William Roger Dooley, an employee of Kingston Mining in West Virginia, died in a roof fall accident. He was working as a Roof Bolt Operator on the No.1 working section of the mine when a part of the roof collapsed on him.

On average, roof falls cause the deaths of more underground coal miners than any other single cause of death. What safety measures could have been implemented at Kingston Mining to prevent the roof from collapsing and causing the death of Mr. Dooley? Perhaps the roof bolts that were purchased to support the roof were not of the proper diameter to insure that the roof was properly supported?

On April 4, 2010 an explosion in the Upper Big Branch Mine in West Virgina took the lives of 29 miners in the worst mine disaster in 40 years. Underground mine safety took on new meaning as the nation witnessed the devastation and pain of the families, friends and communities of the miners who died in the catastrophe.

In the modern age of coal mining, mine explosions, like the explosion at the Upper big Branch Mine, are rare. They are invariably caused by a failure of the ventilation system of the mine to adequately sweep away the explosive methane gas and prevent the gas from concentrating to explosive levels. What could mine personnel have done to prevent the Upper

Big Branch Mine explosion? Perhaps engineers could have correctly calculated the distribution of air at the mine in order to prevent the buildup of methane gas?

On Oct 11, 2000, a coal slurry dam at Martin County Coal Corporation's preparation plant near Inez, Kentucky failed. This failure was the result of the sudden and unexpected collapse of an abandoned underground coalmine underneath the impoundment. The bottom of the slurry pond collapsed, allowing its contents to pour into the mine tunnels. The slurry then poured out of two mine entrances, about 2 miles apart, into two different watersheds.

Even though the state had inspected the Martin County Coal slurry pond on September 22nd it did not predict or prevent the eventual collapse of the impoundment. What could Martin County Coal have done to prevent this disaster? Perhaps engineers could have calculated the Holland-Gaddy "safety factor" to determine whether it was safe to place the slurry pond over an abandoned underground mine?

As the students in my Advanced Mathematics and AP Calculus classes discussed each of the different topics for this year's coal study unit, we decided that our unit should be broad enough to include the participation of interested students from every academic department in our school. It should also contain several other key elements that are crucial for exploring our chosen topic to a maximum degree. First, the unit should challenge students to solve real world problems encountered in coal mining. They should have to think critically, use problem solving skills, and be engaged at the highest levels of Blooms Taxonomy. Second, the unit should emphasize contextual learning because research shows, students that are engaged in hands-on project based learning activities are much more likely to retain what they have learned. Third, the unit should address core content standards in each academic area and should satisfy specific elements for each course within the Program of Studies.

The students in my Advanced Mathematics and AP Calculus classes were asked to come up with a concept for this year's coal study unit. We discussed many different aspects of coal mining and eventually settled upon three topics: 1. Surface mine design and operation, 2. Coal liquefaction and gasification 3. Underground coalmine safety. They were then asked to vote on their favorite topic. This year's class decided to investigate "how to design and safely operate an underground coal mine".

The students in each participating class were given the task of investigating at least one specific element of safety, design, or production at an underground coalmine. To get the unit started, students that were enrolled in our pre-engineering curriculum were placed in groups of four and asked to design a small underground coalmine.

The unit addressed the following major objectives; and the student will

1. Use computer design software (SurpacVision, MineSimU, AutoCad, ect.) to accurately design an underground coal mine that provides a safe working environment for the workers.
2. Use techniques of Integral Calculus to calculate the fluid force on the outer wall of the coalmine after it has been abandoned and filled with water to within 15% of the accepted value.
3. Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a pond located on the property to within two foot of the accepted height.
4. Use the polygonal method to accurately estimate the volume of coal in the coal seam and determine its current market value.
5. Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 15% of the accepted value.
6. Use a computer ventilation software program (VnetPC 2000, MineVent, ect.) to accurately design a ventilation schematic of the coalmine.
7. Use Surfer 8 computer software to correctly draw at least two different 2-dimensional pictures of the coal seam.
8. Use Surfer 8 computer software to correctly draw at least two different 3-dimensional pictures of the coal seam.
9. Use core drilling data and Surfer 8 computer software to predict the height of the coal seam at a gas well located on the property to within one foot of the accepted value.
10. Use algebraic and geometrical techniques to calculate the diameter of the roof bolts needed to adequately support the roof to within 10% of the accepted value.

11. Correctly use algebraic techniques to estimate the maximum pillar size needed to safely support the roof and walls, if the mine incorporates square pillars and maximum recovery is desired (50%).
12. Correctly use algebraic techniques to determine the minimum laboratory compressive strength of the coal at the mine in order for stability to be achieved.
13. Correctly use algebraic techniques to determine the safety factor for compressive failure of the mine pillars by utilizing the Holland-Gaddy relationship.
14. Use algebraic and geometrical techniques to calculate the distribution of air according to natural splitting among at least four parallel splits to within at least 20% of the accepted value.
15. Use algebraic and geometrical techniques to determine the pressure drop and the air horse-power along the panel to within 20% of the accepted value.
16. Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at the site to within 15% of the accepted value.
17. Determine the impact of pressure change on the on the ventilation system of the underground coal mine to within 20% of the accepted value.
13. Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.
15. Correctly research the history of underground coal mining in Eastern Kentucky using at least 2 sources.
16. Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.
17. Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.
18. Given the materials, construct a 2-dimensional or 3-dimensional work of art that correctly illustrates underground coal mining and its impact on the people of our area.
19. Be able to write a proficient short story or poem that has coal as the central cluster theme.

ESSENTIAL QUESTION(S):

1. How can I calculate the fluid force of water on the sides of an abandoned underground coalmine that has filled up with water?
2. What is the volume and current value of the coal located at the property?
3. If there were a pond gas on the property, how can I use core drilling data to predict the height of the coal at the pond?
4. What is the history of underground coal mining in Eastern Kentucky?
5. How has underground coal mining impacted the lives of the people in Eastern Kentucky?
6. How can I determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?
7. How can technology be used in the design and operation of an underground coal mine?
8. How do you write a song about coal mining?

9. How is coal used in as a theme in different types of art?
10. How can I write a short story or essay about coal?
11. How can I draw a ventilation schematic of a small underground coalmine?
12. How do bends cause the air pressure to change in the mine?
13. How can I illustrate a coal seam by baking a cake or pastry?
14. How can I use computer simulation software to design an underground coalmine?

II. ACTIVITIES AND GOALS

This year's coal study unit was an interdisciplinary integration project involving all academic departments at the school. It was integrated horizontally across all subject areas in such a way that the student participated in and became part of a total immersion learning activity. The student practiced cooperative learning and peer teaching skills through collaboration with and by working with other students in small groups. They will use critical thinking and problem solving skills to make decisions concerning the planning and safe operation of an underground coal mine while applying and transferring previously learned skills to real life problems face in today's mines. The following is a brief description of the learning activities implemented in each subject at our school.

A. MATHEMATICS

My Advanced Mathematics students were placed in groups of four and asked to use pre-calculus techniques to investigate at least one problem that would involve the safe design and/or operation of an underground mine. Each group could brainstorm and develop their own problem criteria or the group could analyze at least one criterion from the list below:

1. Use core-drilling data from the coal seam and polygonal method to estimate the volume and value of the coal located on the property.
2. Predict the height of the coal seam beneath a pond that is located on the property directly over the mine.
3. Determine the minimum size roof bolts that will be needed to support the roof of the mine.
4. Calculate the minimum size of the coal pillars that will be needed to safely support the roof of an underground mine.

5. Calculate and utilize the Holland-Gaddy relationship to calculate the "Safety Factor" for compressive failure of the mine pillars to determine whether or not a slurry impoundment can safely be located directly over the mine.
6. Calculate the correct distribution of air, by natural splitting, along the mine panel that will sweep away any explosive methane gas.
7. Determine the pressure drop and air horsepower along the mine panel.

Students enrolled in my AP Calculus class investigated problems that would be encountered at a mine if a low-lying part of the mine were to fill with water. They used techniques of integral calculus to calculate the fluid force exerted by the water on the vertical side of the mine wall closest to the hillside. They also investigated whether this force could be reduced if the mine wall closest to the hillside were slanted at a 45-degree angle. They calculated the amount of time and the size of two pumps that would be needed to pump the water out of the mine. These students also used integral calculus to calculate the amount of "work" needed to pump the water from the low-lying area inside the mine to a higher point outside the mine.

B. SCIENCE

Chemistry students used laboratory methods to determine the ash, moisture, and BTU content of the coal taken from the mine.

Physics students investigated the change in the frictional pressure drop along the air pathway of the mine as a function of the airflow (ft^3/min). They focused on two variables associated with underground coalmine ventilation.

1. How does the "roughness or coarseness" of the sides of the mine impact the frictional pressure drop along the air pathway?
2. How do the corners in the air pathway (bend and yaw) impact the frictional drop along the air pathway?

These ventilation experiments were performed in the school commons area on three 40-foot long wind tunnels.

C. Pre-Engineering

Students enrolled in our Pre-engineering curriculum worked in groups of four to calculate the volume of the coal in the coal seam located at the small mine. They used Surfer 8 Contouring and 3-D Mapping Computer Software to determine the volume of the coal seam and the height of the coal directly beneath a pond that is located over the area to be mined. Each group then generated a numerical picture of the mine. They then entered this data into our SURPAC VISION computer design software and generated 2-dimensional and 3-dimensional pictures of the coalmine. After designing the mine, the pre-engineering students used Vnet 2000 ventilation simulation software to ventilate their mine. This program generated a schematic using the 3-dimensional coordinates of the junction and branches of the mine.

D. ENGLISH

Senior English students wrote short stories and poems with coal as a central cluster theme.

E. SOCIAL STUDIES

Political Science students used the library facilities to research topics related to the history of underground coal mining in Eastern Kentucky.

F. TECHNOLOGY

Technology was used in every academic area as a powerful tool to solve complex problems and make important decisions concerning the safety, design, and operation of the small mine. The application of technology in this unit was both challenging and relevant to the problems faced in the safe operation of an underground coalmine. A list of some important types of technology used in our unit would include: Computers, Surfer 8 Simulation Software, Vnet

2000 Ventilation Simulation Software, calculators, VCR, TV camcorders, sound mixers, digital camera, mapmaking hardware, and the Internet.

G. ART

Students in the art department were asked to produce 2-dimemsional and 3-dimenstional works of art with coal as the central theme. These could include sculpturing, posters, paintings, coal drawing, and photographs.

H. MUSIC

Music students composed and recorded songs about various aspects of coal mining and its impact on the people of Eastern Kentucky.

I. FOOD SERVICES

Students in the culinary skills course baked cakes and pastries that illustrated a 3-dimensional "cut-a way" view of the coal seam and the surrounding rock strata. They then shared these baked goods with other students and faculty members within the school community.

III. SUMMARY

Students at our school had fun participating in this unit and they learned a lot about underground coalmine safety.

This year's coal study unit must be considered an unqualified success. It has successfully demonstrated to our students the difficulties of safely extracting coal from an underground coalmine. The students learned in a contextual manner and used hands-on, technology intensive activities that helped them retain what they learned. They became active learners in a coal related integration project involving all academic areas.

Our pre-engineering students will experience an additional positive impact from our unit. Due to the training they received with the mine design computer software, they will have an opportunity to market job ready skills to any number of engineering firms located in our area. This could provide them with the training they would need to work after school or during the summer at a challenging job earning double or triple the salary earned by their minimum wage earning peers.

Students participating in our unit were engaged at the highest levels of Blooms Taxonomy: analysis, synthesis, and evaluation. They were asked to judge the success of the entire unit and make recommendations for improvements. Several of these recommendations may be used to improve the unit when it is taught again. Students were also asked to judge and critique each other's culmination projects. They listed two things they liked about the project and noted one area in which the project could be improved. These evaluations became a valuable tool that many students used to improve their projects.

Participating teachers in each department evaluated their students using one or all of the following methods:

1. Formative Evaluation
    a. Daily oral questions of students by the teacher
    b. Oral presentation
    c. Open-response questions
    d. Investigation and group product evaluations
    e. Quizzes
2. Summative Evaluation
    a. Culminating projects
    b. Unit tests

The participating teachers and the unit coordinator evaluated the effectiveness of the unit based upon the degree to which the unit taught the high school core content, covered the program of studies, and met components of our schools Comprehensive Improvement Plan. It was apparent that this unit met and exceeded all expectations set by participating teachers at the inception of the unit.

One aspect of this unit that will require improvement is the greater distribution if the computer simulation software at our school. Due to the expense of these software packages, we were only able to purchase one site license for both the contouring and ventilation software simulation packages. This severely restricted the number of students that were able to use their software packages. Extra site licenses should be purchased when this unit is taught again.

The activities taught in this unit were designed to allow student the opportunity to learn in the type of multiple intelligence and style of learning that best suited their needs. All the participating teachers were able to differentiate their instruction to meet the needs of student containing IEP modification. These would include special education students, 504 students, and students in our gifted and talented program. To see a complete list of these components, see the coal study unit outline included in this report.

This year's coal study unit involved the active participation of 20 teachers, 392 students, and one administrator. It has excited the entire community at our high school. Almost every student at our school is aware of at least one of the activities in our coal study unit. The responses of the student that participated in the unit were overwhelmingly favorable. They sincerely believe that their knowledge of underground coalmine safety has been enhanced. They indicated that they especially liked the hands-on nature of the instructional activities and they enjoyed working with other students in the cooperative learning peer teaching aspects of the unit.

In conclusion, this coal study unit must be considered a total success because the overarching goal set for the unit was achieved. The 19 objectives were either met or exceeded and the four elements described in the introduction were all realized. Student learning was significantly enhanced. Their critical thinking and problem solving skills have been vastly improved. Most importantly, these students now realize how critically important it is to extract coal from an underground coalmine in a safe, effective manner. They understand that there will always be dangers associated with coal mining and that the mining industry is committed to minimizing and hopefully, one day, eliminating these dangers. They will take with them a greater understanding of underground coal mining, an appreciation of the difficult, dangerous job performed by coal miners, and a greater realization of how important coalmining is to Pike County, the state of Kentucky, and the United States of America.

Date: January 3 – May 6, 2011
Type: ☐ **Daily** ☒ **Unit** **Length: __78__ (# days)**

Teacher:
Class :

THEME/ORGANIZER:

Integrating Safety into the Design and Operation of an Underground Coal Mine.

TARGET STANDARD(S): (Expressed in High Order Thinking Skills, "HOTS"/Williams and Blooms Taxonomies)
The students will be able to:

1. Use computer design software (SurpacVision, MineSimU, AutoCad, ect.) to accurately design an underground coal mine that provides a safe working environment for the workers.
2. Use techniques of Integral Calculus to calculate the fluid force on the outer wall of the coalmine after it has been abandoned and filled with water to within 15% of the accepted value.
3. Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a pond located on the property to within two foot of the accepted height.
4. Use the polygonal method to accurately estimate the volume of coal in the coal seam and determine its current market value.
5. Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 15% of the accepted value.
6. Use a computer ventilation software program (VnetPC 2000, MineVent, ect.) to accurately design a ventilation schematic of the coalmine.
7. Use Surfer 8 computer software to correctly draw at least two different 2-dimensional pictures of the coal seam.
8. Use Surfer 8 computer software to correctly draw at least two different 3-dimensional pictures of the coal seam.
9. Use core drilling data and Surfer 8 computer software to predict the height of the coal seam at a gas well located on the property to within one foot of the accepted value.
10. Use algebraic and geometrical techniques to calculate the diameter of the roof bolts needed to adequately support the roof to within 10% of the accepted value.
11. Correctly use algebraic techniques to estimate the maximum pillar size needed to safely support the roof and walls, if the mine incorporates square pillars and maximum recovery is desired (50%).
12. Correctly use algebraic techniques to determine the minimum laboratory compressive strength of the coal at the mine in order for stability to be achieved.
13. Correctly use algebraic techniques to determine the safety factor for compressive failure of the mine pillars by utilizing the Holland-Gaddy relationship.
14. Use algebraic and geometrical techniques to calculate the distribution of air according to natural splitting among at least four parallel splits to within at least 20% of the accepted value.
15. Use algebraic and geometrical techniques to determine the pressure drop and the air horse-power along the panel to within 20% of the accepted value.
16. Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at

the site to within 15% of the accepted value.

17. Determine the impact of pressure change on the on the ventilation system of the underground coal mine to within 20% of the accepted value.
13. Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.
15. Correctly research the history of underground coal mining in Eastern Kentucky using at least 2 sources.
16. Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.
17. Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.
18. Given the materials, construct a 2-dimensional or 3-dimensional work of art that correctly illustrates underground coal mining and its impact on the people of our area.
19. Be able to write a proficient short story or poem that has coal as the central cluster theme.

ESSENTIAL QUESTION(S):

1. How can I calculate the fluid force of water on the sides of an abandoned underground coalmine that has filled up with water?
2. What is the volume and current value of the coal located at the property?
3. If there were a gas well on the property, how can I use core drilling data to predict the height of the coal at the well?
4. What is the history of underground coal mining in Eastern Kentucky?
5. How has underground coal mining impacted the lives of the people in Eastern Kentucky?
6. How can I determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?
7. How can technology be used in the design and operation of an underground coal mine?
8. How do you write a song about coal mining?
9. How is coal used in as a theme in different types of art?
10. How can I write a short story or essay about coal?
11. How can I draw a ventilation schematic of a small underground coalmine?
12. How do bends cause the air pressure to change in the mine?
13. How can I illustrate a coal seam by baking a cake or pastry?
14. How can I use computer simulation software to design an underground coalmine?

