Name:_____

Levees

Part 1: *Reading Questions*

1) What causes rivers to flood?_____

2) Does flooding affect people? Yes No

3) What can engineers do to protect people from flooding?_____

4) Draw the following pictures

Land Before Levee was Built	Land After Levee was Built

5) _____ allow the levees to <u>hold back water.</u>
Structure of the Levee — Function

6) <u>Rocks along the side of the levee</u> allow the levee to _____
Structure of the Levee — Function

7) What factors do people need to think about when designing a levee? _____

_____

_____

8) Do all people agree that all factors are equally important? Yes No

9) How do levees fail? _____

_____

Part 2: *Material Exploration*

Engineering Problem

The city of Lowlandia has contacted several engineering firms and requested that each firm put together a bid and a scale model of a levee that they could construct for the town. The firm with the "best" levee will be hired to build the towns new levee.

Earth Materials

Lowlandia has the following materials that can be used to build the levee:

Rocks Gravel Sand Clay Grass

Testing Earth Materials

For each of the materials above, construct a levee solely out of that material. Test how well the levee holds back flood waters by pouring 50 mL of water behind the levee and letting it sit for 30 s. Then test how well the levee withstands erosion from rain by filling the rain cup 1/4 of the way full of water and letting it rain on the levee for 10 seconds.

10) Rocks (Cost: $20 per cup)

Drawing of Material

The material held back floodwater (water behind levee).

Agree 1 2 3 4 5 Disagree

The material eroded with rain (water on top of levee).

Agree 1 2 3 4 5 Disagree

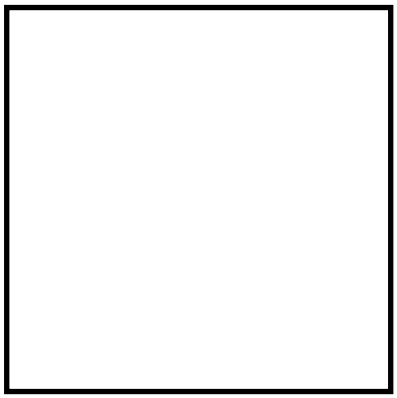
What function could rocks serve in the levee?_____

_____

_____

11) Gravel (Cost: $20 per cup)

Drawing of Material



The material held back floodwater (water behind levee).

Agree 1 2 3 4 5 Disagree

The material eroded with rain (water on top of levee).

Agree 1 2 3 4 5 Disagree

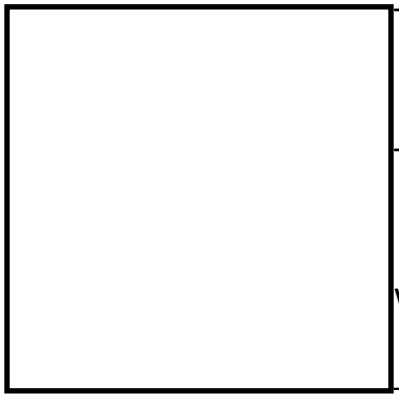
What function could gravel serve in the levee?_____

_____

_____

12) Sand (Cost: $20 per cup)

Drawing of Material



The material held back floodwater (water behind levee).

Agree 1 2 3 4 5 Disagree

The material eroded with rain (water on top of levee).

Agree 1 2 3 4 5 Disagree

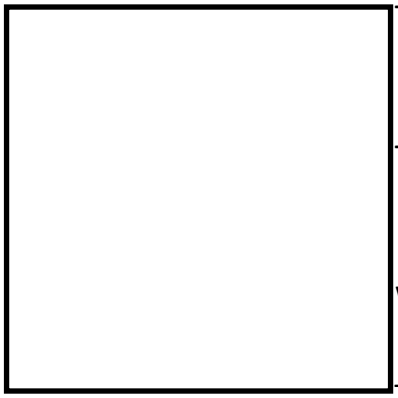
What function could sand serve in the levee?_____

_____

_____

13) Clay (Cost: $100 per cup)

Drawing of Material



The material held back floodwater (water behind levee).

Agree 1 2 3 4 5 Disagree

The material eroded with rain (water on top of levee).

Agree 1 2 3 4 5 Disagree

What function could clay serve in the levee?_____

_____

_____

14) Grass (Cost: $10 per 5 cm x 5 cm square (size of drawing box below))

Drawing of Material

The material held back floodwater (water behind levee).

Agree 1 2 3 4 5 Disagree

The material eroded with rain (water on top of levee).

Agree 1 2 3 4 5 Disagree

What function could grass serve in the levee?_____

_____

_____

Part 2: *Designing Levees*

Levee Testing

To see how the levees perform, the following tests will be done:

Test 1: 100 mL of rain will fall on the levee.

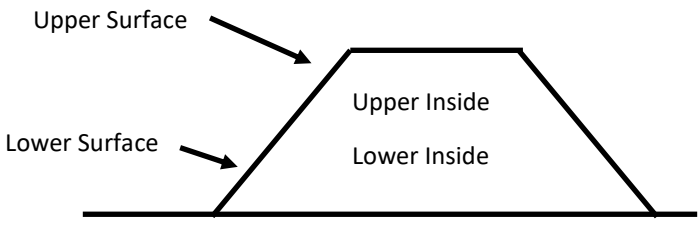
Test 2: The floodwaters will rise to half the maximum predicted flood height and will sit for 30 seconds.

Test 3: The floodwaters will rise to the maximum predicted flood height and will sit for 30 seconds.

Levees will be evaluated on how well they perform and their cost.

Preliminary Levee Design

As a group, use your findings about how the Earth materials interact with water to help you design the best levee for Lowlandia. Lowlandia has set your budget to be $400. City planners think you will need ~12 cups of material in your final levee construction. Use the terms in the picture below when deciding where to use materials. In the city yard are the following tools that you can use: a water truck (squirt bottle), a backhoe (spoon), and a dump truck (bowl).



Levee Material	Price per Unit
Rocks	$20 per cup
Gravel	$20 per cup
Sand	$20 per cup
Clay	$100 per cup
Grass	$10 per square (5 cm x 5 cm)

15) We will use **rocks** in our levee: yes no (if no, skip to gravel)

Rocks will be used in the following locations: (circle all that apply)

Upper Surface Lower Surface Upper Inside Lower Inside

We are putting rocks here because:

- ☐ It is resistant to rain or normal erosion
- ☐ It helps hold water back
- ☐ It is cheap
- ☐ It is expensive
- ☐ Other:_____

16) We will use **gravel** in our levee: yes no (if no, skip to sand