DIFFERENTIATED INSTRUCTION: ***(Place initials of students beside modifications needed)***

IEP Modifications:

- [x] Extended Time
- [x] Reading Assistance
- [ ] Preferential Seating
- [x] Oral Assessment
- [ ] Highlight Information to be Learned
- [ ] Other *(Explain)*
- [x] Individualized Assistance
- [x] Reduced Work
- [x] Modified Grading
- [x] Use of Calculators
- [x] Slow the Rate of Presentation

GT Modifications:

- [x] Additional Instruction and Assistance
- [ ] Other
- [x] Enrichment Activities
- [x] Research

Multiple Intelligencies:

- [x] Linguistics
- [x] Interpersonal
- [x] Spatial
- [x] Intra-personal
- [x] Logical/Mathematical
- [x] Naturalist/Outdoors
- [x] Musical
- [ ] Other
- [x] Bodily/Kinesthetic

Learning Styles:

- [x] Verbal
- [x] Reflective
- [x] Global
- [x] Active
- [x] Introversion
- [x] Auditory/Verbal
- [x] Extraversion
- [x] Kinesthetic
- [x] Reflective
- [x] Sensing
- [x] Visual
- [x] Sequential
- [x] Intuitive

Cooperative Learning:

- [x] Jigsaw
- [ ] Think-pair-share
- [ ] Other

Other:

PROCEDURES:

MATHEMATICS

1. **Students will be placed in cooperative learning/peer teaching groups and assigned the task of designing a core drilling pattern and generating a numerical picture of the mine site.**
2. **Students will work in groups of four to determine the extraction ratio, size of the remaining coal pillar, and the minimum roof bolt size needed for the mine.**
3. **Each group will use the methods of inverse distance and/or delaunay triangulation to predict coal seam height at a specific point by using the surrounding core drilling data.**
4. **Each group will work in groups of four to use the polygonal method to estimate the volume of coal at the mine site and determine its current market value.**
5. **Each group will verify the height of the coal seam at the specific point by using Surfer 8 computer software.**

6. Students in the AP Calculus class will work in groups of four to anticipate and prevent a mine blowout by calculating the fluid force on the sides of the mine after it has been abandoned and filled with water.

SCIENCE
1. Review laboratory methods and safety procedures with class as a large group.
2. Students will be placed in a group with 3 other lab partners and assigned the task of determining the ash, moisture, BTU, and sulfur content of a sample of coal.
3. Physics students will work in groups of 4 to set up a wind tunnel simulation of the airflow inside the mine using 3-inch diameter PVC pipe. They will investigate the effect that "bend and yaw" has on the air pressure inside the mine.

PRE-ENGINEERING
1. These students will work in groups of four to use a computer software program (SurpacVision, MineSimU, AutoCad, ect.)to design the underground coalmine.
2. Each group of 4 will use the Surfer 8 contouring software to determine the volume of coal in the coal seam.
3. Each group of 4 will produce at least four 2 and 3-dimensional pictures of the coal seam using the Surfer 8 software.
4. Each group of 4 will use a computer ventilation software program (VnetPC 2000, MineVent, ect.) to design a ventilation schematic of their underground coalmine.
5. Each group of 4 will use technology as a powerful tool to assist in making decisions about the development and operation of the underground mine.

ENGLISH
1. Classes will be assigned the task of writing a short story, poem, or essay involving coal as a central cluster theme.

SOCIAL STUDIES
1. Students will be taken to the library to research the history of underground mining in our area.
2. Each student will work individually to write a report on his/her research findings.

ART
1. Students will be assigned the task of producing a 2 or 3-dimensional work of art with coal as the central theme.

MUSIC
1. Students in the band and chorus classes will compose a song or write a musical play with coal as a central theme.

HOME ECONOMICS

1. **Students will work with a partner to bake a cake or pastry that illustrates the coal seam and the surrounding rock strata.**

Review of Previous Lesson:

ENABLING KNOWLEDGE

MATH

1. **Understand variance and central tendency.**
2. **Apply right triangle trigonometry.**
3. **Solving matrix equations and evaluating 3x3 determinants by expansion of minors.**
4. **Graphing in 3-dimensions.**
5. **Calculate area and volume of polyhedrons.**
6. **Use a graphics calculator.**
7. **Understand various techniques of integration.**

SCIENCE

1. **Understand the scientific method.**
2. **Follow basic experimental procedure.**
3. **Understand and follow lab safety rules.**
4. **Understand and apply basic concepts from algebra and geometry.**
5. **Balance chemical equations.**

PRE-ENGINEERING

1. **Apply right triangle trigonometry.**
2. **Graph in 3-dimensions.**
3. **Use a graphics calculator.**
4. **Calculate area and volume of polygons.**

ENGLISH

1. **Write a short story or essay.**
2. **Construct a paragraph.**

SOCIAL STUDIES

1. **Use the internet to research a topic.**
2. **Construct a report and document sources.**

ART

1. **Understand the basics of drawing.**
2. **Be able to use a camera and develop film.**

3. Paint with acrylic or oil.

MUSIC
1. Read and sing written music.
2. Use recording instruments.
5 Compose a musical composition.

HOME ECONOMICS
1. Understand simple baking techniques.

Manipulatives/Materials/Resources:

Calculators, rulers, protractors, compass, overhead projector, tape, graph paper, lined paper, scissors, TV., VCR, flat square, string, straightedge, graphics calculators, digital camera, Bunsen burner, beakers, graduated cylinders, computers, simulation software, drawing paper, paint, brushes, pencils, wall paper paste, mapping hardware, camcorders, sound mixers, engineering texts, and lab manuals.

Enrichment Activities/Learning Extensions:

Compare dust control at a surface mine to ventilation requirements at an underground coalmine.

Culminating Activities:

Coal Fair Projects

Review of Objectives in this Lesson:

Definitions and concepts introduced in this unit.

Assessment(s): *(Attach to Lesson Plan)* (F=Formal I=Informal)

[f] Multiple Choice [f] Open Response [i] On Demand [f] Rubric

[f] Writing Portfolio [f] Activity [f] Quiz [f] Test

[f] Graphic Organizer [ ] Other (Explain):

Scoring Guide: [x] Yes [ ] No *(Attach to Lesson Plan)*

Technology Utilized:

[x] Overhead Projector [x] Digital Camera [x] Scanner [x] Computer [ ] Databases

[x] Scan Converter [x] Word Processor [x] Power Point [x] Spreadsheet [x] Internet

☐ Distance Learning ☒ Graphs/Charts/etc. ☒ Calculators ☒ Graphing Calculators

☒ Other

Pike County Central Comprehensive School Improvement Plan:

1a, 1b, 1c, 1d, 3a, 3c, 3d, 3e, 4a, 4d, 4c, 4d, 4e, 4f, 4g,

Literacy Action Plan:

1. **Expand vocabulary specific it advanced mathematics.**
2. **Utilize power verbs in instruction and assessment.**
3. **Implement reading, writing, and organizing techniques in instruction.**
4. **Implement reading strategies to improve comprehension and reading speed.**
5. **Read to students and assign reading materials.**
6. **Parents will be contacted whenever a student is in danger of failing a course.**
7. **Graphic organizers will used in instruction.**

Content Specific Vocabulary:

Additional Information:

A. ACADEMIC EXPECTATIONS

Mathematics:	1.5, 1.6, 1.7, 1.8, 1.9, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 5.1, 5.2, 5.3, 1.11, 1.12, 5.5, 6.1, 6.2, 6.3
Science:	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 5.1, 5.2, 5.13, 5.3, 5.5, 6.1, 6.2, 6.3
Social Studies:	2.15, 2.16, 2.18, 2.19, 2.20, 5.1, 5.2, 5.5, 6.1, 6.2, 6.3
Music:	1.14, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2
Art:	1.13, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2
English:	1.1, 1.11, 1.12

B. CORE CONTENT

Mathematics:	1.1.1, 1.1.3, 1.2.1, 1.2.2, 1.2.3, 1.3.2, 1.3.4, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.2, 2.2.3, 2.2.4, 2.2.6, 2.2.7, 2.3.1, 2.3.2, 2.3.4, 3.1.2, 3.1.3, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.3.2, 3.3.4, 4.1.4, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.2.1, 4.2.2, 4.2.3, 4.2.4, 4.2.8, 4.3.1, 4.3.2, 4.3.5
Science:	1.2.5, 1.3.1, 1.3.2, 1.4.1, 1.5.2, 1.5.3, 2.1.1, 2.2.2, 2.3.3, 3.4.1, 3.4.2
Sc. Studies:	1.1.3, 2.3.1, 3.1.1, 3.2.3, 3.4.3, 3.4.4, 4.1.3, 4.4.2, 5.1.1, 5.1.3, 5.3.6
Music:	AH-H 1.1.12, AH-H 1.1.13, AH-H 1.1.34
Art:	AH-H 4.1.41, AH-H 4.1.3.2, AH-H 4.2.32, AH-H 4.1.33
English:	WR-H 1.3, WR-H 1.4

Adjustments to the Lesson Plan:

Reflections:

Student Work Samples

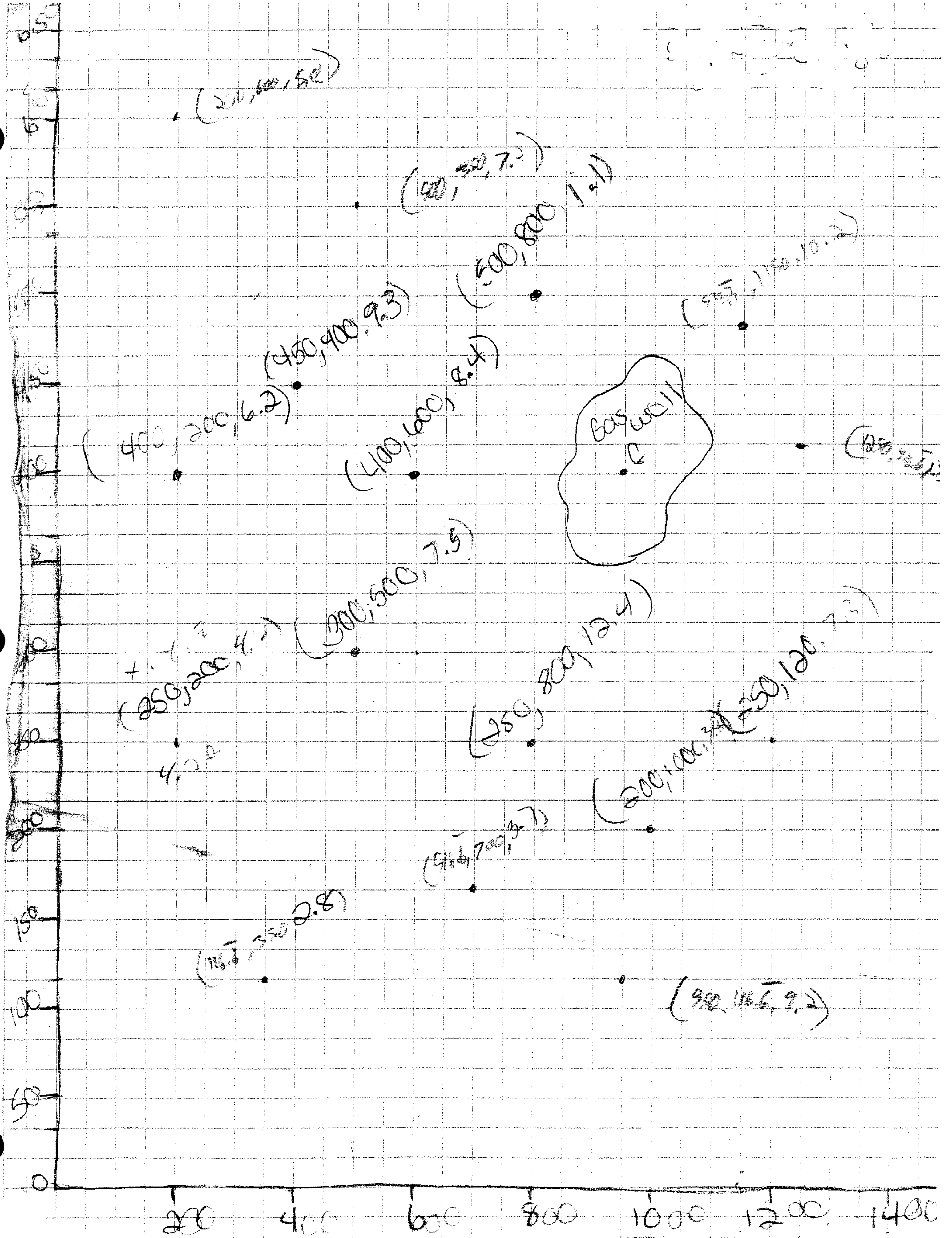
Land track

2-Dimensional Pictures

Volume Results

2-Dimensional sketch of Underground Mine

3-D Data Points

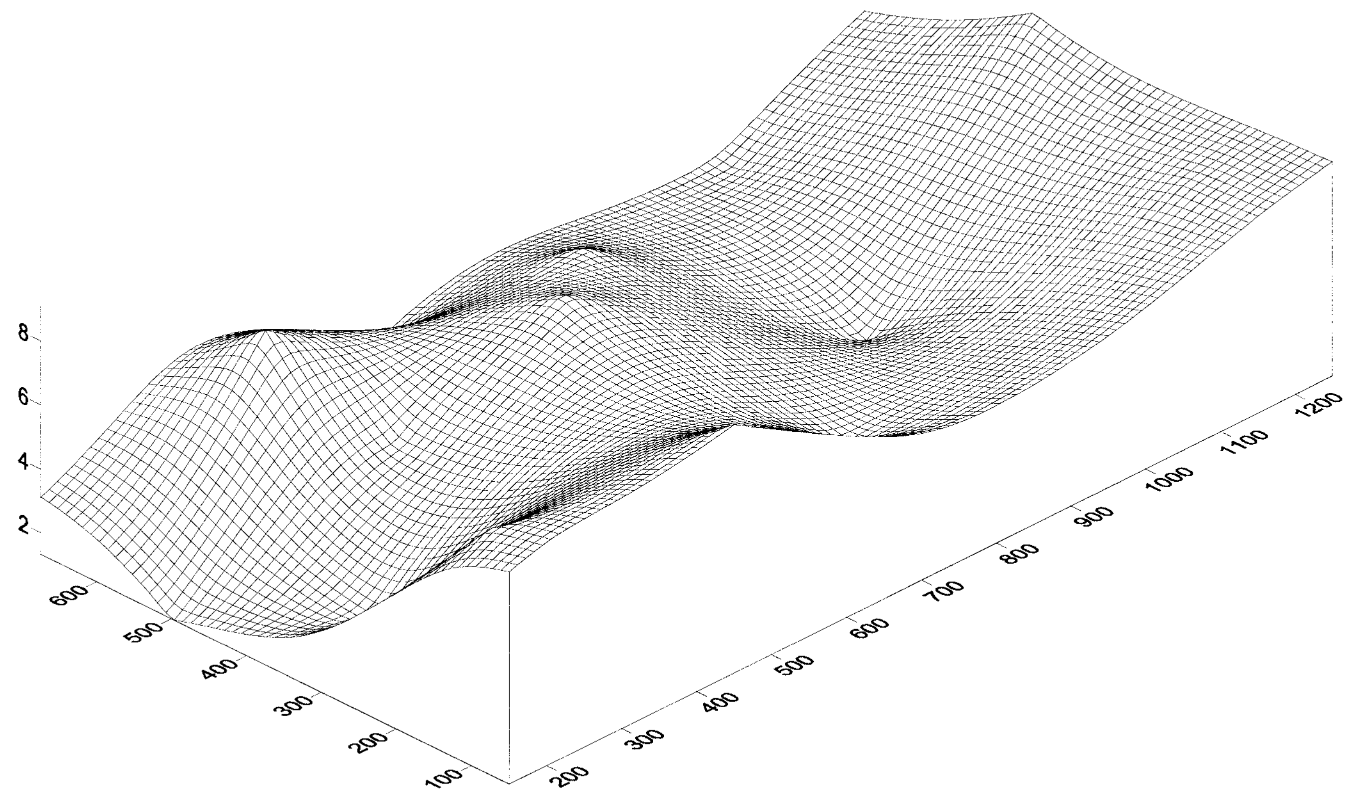


(400,200,6.2)
(450,400,9.3)
(400,600,8.4)
(500,800,7.1)
(300,500,7.5)
(250,200,4.2)
(250,800,12.4)
(250,120,7.3)
(200,1000,3.7)
(2.8)
(9.2)
0
50
100
150
200
250
200
400
600
800
1000
1200
1400

, 675, 2.8
Y Z

Combo Mines

	X	Y	Z
1.	600	675	2.8
2.	1050	650	3.27
3.	350	575	7.2
4.	750	550	5.42
5.	150	500	1.3
6.	400	450	4.5
7.	1250	450	8.13
8.	600	425	7.1
9.	950	375	2.2
15.	250	325	2.2
11.	600	275	6.1
12.	200	125	7.9
13.	700	150	4.5
14.	1150	150	7.3
10.	450	50	9.1



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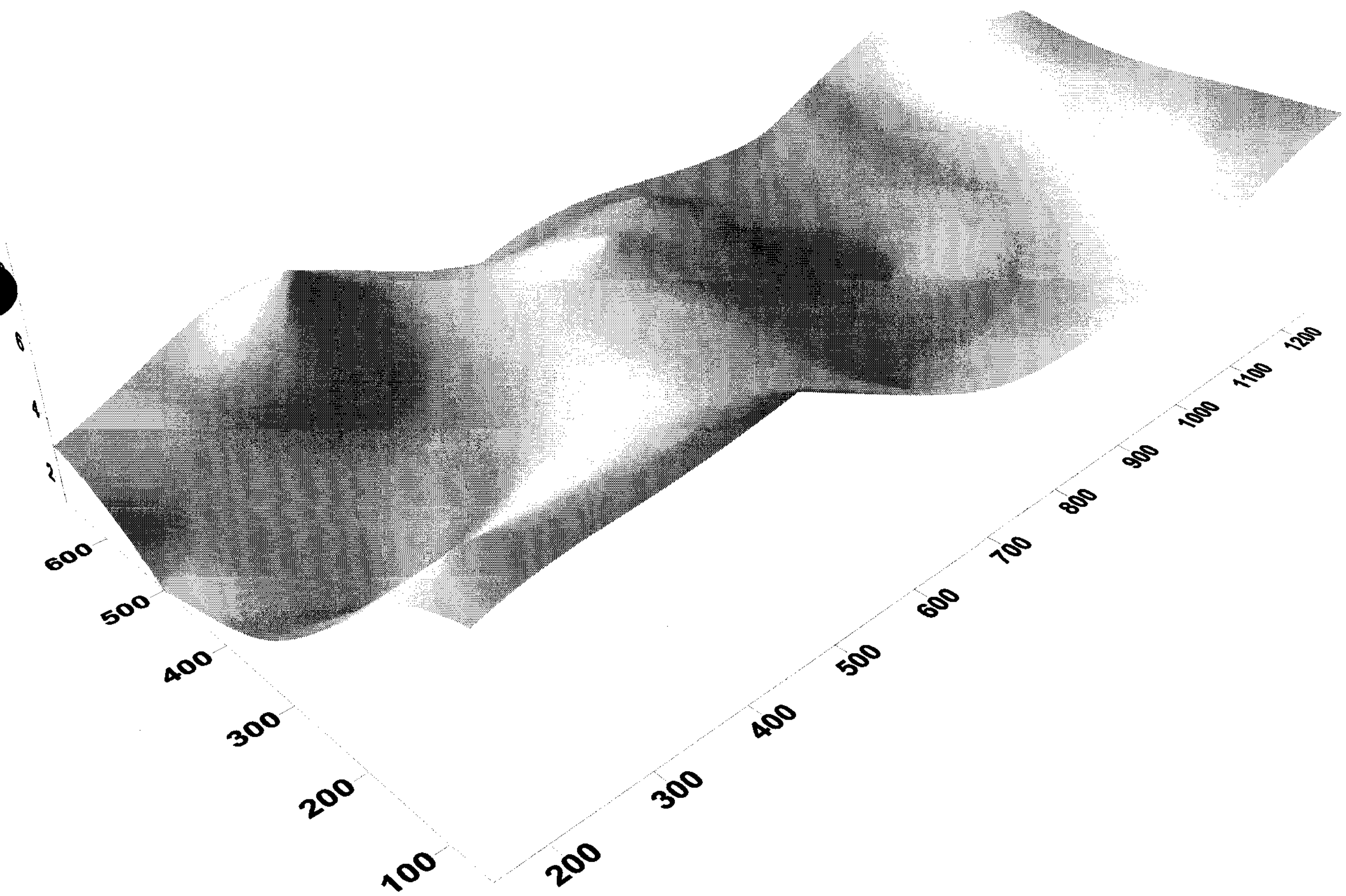

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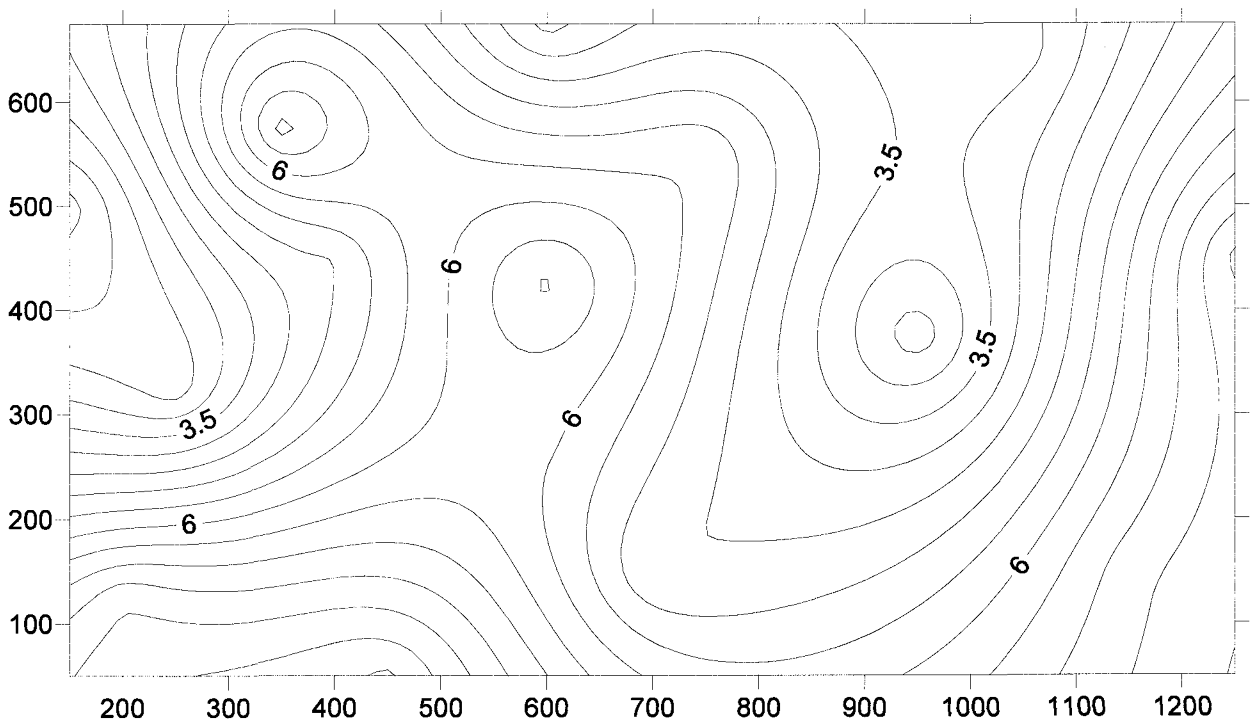

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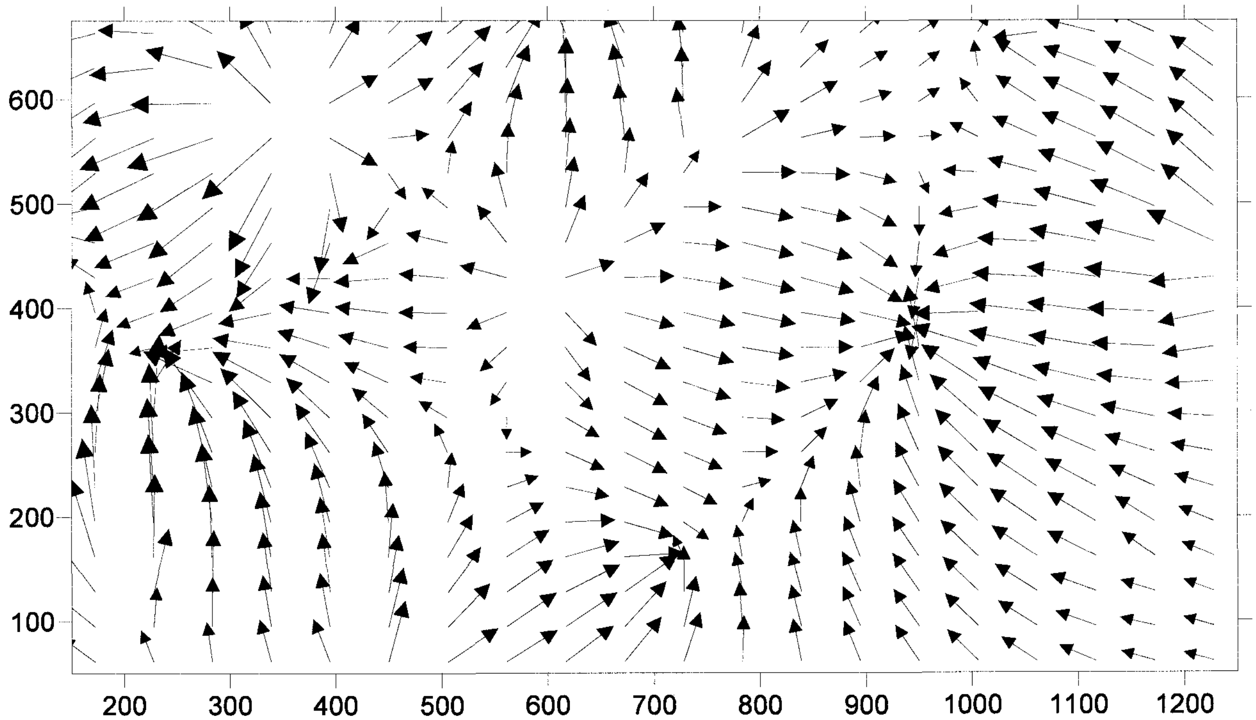
6


600
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200
100
200 300 400 500 600 700 800 900 1000 1100 1200

Gridding Report

Tue Apr 19 14:47:24 2011
Elasped time for gridding: 0.02 seconds

Data Source

Source Data File Name: H:\sheet.bln
X Column: A
Y Column: B
Z Column: C

Data Counts

Active Data: 15

Original Data: 15
Excluded Data: 0
Deleted Duplicates: 0
Retained Duplicates: 0
Artificial Data: 0
Superseded Data: 0

Univariate Statistics

	X	Y	Z
Minimum:	150	50	1.3
25%-tile:	350	150	2.8
Median:	600	425	5.42
75%-tile:	950	550	7.3
Maximum:	1250	675	9.1
Midrange:	700	362.5	5.2
Range:	1100	625	7.8
Interquartile Range:	600	400	4.5
Median Abs. Deviation:	250	150	2.15
Mean:	630	381.66666666667	5.268
Trim Mean (10%):	619.23076923077	384.61538461538	5.2784615384615
Standard Deviation:	334.56439340332	190.93337988826	2.4161793531662
Variance:	111933.33333333	36455.555555556	5.8379226666667
Coef. of Variation:			0.4586521171538
Coef. of Skewness:			-0.11282344066967

Inter-Variable Correlation

	X	Y	Z
X:	1.000	0.099	0.153
Y:		1.000	-0.468
Z:			1.000

Inter-Variable Covariance

	X	Y	Z
X:	111933.33333333	6300	123.56
Y:		36455.555555556	-216.12
Z:			5.8379226666667

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C
Parameter Value:	0.0014516572437304	-0.0061791800235279	6.711842978763
Standard Error:	0.0018028114402587	0.0031589893620682	1.6833886390647

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.099	-0.604
B:		1.000	0.650
C:			1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	22.722167335803	11.361083667902	2.1024
Residual:	12	64.846672664197	5.4038893886831	
Total:	14	87.56884		

Coefficient of Multiple Determination (R^2): 0.25947777012694

Nearest Neighbor Statistics

	Separation	|Delta Z|
Minimum:	134.62912017836	0.9
25%-tile:	150	1.2
Median:	195.25624189767	2.62
75%-tile:	265.75364531837	4.86
Maximum:	301.03986446981	5.7
Midrange:	217.83449232409	3.3
Range:	166.41074429144	4.8
Interquartile Range:	115.75364531837	3.66
Median Abs. Deviation:	45.256241897666	1.42
Mean:	207.75355962894	2.8253333333333
Trim Mean (10%):	206.20264690661	2.7523076923077
Standard Deviation:	55.57390090236	1.5658602179704
Variance:	3088.4584615054	2.4519182222222
Coef. of Variation:	0.26749915140621	0.55422140796497
Coef. of Skewness:	0.28080876317227	0.46592169790939
Root Mean Square:	215.05813167607	3.2302363174645
Mean Square:	46250	10.434426666667

Complete Spatial Randomness

Lambda:	2.1818181818182E-005
Clark and Evans:	1.9408311218031
Skellam:	95.104577604127

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep:	First
X Duplicate Tolerance:	0.00013
Y Duplicate Tolerance:	7.4E-005

No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Gridding Rules

Gridding Method:	Kriging
Kriging Type:	Point

Polynomial Drift Order:	0
Kriging std. deviation grid:	no

Semi-Variogram Model

Component Type:	Linear
Anisotropy Angle:	0
Anisotropy Ratio:	1
Variogram Slope:	1

Search Parameters

No Search (use all data):	true

Output Grid

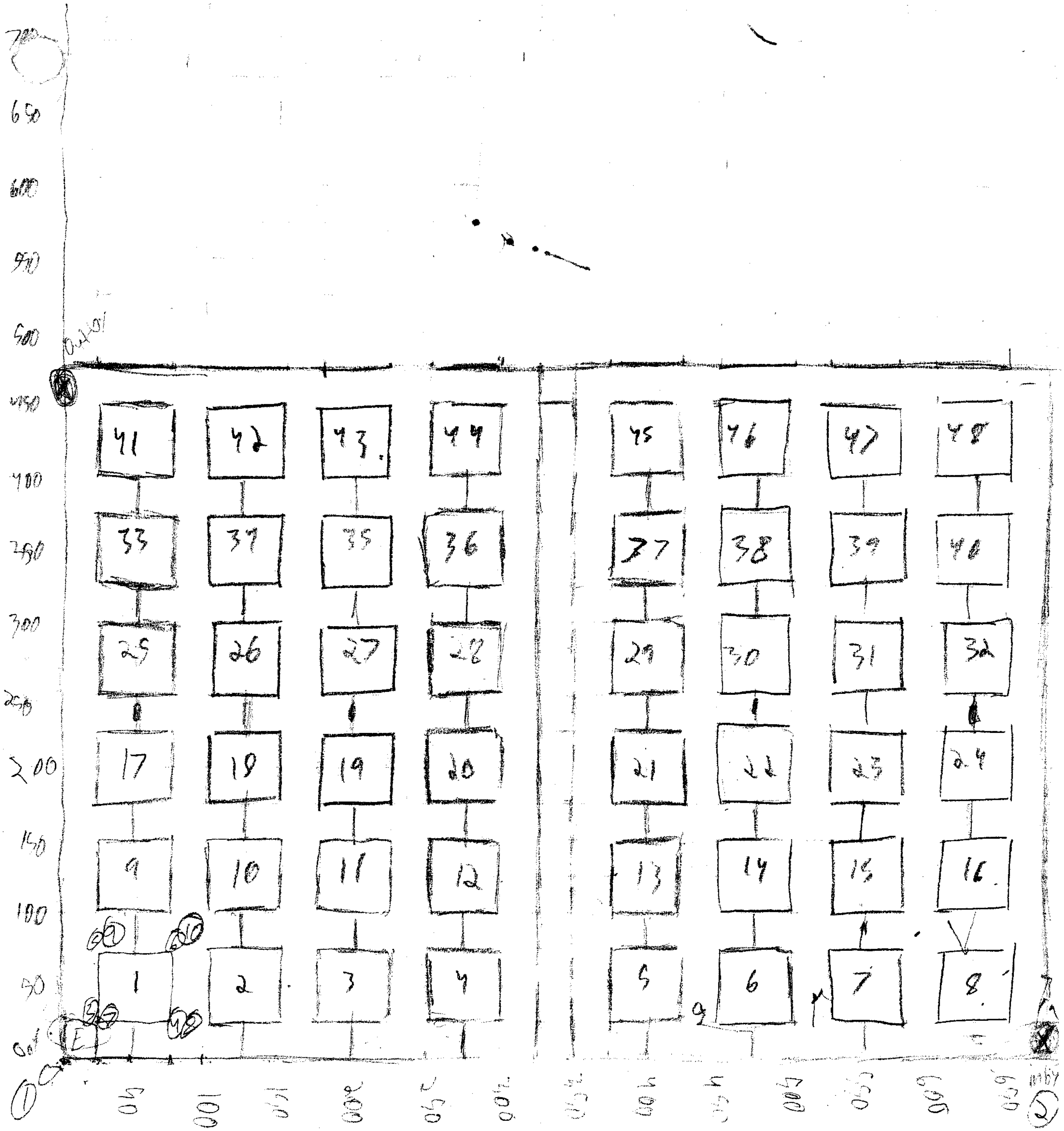
Grid File Name:	H:\sheet.grd
Grid Size:	57 rows x 100 columns
Total Nodes:	5700
Filled Nodes:	5700
Blanked Nodes:	0

Grid Geometry

X Minimum:	150
X Maximum:	1250
X Spacing:	11.111111111111
Y Minimum:	50
Y Maximum:	675
Y Spacing:	11.160714285714

Grid Statistics

Z Minimum:	1.3284854406556
Z 25%-tile:	4.0765206195072
Z Median:	5.2375266750738
Z 75%-tile:	6.2309717083814
Z Maximum:	9.1000000022225
Z Midrange:	5.214242721439
Z Range:	7.7715145615669
Z Interquartile Range:	2.1544510888742
Z Median Abs. Deviation:	1.0562806237821
Z Mean:	5.2147768078636
Z Trim Mean (10%):	5.208656871676
Z Standard Deviation:	1.4871152955659
Z Variance:	2.2115119023061
Z Coef. of Variation:	0.28517333538099
Z Coef. of Skewness:	0.079281290698308
Z Root Mean Square:	5.4226754520382
Z Mean Square:	29.405409058138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33 34 35 36 37 38 39 40
25 26 27 28 29 30 31 32
17 18 19 20 21 22 23 24
9 10 11 12 13 14 15 16
1 2 3 4 5 6 7 8

97, 250, 100,
98, 250, 100,
99, 300, 100,
100, 300, 100,
12 101, 300, 150,
102, 300, 150,
103, 250, 150,
104, 250, 150,

105, 375, 100,
106, 375, 100,
107, 425, 100,
108, 425, 100,
13 109, 425, 150,
110, 425, 150,
111, 375, 150,
112, 375, 150,

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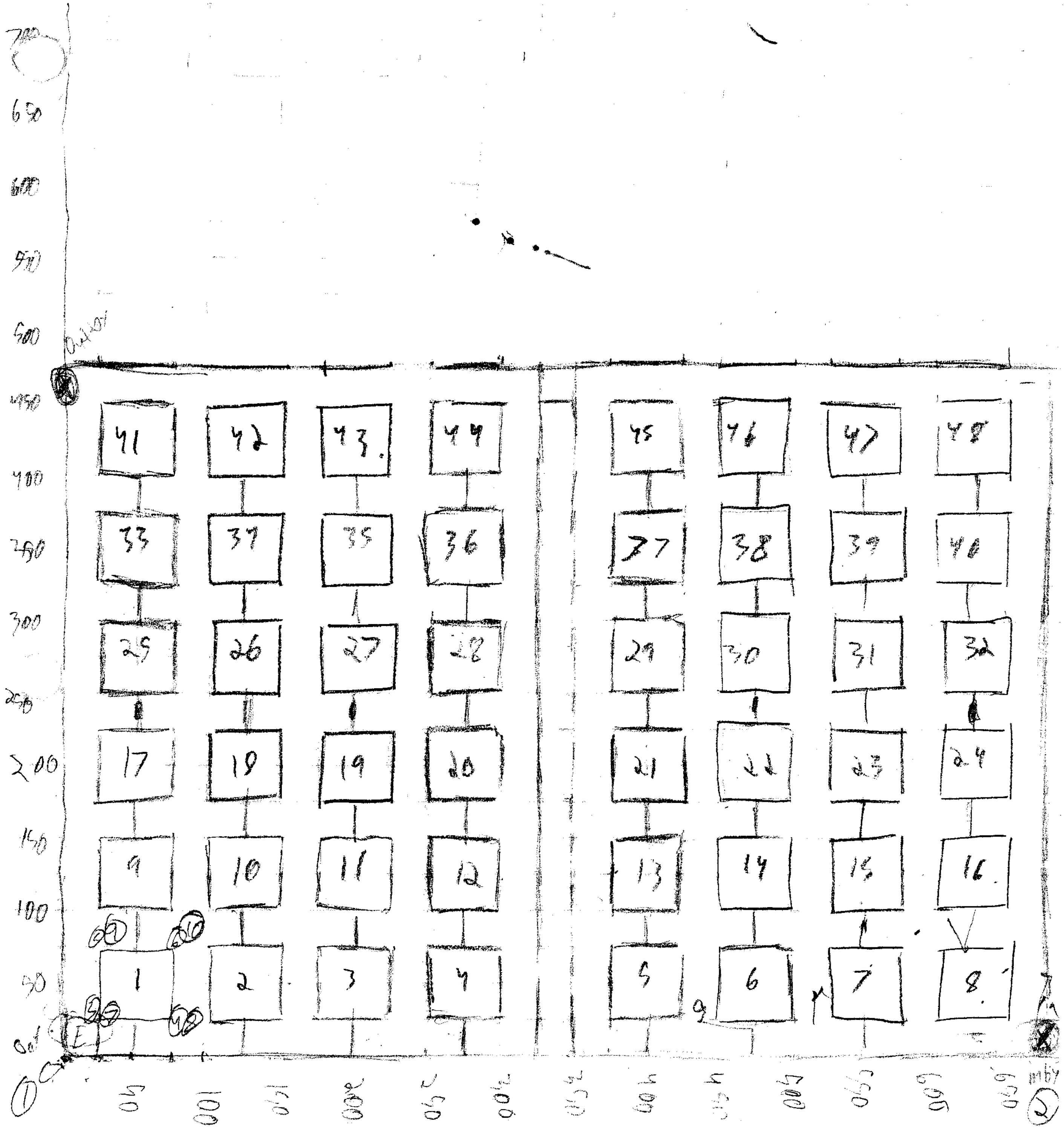
14 117, , ,
118, , ,
119, , ,
120, , ,



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E

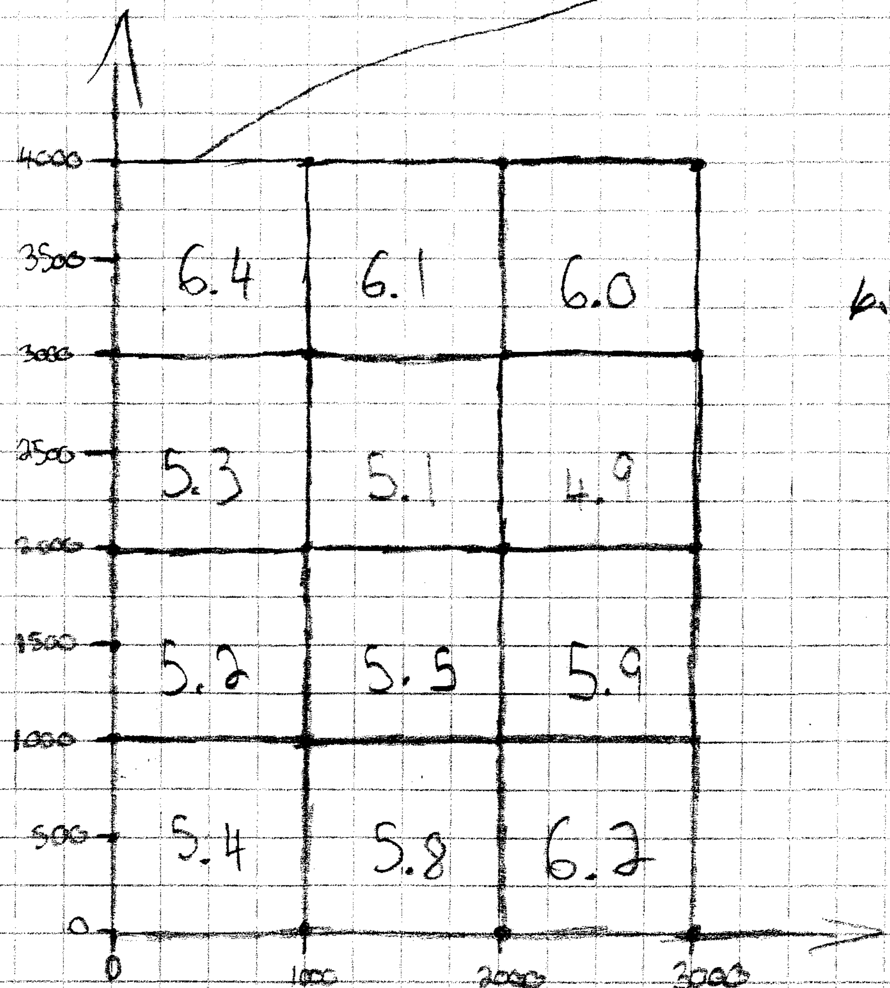
	1. 0, 0,		33. 250, 25,		65. 600, 25,
	2. 0, 0,		34. 250, 25,		66. 600, 25,
	3. 675, 0,		35. 300, 25,		67. 650, 25,
Mine	4. 675, 0,	4	36. 300, 25,	8	68. 650, 25,
	5. 675, 475,		37. 300, 75,		69. 650, 75,
	6. 675, 475,		38. 300, 75,		70. 650, 75,
	7. 0, 475,		39. 250, 75,		71. 600, 75,
	8. 0, 475,		40. 250, 75,		72. 600, 75,
	9. 25, 25,		41. 375, 25,		73. 25, 100,
	10. 25, 25,		42. 375, 25,		74. 25, 100,
	11. 75, 25,		43. 425, 25,		75. 75, 100,
1	12. 75, 25,	5	44. 425, 25,	9	76. 75, 100,
	13. 75, 75,		45. 425, 75,		77. 75, 150,
	14. 75, 75,		46. 425, 75,		78. 75, 150,
	15. 25, 75,		47. 375, 75,		79. 25, 150,
	16. 25, 75,		48. 375, 75,		80. 25, 150,
	17. 100, 25,		49. 450, 25,		81. 100, 100,
	18. 100, 25,		50. 450, 25,		82. 100, 100,
	19. 150, 25,		51. 500, 25,		83. 150, 100,
2	20. 150, 25,	6	52. 500, 25,	10	84. 150, 100,
	21. 150, 75,		53. 500, 75,		85. 150, 150,
	22. 150, 75,		54. 500, 75,		86. 150, 150,
	23. 100, 75,		55. 450, 75,		87. 100, 150,
	24. 100, 75,		56. 450, 75,		88. 100, 150,
	25. 175, 25,		57. 525, 25,		89. 175, 100,
	26. 175, 25,		58. 525, 25,		90. 175, 100,
	27. 225, 25,		59. 575, 25,		91. 225, 100,
3	28. 225, 25,	7	60. 575, 25,	11	92. 225, 100,
	29. 225, 75,		61. 575, 75,		93. 225, 150,
	30. 225, 75,		62. 575, 75,		94. 225, 150,
	31. 175, 75,		63. 525, 75,		95. 175, 150,
	32. 175, 75,		64. 525, 75,		96. 175, 150,

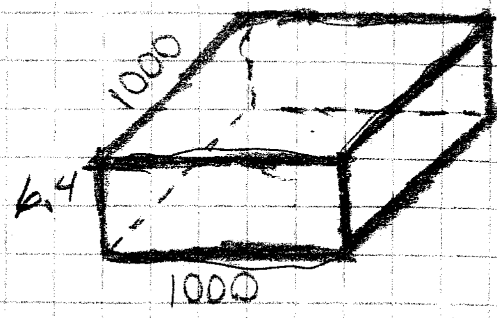
Polygonal Method

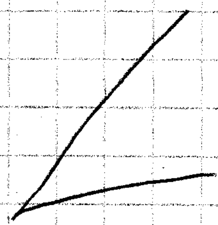
Inverse Distance

Delauney triangulation

Triangulation







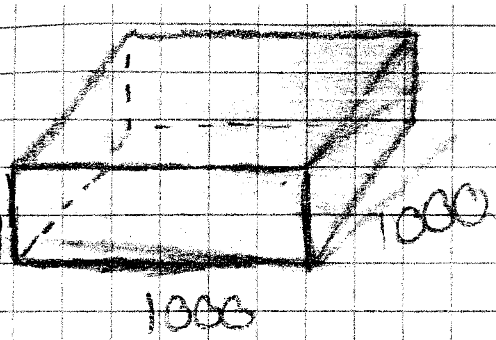
Price of coal = 72.80

4
6400000
6100000
6000000
5300000
5100000
4900000
5200000
5500000
5900000
5400000
5800000
6200000
66,800000 total sq ft

66,800,000
x .04
2672000 tons

2672000
x 72.80
194521,600$
total price of coal

1.

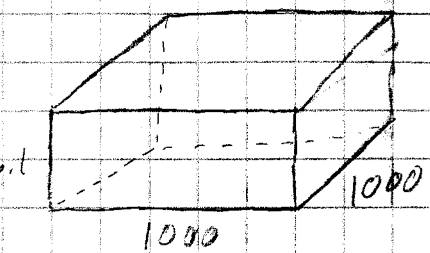


$A = L \cdot W \cdot H$

$A = 1000 \cdot 1000 \cdot 6.4$

$A = 1000000 \cdot 6.4$

$A = 6400000 \, ft^2$

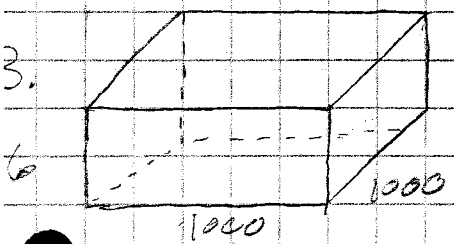


$A = 1000 \cdot 1000 \cdot 6.1$

$A = 1000000 \cdot 6.1$

$A = 6100000 \, ft^2$

3.

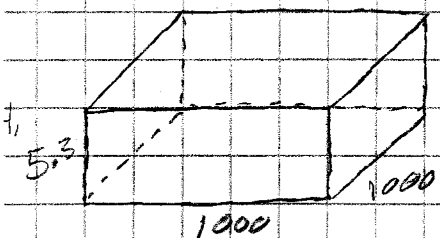


$A = 1000 \cdot 1000 \cdot 6$

$A = 1000000 \cdot 6$

$A = 6000000 \, ft^2$

4.

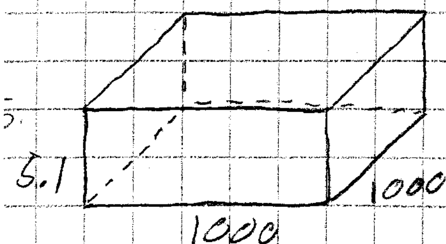


$A = 1000 \cdot 1000 \cdot 5.3$

$A = 1000000 \cdot 5.3$

$A = 5300000 \, ft^2$

5.

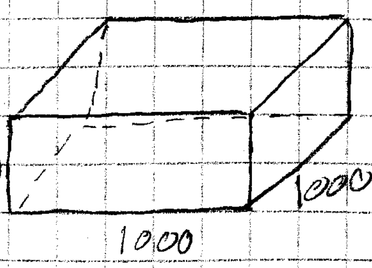


$A = 1000 \cdot 1000 \cdot 5.1$

$A = 1000000 \cdot 5.1$

$A = 5100000 \, ft^2$

6.

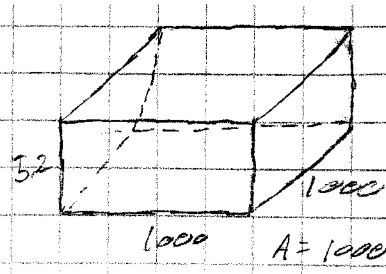


$A = 1000 \cdot 1000 \cdot 4.9$

$A = 1000000 \cdot 4.9$

$A = 4900000 \, ft^2$

2.

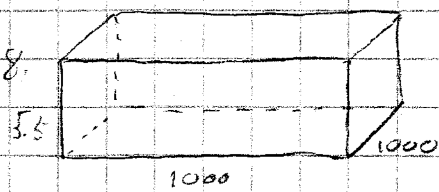


$A = 1000 \cdot 1000 \cdot 5.$

$A = 1000000 \cdot 5.2$

$A = 5200000 \, ft^2$

8.

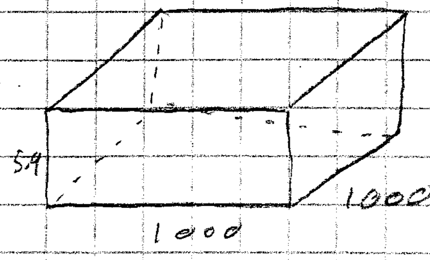


$A = 1000 \cdot 1000 \cdot 5.5$

$A = 100000 \cdot 5.5$

$A = 5500000 \, ft^2$

9.

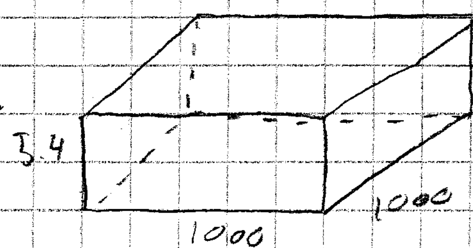


$A = 1000 \cdot 1000 \cdot 5.9$

$A = 100000 \cdot 5.9$

$A = 5900000 \, ft^2$

10.

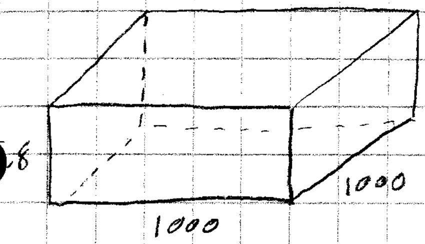


$A = 1000 \cdot 1000 \cdot 5.4$

$A = 1000000 \cdot 5.4$

$A = 5400000 \, ft^2$

11.

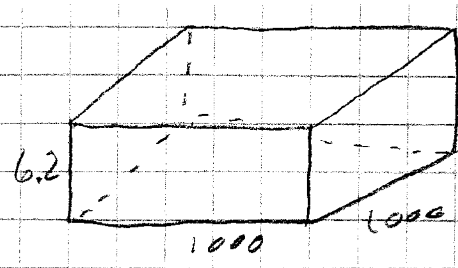


$A = 1000 \cdot 1000 \cdot 5.8$

$A = 1000000 \cdot 5.8$

$A = 5800000\ ft^2$

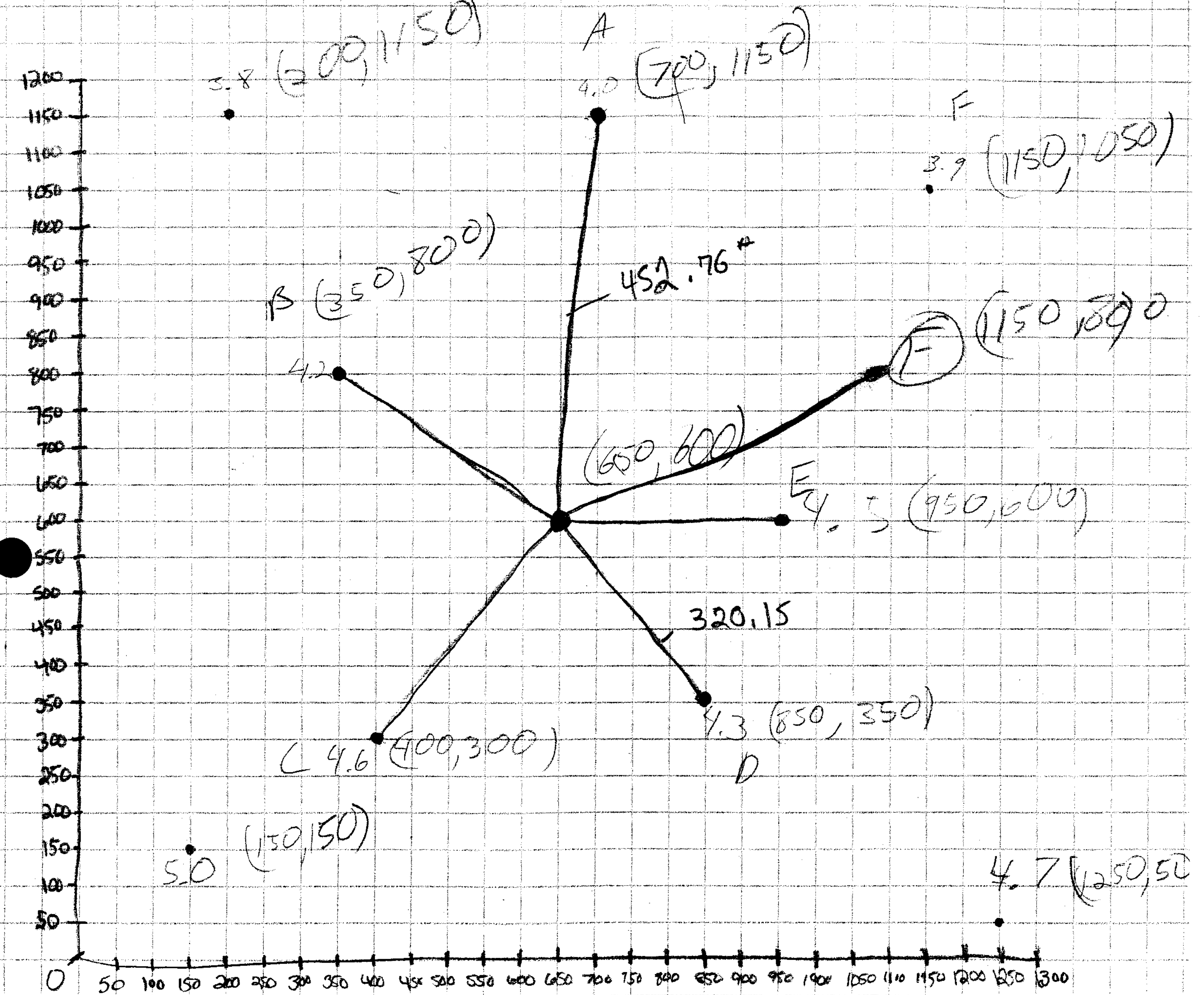
12.



$A = 1000 \cdot 1000 \cdot 6.2$

$A = 1000000 \cdot 6.2$

$A = 6200000\ Ft^2$



A
4.0 (700, 1150)
3.8 (200, 1150)
F
3.9 (1150, 1050)
B (350, 800)
4.2
452.76
F
(1150, 800)
(650, 600)
E
4.5 (950, 600)
320.15
4.3 (850, 350)
D
C 4.6 (400, 300)
5.0 (150, 150)
4.7 (1250, 50)
0

$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Austin Maynard A.) $d = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$

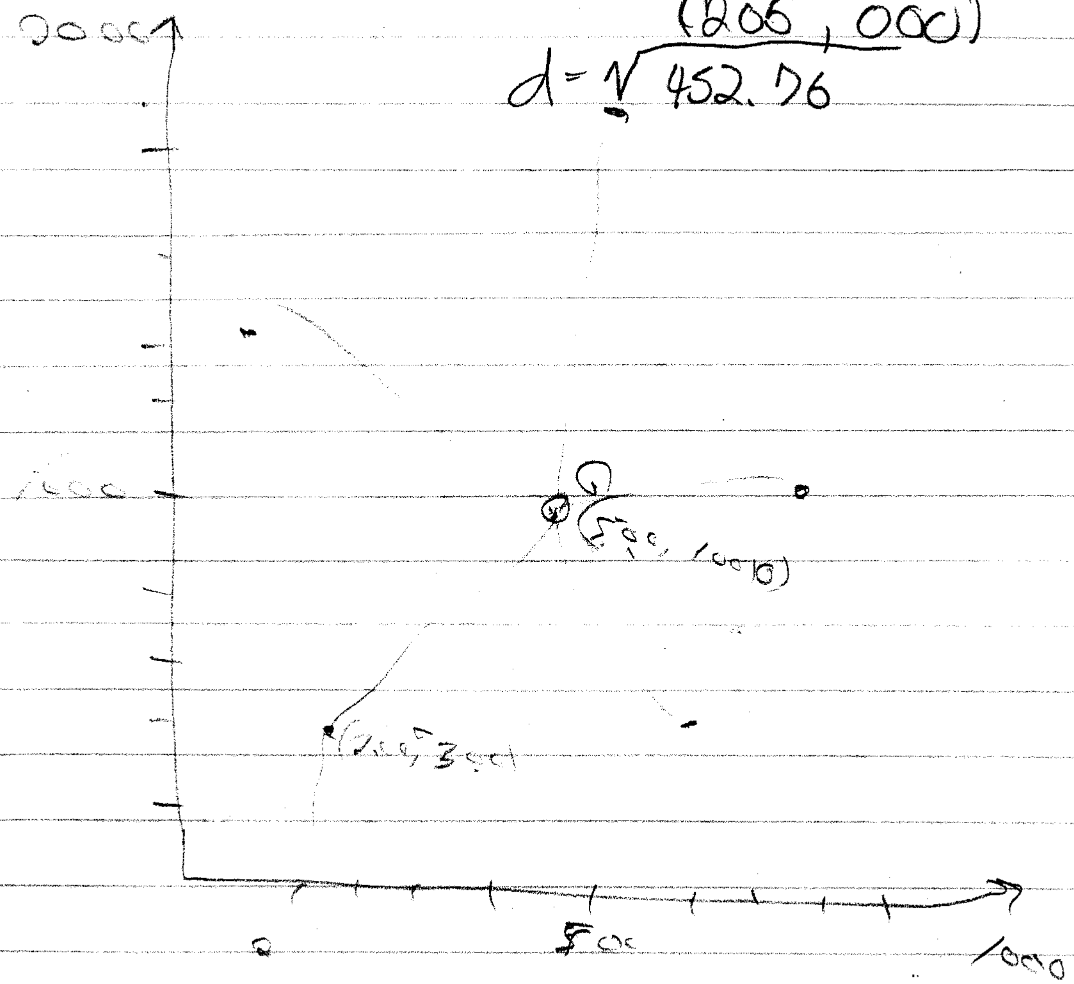
$d = \sqrt{(700-650)^2 + (1150-600)^2}$

H) (3.3)

2500 + 202,500

(205,000)

$d = \sqrt{452.76}$



$d = \sqrt{(1150-600)^2 + (1050-600)^2}$

$550^2 + 450^2$

302500 + 202500 = 710.63 ft

Starter

B) $\sqrt{(350-650)^2 + (800-600)^2}$

$(-300)^2 + (200)^2$

$90000 + 4000$

$13,000 = 114.02$ ft

C) $(400-650)^2 - (300-600)^2$

$(-250)^2 + (-300)^2$

$62500 + 90000$

$152500 = 390.51$ ft

D $\sqrt{(850-650)^2 + (350-600)^2}$

200 250

40,000 62,500

102,500

320.15 ft

E $\sqrt{(950-650)^2 + (600-600)}$

300^2 300 ft

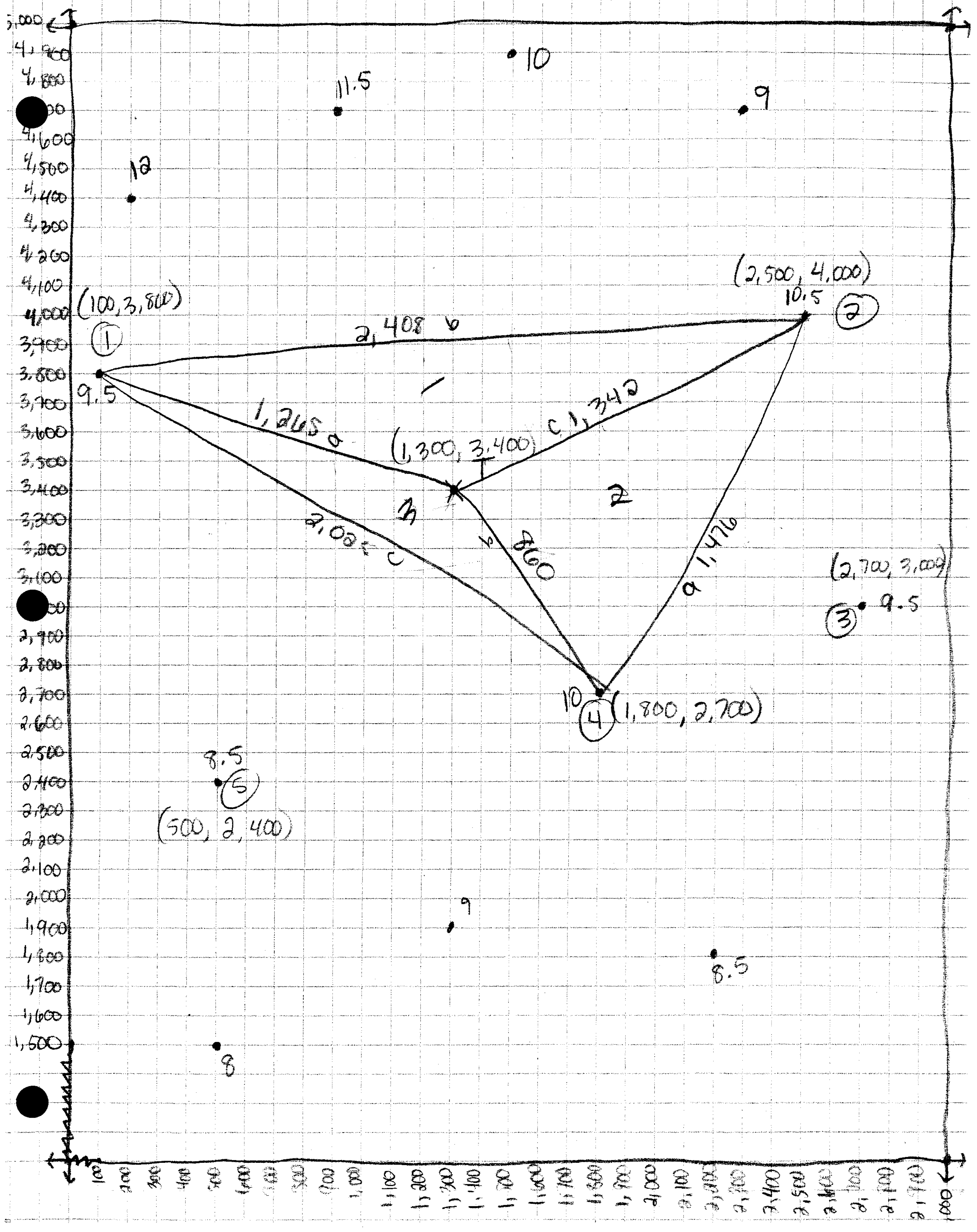
F. $(1150-650)^2 + (800-600)$

500 + 200

250000 + 40000

290000

538.51 ft


(100, 3,800)
1
9.5
(2,500, 4,000)
10.5
2
(2,700, 3,000)
3
9.5
(1,800, 2,700)
4
10
(500, 2,400)
5
8.5
(1,300, 3,400)
2,408 b
1,265 a
c 1,342
2,02 c
860
a 1,476
1
2
3
12
11.5
10
9
9
8.5
8

Part 2!

$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

- Line 1-4

$(1,800 - 100)^2 + (2,700 - 3,800)^2 = \sqrt{4100000}$

$= 2025 ft$

- Line 4-2

$(2,500 - 1,800)^2 + (4,000 - 2,700)^2 = \sqrt{2180000}$

$= 1,476 ft$

- Line 1-2

$(2,500 - 100)^2 + (4,000 - 3,800)^2 = \sqrt{5800000}$

$= 2,408 ft$

$\Delta 1$

$S = 2508$

$A = \sqrt{2508(2508 - 1,265)(2508 - 2,408)(2508 - 1,342)}$

$A = 602905 ft^2$

$\Delta 2$

$S = 1839$

$A = \sqrt{1839(1839 - 1476)(1839 - 860)(1839 - 1,342)}$

$A = 569920 ft^2$

$\Delta 3$

$S = 2075$

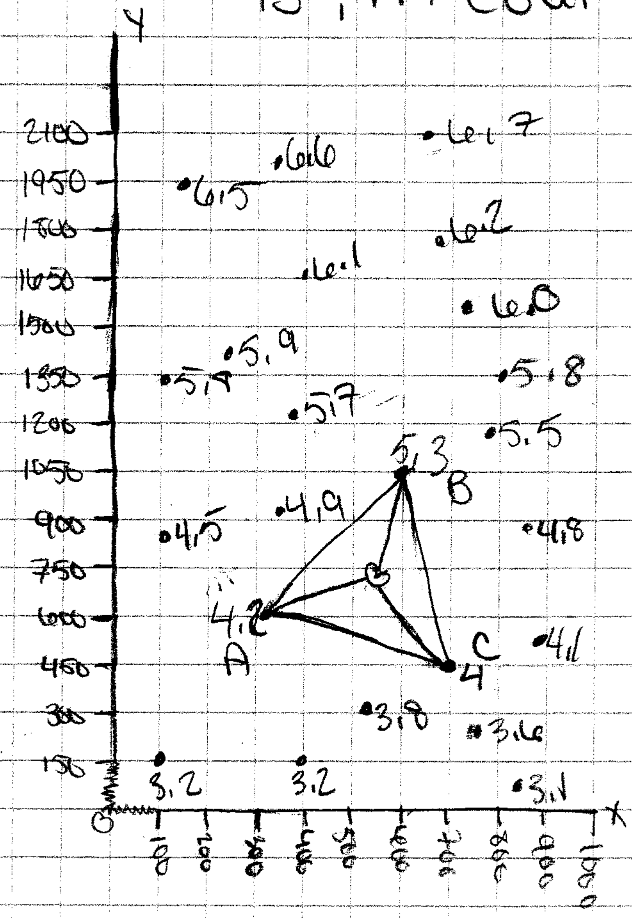
$A = \sqrt{2075(2075 - 1265)(2075 - 860)(2075 - 2,025)}$

$A = 314596 ft^2$

$\hat{V} = \dfrac{(9.5)(569920) + (10.5)(314596) + (10)(602905)}{1487421}$

$= 9.91 \rightarrow 10$

B & M Coal



A = (680, 800)
B = (1050, 600)
C = (450, 700)

Brooke Hunt 1/3

(−) * $^-300a + ^-600b + ^-c = ^-4.2$

* $600a + 1050b + c = 5.3$

(−) * $700a + 450b + c = 4$

$-300a - 600b - c = -4.2$

$+\ 600a + 1050b + c = 5.3$

$300a + 450b = 1.1$

$600a + 1050b + c = 5.3$

$+\ -700a - 450b - c = -4$

$-100a - 600b = 1.3$

$300a + 450b = 1.1$

$\cdot 3\ \ -100a - 600b = 1.3$

$300a + 450b = 1.1$

$-300a - 1800b = 3.9$

$-1350b = 5$

$\frac{-1350b}{-1350} = \frac{5}{-1350}$

$b = ^-.0037$

$300a + 450(^-.0037) = 1.1$

$300a - 1.665 = 1.1$

$+1.665 \quad 1.665$

$\frac{300a}{300} = \frac{2.765}{300}$

$a = .0092$

$300(.0092) + 600(^-.0037) + C = 4.2$

$2.76 - 2.22 + C = 4.2$

$+2.22 \quad +2.22$

$2.76 + C = 6.42$

$-2.76 \quad -2.76$

$C = 3.66$

$V = .0092x + ^-.0037y - 3.66$

$V = .0092(550) + ^-.0037(750) + 3.66$

$5.06 - 2.775 + 3.66$

$V = 5.94\text{ ft.}$

Minimum Roof Bolt Thickness

Ventilation Calculations

Minimum Pillar Size

Safety Factor

Coaleducation.org

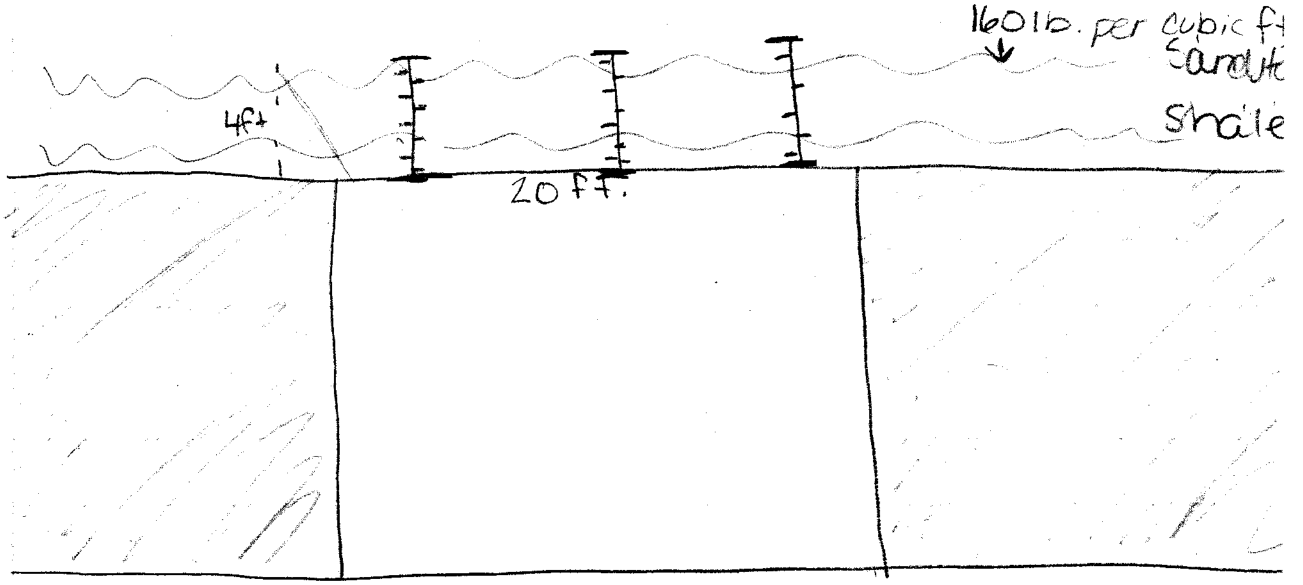
Roof Bolt Thickness

4 rows, therefore $n_1 = 4$

4 bolts per row, therefore $n_2 = 4$

$$P = \frac{wtBL}{(n_1+1)(n_2+1)}$$

w = 160 lb per cu. ft,
t = 4 ft, B = 16 ft
L = 20 ft
safety factor = 2.1



$$P = \frac{(160)(4)(16)(20)}{(5)(5)} \quad \frac{204800}{25} = 8192 \text{ lb per bolt}$$

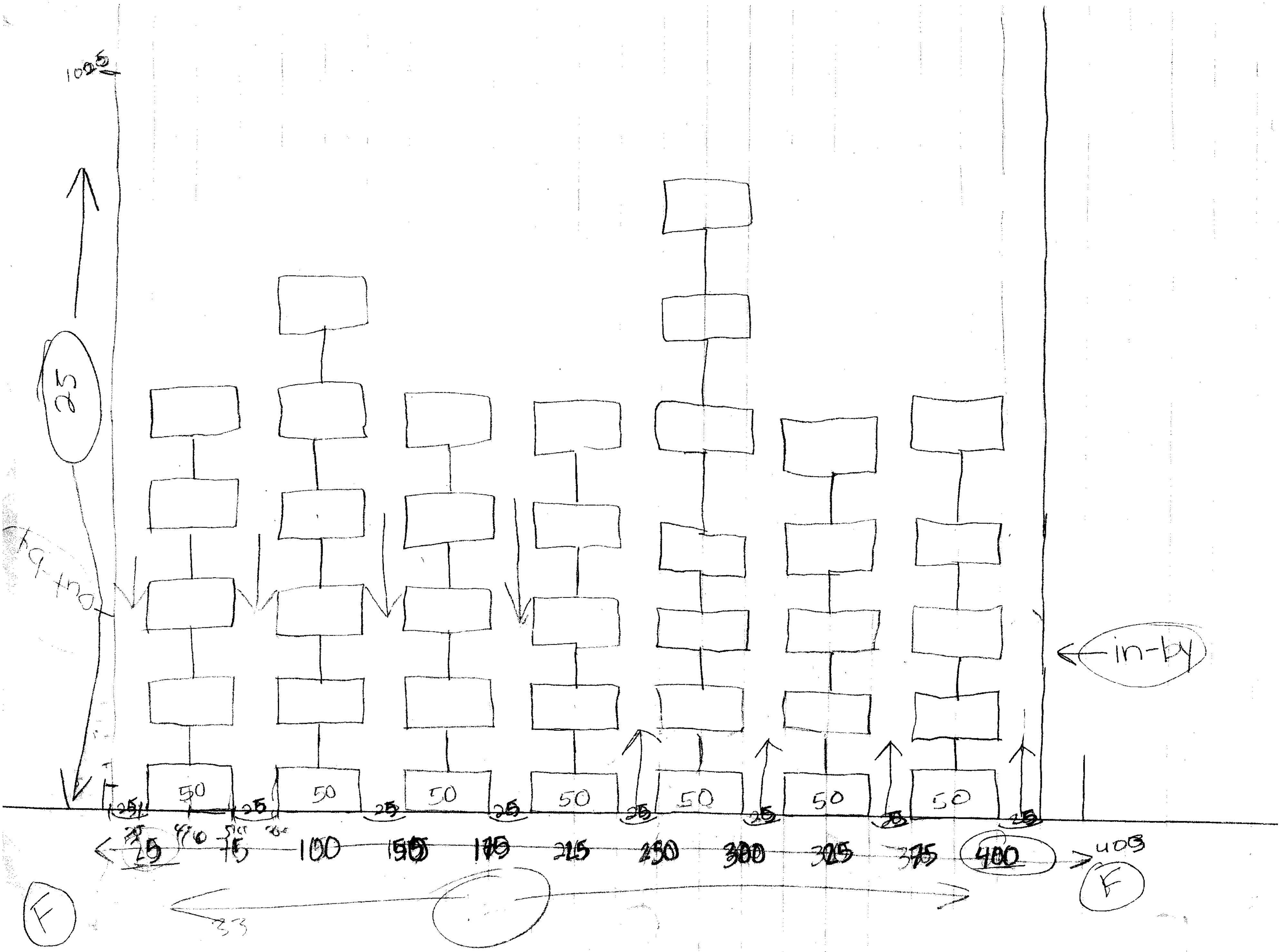
$$\frac{8192 \text{ lb}(2)}{40{,}000 \text{ psi}} = A$$

$$\frac{16384}{40{,}000} = A = 0.4096 \text{ sq. in.} = \pi(0.361)^2$$

$$2(0.361) = d = .722 \text{ in.}; \quad \sqrt{\frac{0.4096}{\pi}} = \frac{\pi r^2}{\pi}$$

1 in. roof bolts

$0.361 = r$



25
in-by
50
F
400

todo list

Kayla, Kayla, ashley

- expand graph to 3000

Split	Cross	Lenght in feet
A	3 x 16	2500
B	6 x 18	1700
C	4 x 17	3000
D	6 x 20	1050

(area) (lenght)

K

$60\cdot10^{-10} = 6^{-9}$

A- Area → cross
K- Chart → $K\cdot10^{-10}$
L- Lenght → lenght in feet
O- Perimeter → sides

1. $48\sqrt{\left[\dfrac{48}{(60\cdot10^{-10})(2500)(38)}\right]^{0.5}} = 13929.144\text{cfm}$

2. $108\sqrt{\left[\dfrac{108}{(60\cdot10^{-10})(1700)(48)}\right]^{0.5}} = 84540.2793\text{cfm}$

3. $68\sqrt{\left[\dfrac{68}{(60\cdot10^{-10})(3000)(42)}\right]} = 741722.7051\text{cfm}$

4. $120\sqrt{\left[\dfrac{120}{(60\cdot10^{-10})(1050)(52)}\right]} = 523722.9366\text{cfm}$

$$\left(\frac{13929.144\text{cfm}}{1363915.065\text{cfm}}\right)(160{,}000) = 1634.018934\text{cfm}$$

$$\frac{84540.2793\text{cfm}}{1363915.065\text{cfm}}(160{,}000) = 9917.36585\text{cfm}$$

$$\frac{741722.7051\text{cfm}}{1363915.065\text{cfm}}(160{,}000) = 87011.014\text{cfm}$$

$$\frac{523722.9366\text{cfm}}{1363915.065\text{cfm}}(160{,}000) = 644378.0009\text{cfm}$$

Hard hat
pick axe
ventilation fan

Problem #1

$A_r = (x+20)^2 = x^2 + 40x + 400$

$A_m = A_r - A_p = \cancel{x^2} + 40x + 400 - \cancel{x^2} = 40x + 400$

$$50\% = \frac{A_m}{A_t}$$

$$(x^2+40x+400) \cdot 0{,}5 = \frac{40x+400}{\cancel{x^2+40x+400}} \cdot \cancel{(x^2+40x+400)}$$

$0{,}5x^2 + 20x + 200 = 40x + 400$

$0{,}5x^2 + 20x - 40x + 200 - 400 = 0$

$0{,}5x^2 - 20x - 200 = 0$

$a = 0{,}5$

$b = -20$

$c = -200$

$$x_{1,2} = \frac{20 \pm \sqrt{(-20)^2 - 4(0{,}5)(-200)}}{2(0{,}5)}$$

$$x_{1,2} = \frac{20 \pm \sqrt{400 + 400}}{1}$$

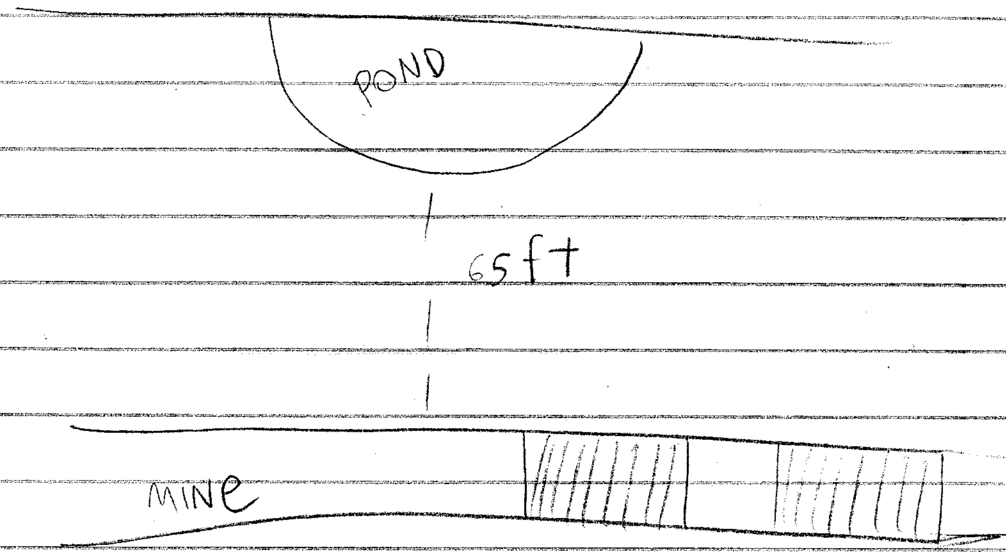
$x_{1,2} = 20 \pm \sqrt{800}$

A✓

$x_1 = 20 + 28{,}28 = 48{,}28 \ ft^2$

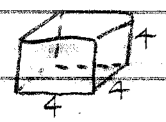
$x_2 = 20 - 28{,}28 = -\cancel{8{,}28}$

Safety factor

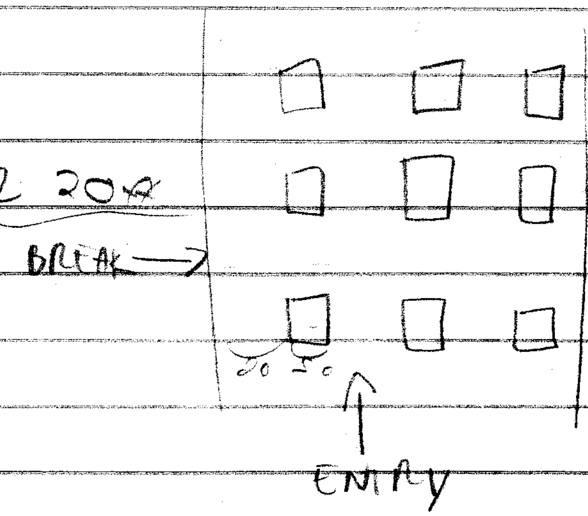


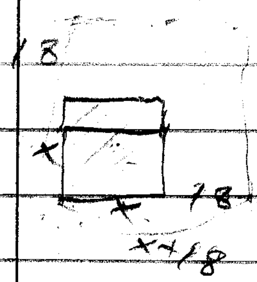
1. $\frac{-b \pm \sqrt{b^2 \; 4ac}}{2a}$ what size pillars

2. MCS



3. H.G. 18 ↔ 22 20





Problem # 2

Avg pillar stress = pre-mining stress × $\frac{\text{tributary area}}{\text{pillar area}}$

$$500\,(1.1) \times \frac{(68.28)^2}{(48.28)^2} =$$

$$= 1100.05 \text{ psi}$$

$$1100.05 = \frac{K\,(48.28 \cdot 12)^{0.5}}{4 \cdot 12}$$

$$K = \frac{48 \cdot 1100.05}{(48.28 \cdot 12)^{0.5}}$$

$$K = 2193.71$$

★K

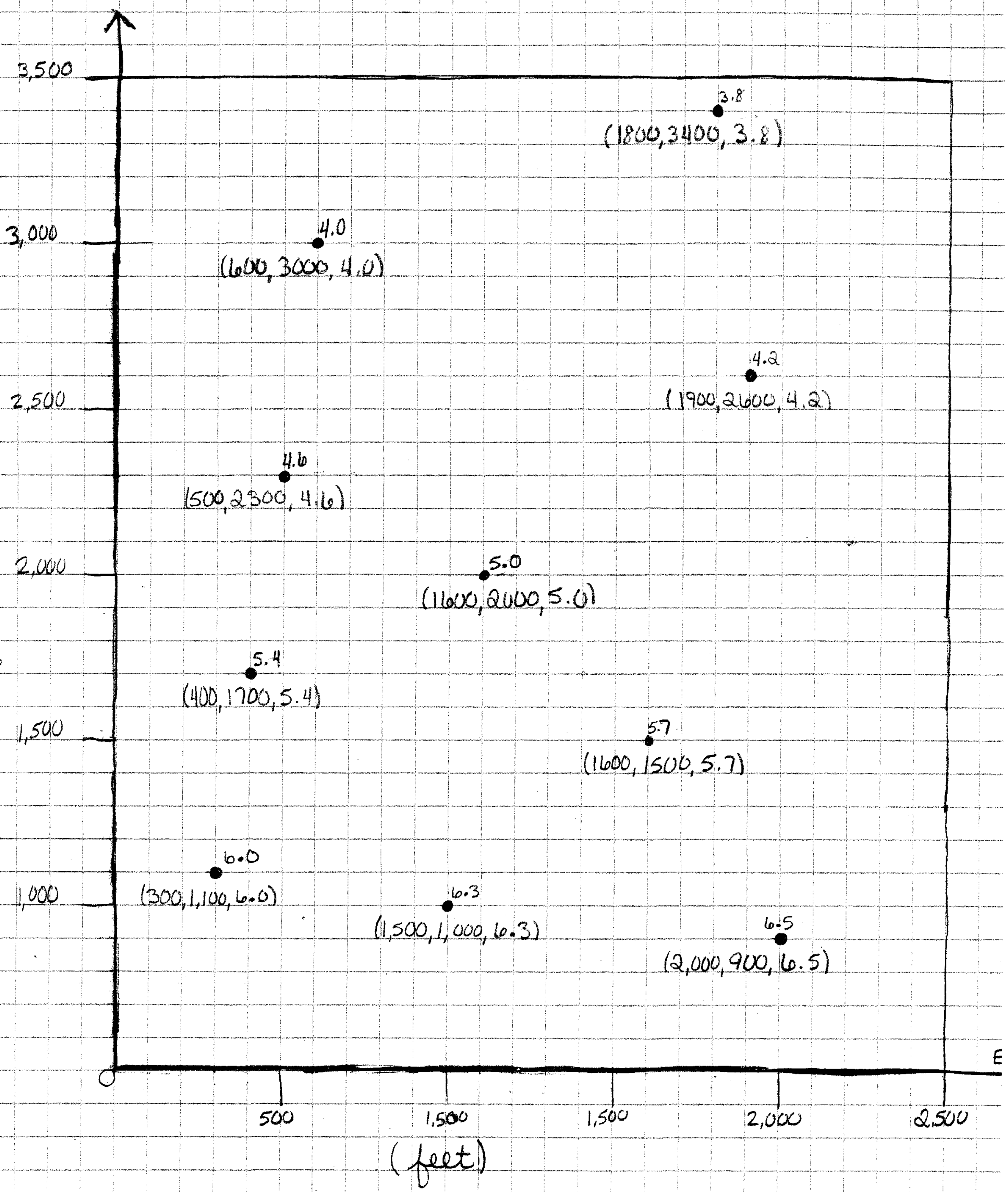
$$\frac{K}{(D)^{0.5}} = \frac{2193.71}{(4)^{0.5}} = 1096.85 \text{ psi}$$

Land Track

2-D & 3-D Pictures of the Mine

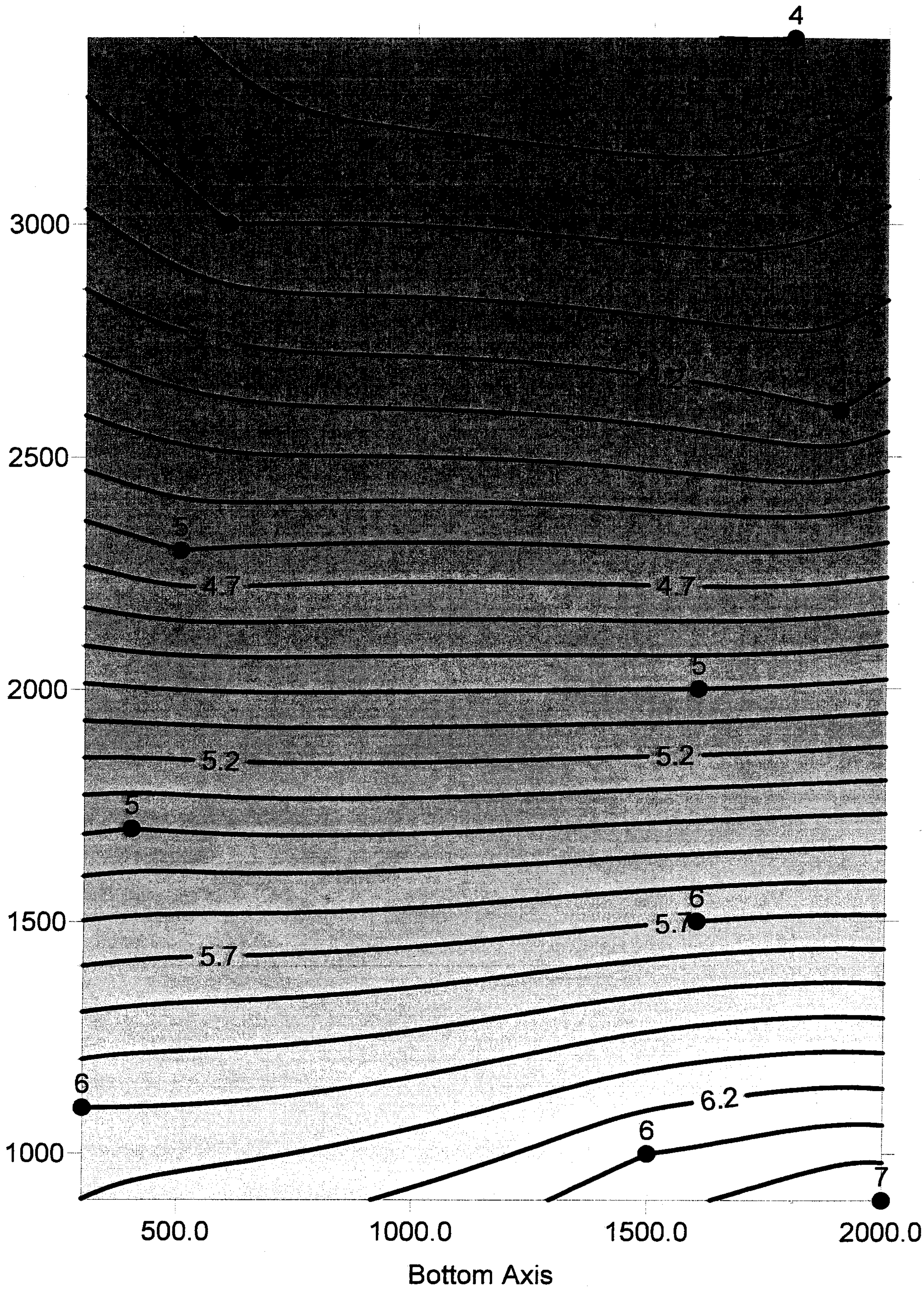
3-D Sketch of Mine

Numerical Picture of Mine

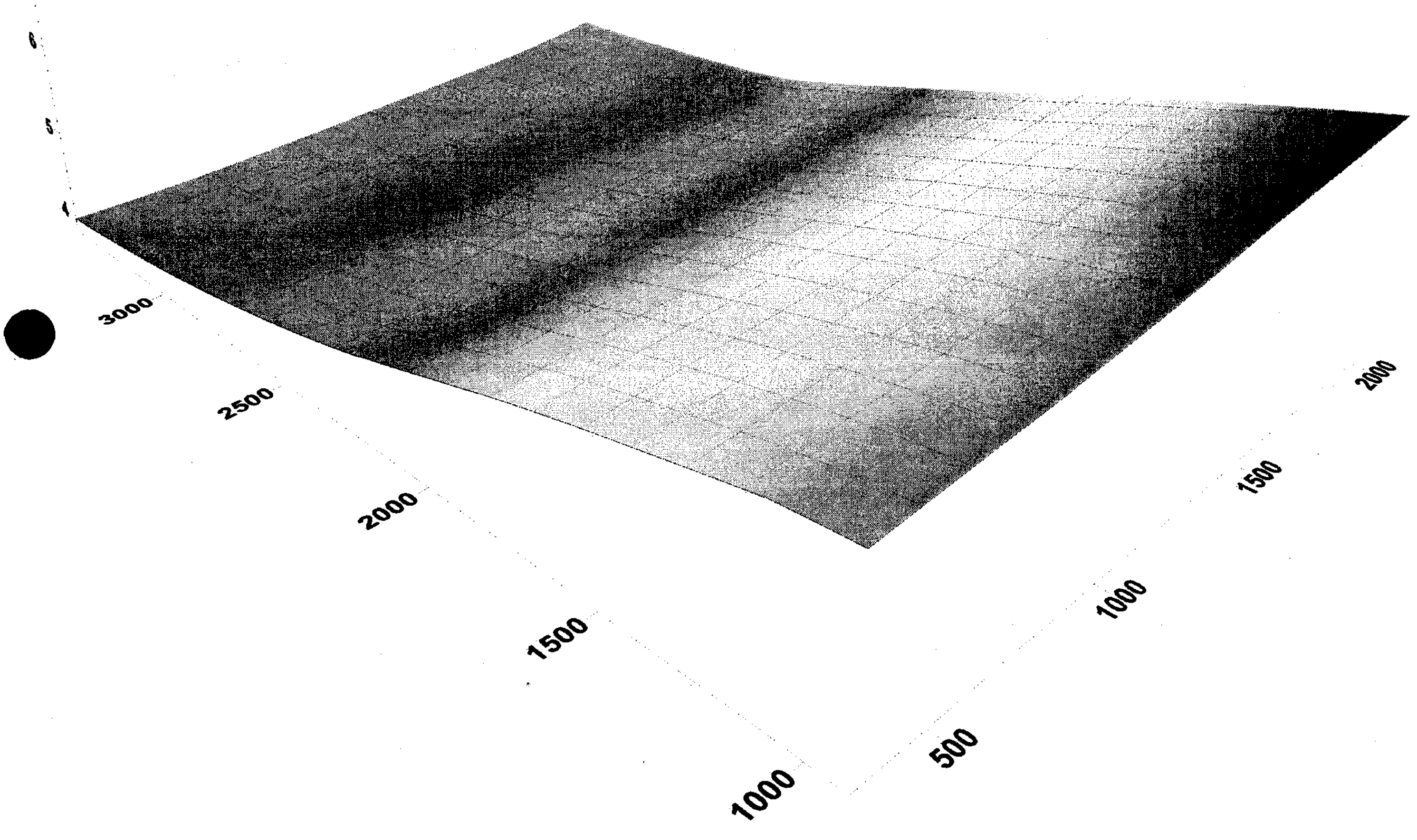


3,500
3,000
2,500
2,000
1,500
1,000
0
500
1,500
1,500
2,000
2,500
(feet)
(feet)
E
(1800,3400,3.8)
(600,3000,4.0)
(1900,2600,4.2)
(500,2300,4.6)
(1600,2000,5.0)
(400,1700,5.4)
(1600,1500,5.7)
(300,1,100,6.0)
(1,500,1,000,6.3)
(2,000,900,6.5)

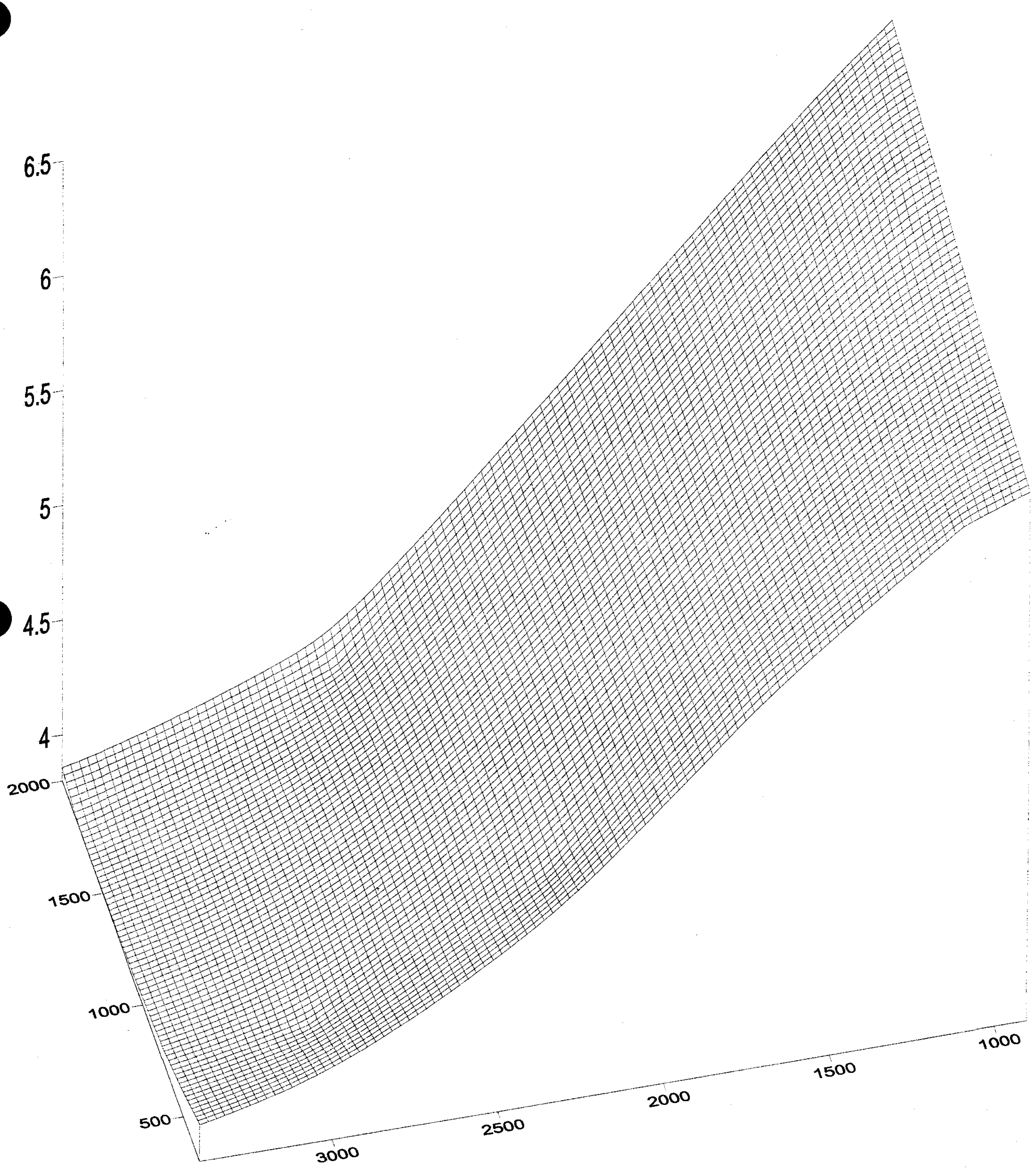
	A	B	C
1	X	Y	Z
2	300	1100	6
3	400	1700	5.4
4	500	2300	4.6
5	600	3000	4
6	1500	1000	6.3
7	1600	2000	5
8	1600	1500	5.7
9	1800	3400	3.8
10	1900	2600	4.2
11	2000	900	6.5



4
4.2
5
4.7
4.7
5
5.2
5.2
5
6
5.7
5.7
6
6.2
6
7
3000
2500
2000
1500
1000
500.0
1000.0
1500.0
2000.0
Bottom Axis

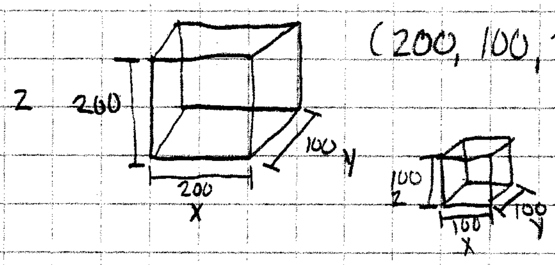


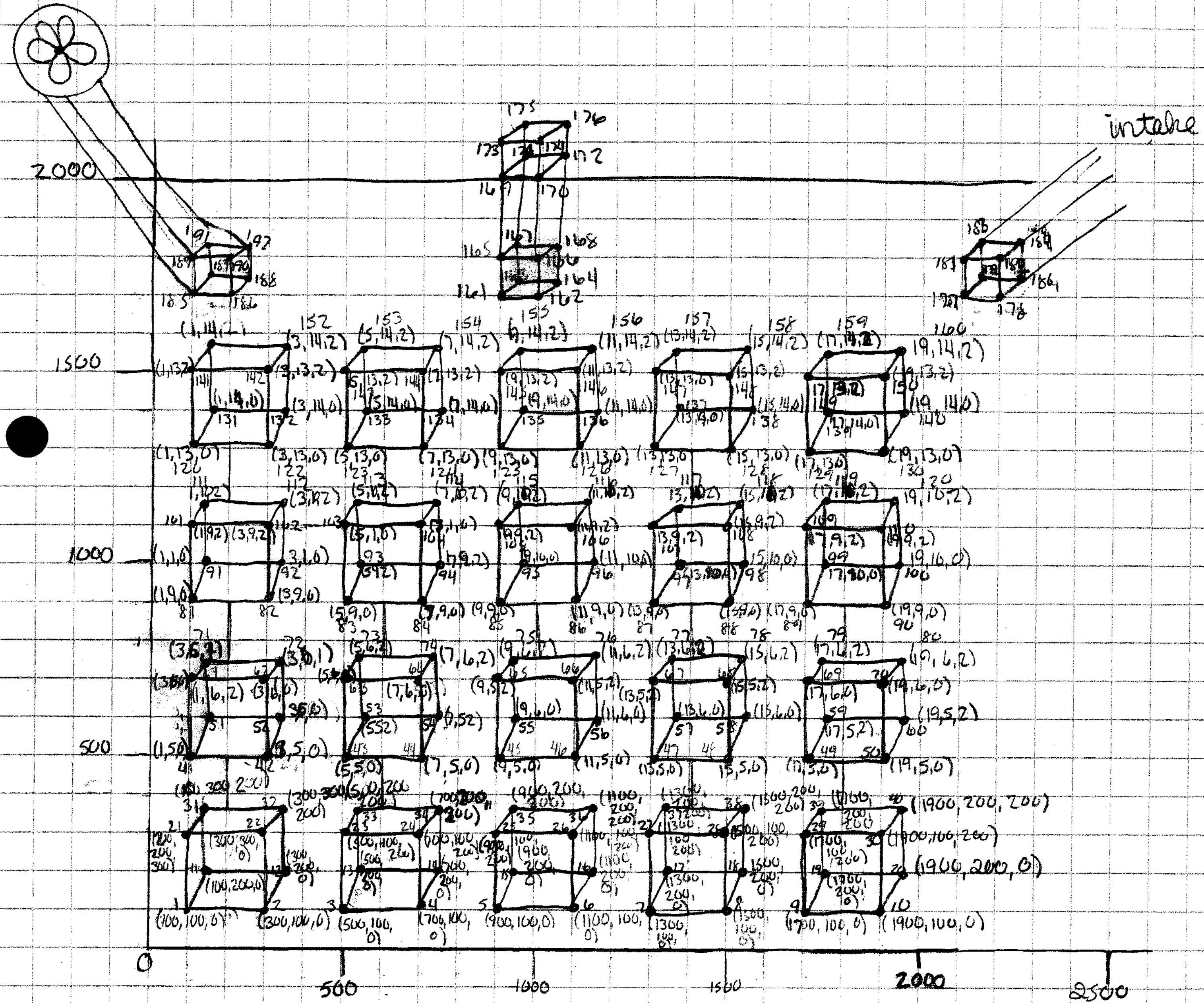
6
5
4
3000
2500
2000
1500
1000
500
1000
1500
2000


6.5
6
5.5
5
4.5
4
2000
1500
1000
500
3000
2500
2000
1500
1000

	A	B	C	D
1	X	Y	Z	Residuals
2	300	1100	1400	-5.999230
3	400	1700	2100	-5.398650
4	500	2300	2800	-4.602987
5	600	3000	3600	-4.002237
6	1500	1000	2500	-6.298421
7	1600	1500	3100	-5.700071
8	1600	2000	3600	-5.000183
9	1800	3400	5200	-3.800670
10	1900	2600	4500	-4.204601
11	2000	900	2900	-6.500000

(200, 100, 200)


Z
200
100
y
200
X
100
Z
100
X
100
y


intake
2000
1500
1000
500
0
500
1000
1500
2000
2500
(100,100,0)
(300,100,0)
(900,100,0)
(1900,100,0)
(1900,200,0)
(1900,100,200)
(1900,200,200)

Point #	(x, y, z)
1	(100, 100, 0)
2	(300, 100, 0)
3	(500, 100, 0)
4	(700, 100, 0)
5	(900, 100, 0)
6	(1100, 100, 0)
7	(1300, 100, 0)
8	(1500, 100, 0)
9	(1700, 100, 0)
10	(1900, 100, 0)
11	(100, 200, 0)
12	(300, 200, 0)
13	(500, 200, 0)
14	(700, 200, 0)
15	(900, 200, 0)
16	(1100, 200, 0)
17	(1300, 200, 0)
18	(1500, 200, 0)
19	(1700, 200, 0)
20	(1900, 200, 0)
21	(100, 100, 200)
22	(300, 100, 200)
23	(500, 100, 200)
24	(700, 100, 200)
25	(900, 100, 200)
26	(1100, 100, 200)
27	(1300, 100, 200)
28	(1500, 100, 200)

30 (1900, 100, 200)
31 (100, 200, 200)
32 (300, 200, 200)
33 (500, 200, 200)
34 (700, 200, 200)
35 (900, 200, 200)
36 (1100, 200, 200)
37 (1300, 200, 200)
38 (1500, 200, 200)
39 (1700, 200, 200)
40 (1900, 200, 200)
41 (100, 500, 0)
42 (300, 500, 0)
43 (500, 500, 0)
44 (700, 500, 0)
45 (900, 500, 0)
46 (1100, 500, 0)
47 (1300, 500, 0)
48 (1500, 500, 0)
49 (1700, 500, 0)
50 (1900, 500, 0)
51 (100, 600, 0)
52 (300, 600, 0)
53 (500, 600, 0)
54 (700, 600, 0)
55 (900, 600, 0)
56 (1100, 600, 0)
57 (1300, 600, 0)
[illegible]

59 (1700, 500, 0)
60 (1900, 500, 0)
61 (100, 500, 200)
62 (300, 500, 200)
63 (500, 500, 200)
64 (700, 500, 200)
65 (900, 500, 200)
66 (1100, 500, 200)
67 (1300, 500, 200)
68 (1500, 500, 200)
69 (1700, 500, 200)
70 (1900, 500, 200)
71 (100, 600, 200)
72 (300, 600, 200)
73 (500, 600, 200)
74 (700, 600, 200)
75 (900, 600, 200)
76 (1100, 600, 200)
77 (1300, 600, 200)
78 (1500, 600, 200)
79 (1700, 600, 200)
80 (1900, 600, 200)
81 (100, 900, 0)
82 (300, 900, 0)
83 (500, 900, 0)
84 (700, 900, 0)
85 (900, 900, 0)
86 (1100, 900, 0)

88 (1500, 900, 0)

89 (1700, 900, 0)

90 (1900, 900, 0)

91 (100, 1000, 0)

92 (300, 1000, 0)

93 (500, 1000, 0)

94 (700, 1000, 0)

95 (900, 1000, 0)

96 (1100, 1000, 0)

97 (1300, 1000, 0)

98 (1500, 1000, 0)

99 (1700, 1000, 0)

100 (1900, 1000, 0)

101 (100, 900, 200)

102 (300, 900, 200)

103 (500, 900, 200)

104 (700, 900, 200)

105 (900, 900, 200)

106 (1100, 900, 200)

107 (1300, 900, 200)

108 (1500, 900, 200)

109 (1700, 900, 200)

110 (1900, 900, 200)

111 (100, 1000, 200)

112 (300, 1000, 200)

113 (500, 1000, 200)

114 (700, 1000, 200)

115 (900, 1000, 200)

[illegible]

Jan:

185 (100, 1700, 0)

186 (200, 1700, 0)

187 (100, 1800, 0)

188 (200, 1800, 0)

189 (100, 1700, 100)

190 (200, 1700, 100)

191 (100, 1800, 100)

192 (200, 1800, 100)

117 (1300, 1000, 200)
118 (1500, 1000, 200)
119 (1700, 1000, 200)
120 (1900, 1000, 200)
121 (100, 1300, 0)
122 (300, 1300, 0)
123 (500, 1300, 0)
124 (700, 1300, 0)
125 (900, 1300, 0)
126 (1100, 1300, 0)
127 (1300, 1300, 0)
128 (1500, 1300, 0)
129 (1700, 1300, 0)
130 (1900, 1300, 0)
131 (100, 1400, 0)
132 (300, 1400, 0)
133 (500, 1400, 0)
134 (700, 1400, 0)
135 (900, 1400, 0)
136 (1100, 1400, 0)
137 (1300, 1400, 0)
138 (1500, 1400, 0)
139 (1700, 1400, 0)
140 (1900, 1400, 0)
141 (100, 1300, 200)
142 (300, 1300, 200)
143 (500, 1300, 200)
144 (700, 1300, 200)

146 (1100, 1300, 200)
147 (1300, 1300, 200)
148 (1500, 1300, 200)
149 (1700, 1300, 200)
150 (1900, 1300, 200)
151 (100, 1400, 200)
152 (300, 1400, 200)
153 (500, 1400, 200)
154 (700, 1400, 200)
155 (900, 1400, 200)
156 (1100, 1400, 200)
157 (1300, 1400, 200)
158 (1500, 1400, 200)
159 (1700, 1400, 200)
160 (1900, 1400, 200)

Intake:
177 (2100, 1700, 0)
178 (2200, 1700, 0)
179 (2100, 1800, 0)
180 (2200, 1800, 0)
181 (2100, 1700, 100)
182 (2200, 1700, 100)
183 (2100, 1800, 100)
184 (2200, 1800, 100)

Shaft:
161 (900, 1700, 0)
162 (1000, 1700, 0)
163 (900, 1800, 0)
164 (1000, 1800, 0)
165 (900, 1700, 100)
166 (1000, 1700, 100)
167 (900, 1800, 100)
168 (1000, 1800, 100)
169 (900, 2000, 0)
170 (1000, 2100, 0)
171 (900, 2000, 0)
172 (1000, 2100, 0)
173 (900, 2000, 100)
174 (1000, 2100, 100)
175 (900, 2000, 100)
176 (1000, 2100, 100)

Minimum Roof Bolt Thickness

Minimum Pillar Size & Safety Factor

Minimum Laboratory Compressive Strength

Distribution of Air by Natural Splitting

Diameter of Roof Bolts

Cameron Skidmore, Nick Hillerman, Allison Curry

$$P = \frac{wtBL}{(n_2+1)(n_2+1)}$$

$$P = \frac{(155)(6)(14)(18)}{(6)\ (4)} = 11718 \text{ lb. per bolt}$$

$$\frac{11718 \text{ lb.}\ (2)}{40{,}000 \text{ psi}} = A = 0.5859 \text{ sq. in.} = \pi r^2$$

Thus, the bolt's diameter is $2r = 2(.369) = 0.738$ in.

A 3/4-in. bolt is recommended

PROBLEM 1:

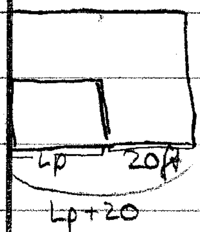
A_T = Area total

L_p = Pillar length

A_p = Pillar area $\qquad A_p = L_p^2$

A_m = minea area

$= A_T - A_p$



$$A_T = (L_p+20)(L_p+20)$$
$$= L_p^2 + 40L_p + 400$$
$$A_m = A_t - A_p$$
$$= L_p^2 + 40L_p + 400 - L_p^2$$
$$= 40L_p + 400$$

$$50\% = \frac{A_m}{A_T}$$

$$0.5 = \frac{40L_p + 400}{L_p^2 + 40L_p + 400} \quad \Big| \cdot L_p^2 + 40L_p + 400$$

$$0.5(L_p^2 + 40L_p + 400) = 40L_p + 400$$

$$0.5L_p^2 + 20L_p + 200 = 40L_p + 400 \quad \Big| -40L_p - 400$$

$$0.5L_p^2 + 20L_p + 200 - 40L_p - 400 = 0$$

$$0.5L_p^2 - 20L_p - 200 = 0$$

↓

$a = 0.5$

$b = -20$

$c = -200$

$$L_p = \frac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2a}$$

$$L_p = \frac{+(+20) \pm \sqrt{(-20)^2 - 4(0.5)\cdot(-200)}}{2(0.5)}$$

$$L_p = +20 \pm \sqrt{400 + 400}$$

$$L_p = 20 \pm \sqrt{800}$$

$L_p = 20 + 28{,}28$ or ~~$L_p = 20 - 28{,}28$~~

$L_p = 48{,}28$ ft pillar (square) ~~$L_p = -8{,}28$~~

Problem 2:

Avg pillar stress.

$$Avg = 700(1.1) \cdot \frac{66^2}{48.28^2} =$$

$$770 \cdot \frac{4356}{2330,9584} =$$

$$770 \cdot 1.9 = \boxed{1463\ psi}$$

$K = ?$

$$1463 = \frac{K \cdot \sqrt{48.28 \cdot 12}}{6 \cdot 12} - \frac{K \cdot 24,1}{72}$$

$$1463 = \frac{24.1K}{72} -$$

$$105336 = 24.1K$$

$$K = 4371$$

$$\frac{4371}{\sqrt{4}} = 2185,5\ psi$$

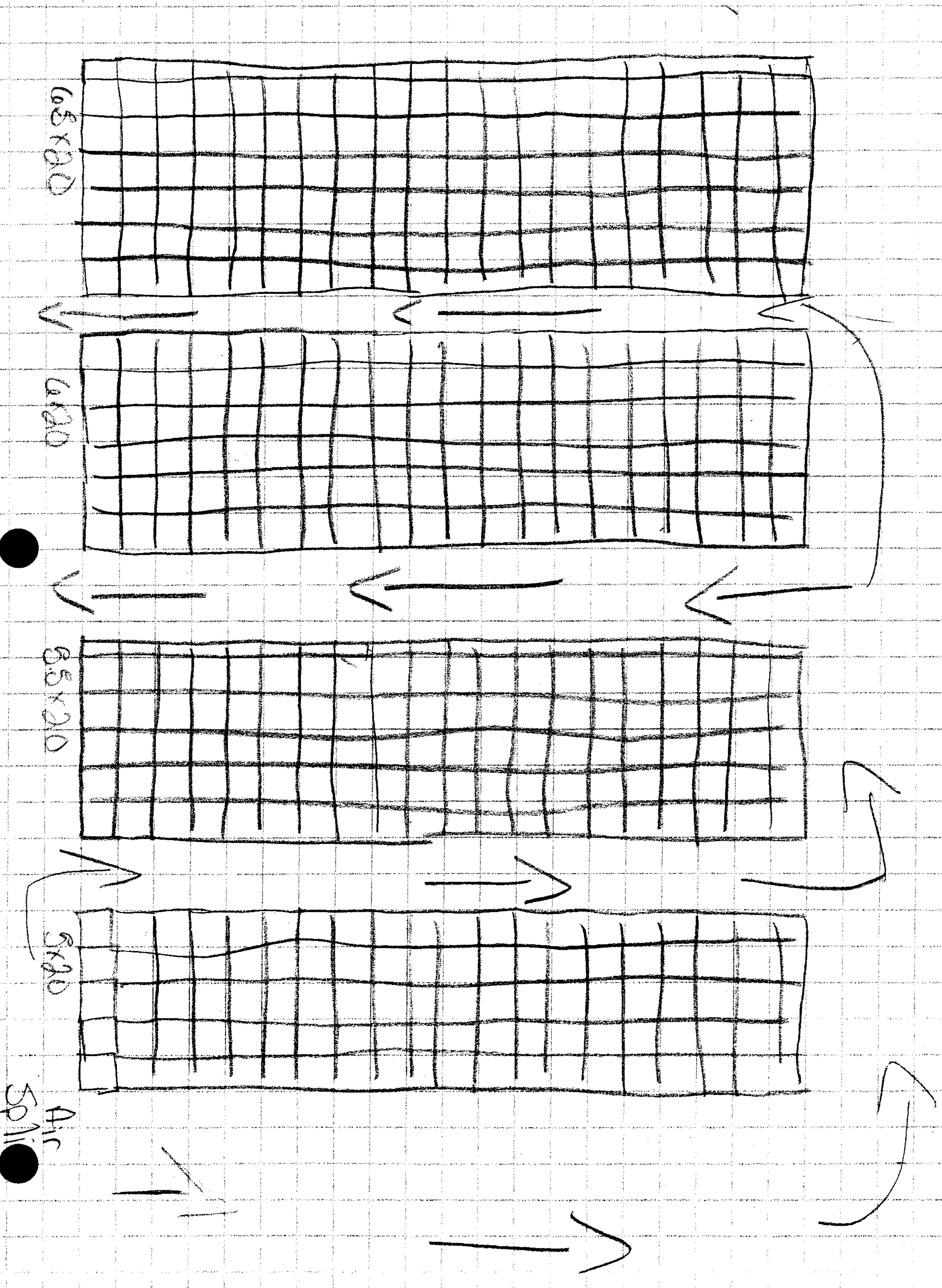
Problem 3:

$$\text{safety factor } F = \frac{2185,5}{\text{average pillar stress}}$$

$$F = \frac{2185,5}{1463} = 1,49 \approx 1.5$$

Key

- each block is a foot
- → Natural air Splitting



Stump me!!

Split	Cross Section (ft)	Length (ft)
A	5 x 20	2000
B	5.5 x 20	2500
C	6 x 20	3000
D	6.5 x 20	3500

(1) $qa \propto 100\left[\frac{100}{(100\times10^{-10})(2000)(50)}\right]^{0.5} = 31,623$ cfm

+

(2) $qa \propto 110\left[\frac{110}{(100\times10^{-10})(2500)(62.5)}\right]^{0.5} = 25,298$ cfm

+

(3) $qa \propto 120\left[\frac{120}{(100\times10^{-10})(3000)(75)}\right]^{0.5} = 27,713$ cfm

+

(4) $qa \propto 130\left[\frac{130}{(100\times10^{-10})(3500)(87.5)}\right]^{0.5} = 26,784$ cfm

111,418

(1a) $\frac{31,623}{111,418} \times 200,000 = 42679$ cfm

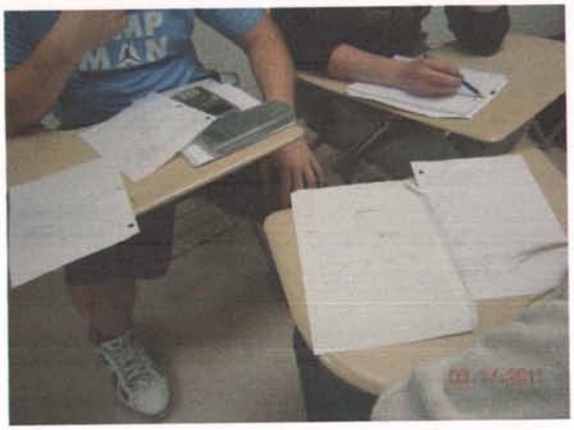
(2a) $\frac{25,298}{111,418} \times 200,000 = 45521$ cfm

(3a) $\frac{27,713}{111,418} \times 200,000 = 49746$ cfm

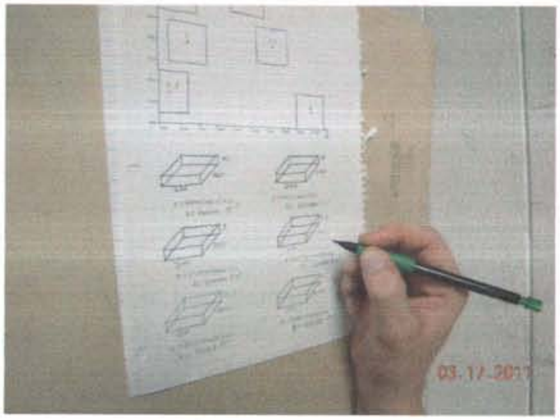
(4a) $\frac{26,784}{111,418} \times 200,000 = 48078$ cfm

Pictures

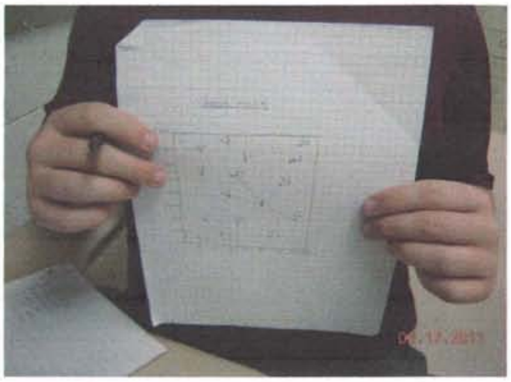
Mathematics



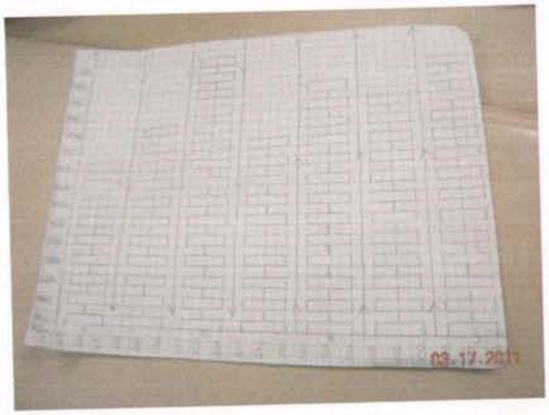
Delauney Triangulation



The Polygonal Method

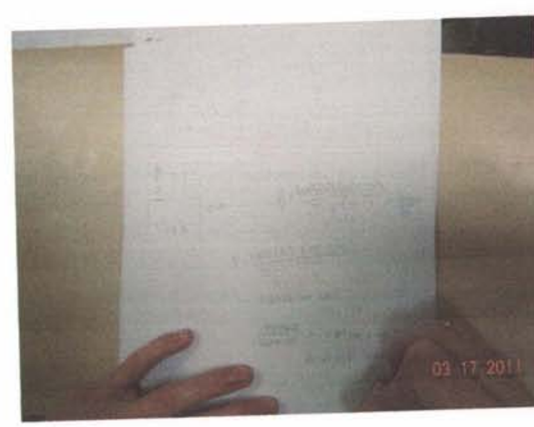


Land Track for Inverse Distance



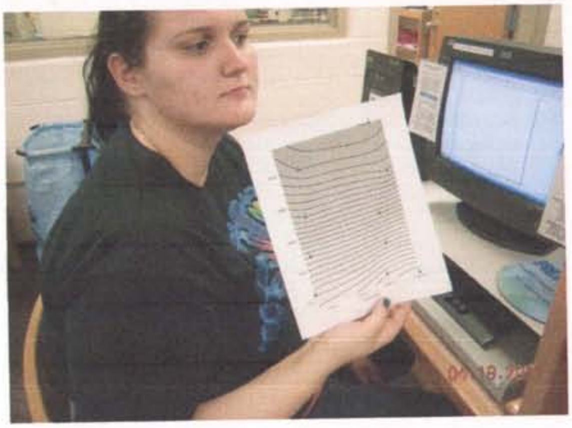
Air Flow in the Mine

Calculating Safety Factor



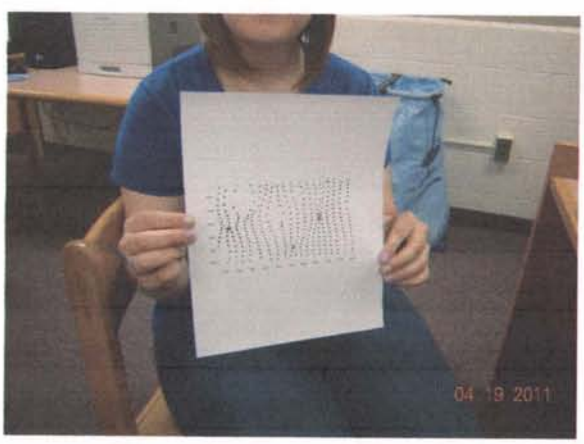
Roof Bolt Thickness

Pre-engineering



2-D Picture of Coal Seam

3-D Picture of Coal Seam



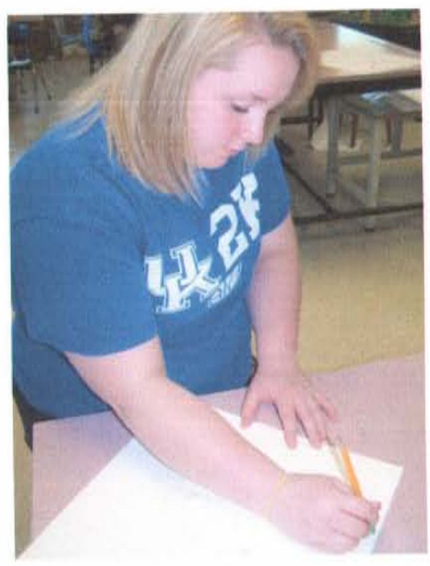
Vector Map of Coal Seam

Food Service

The coal seam is on the bottom

Art

Art Painting



Constructing 2-D Art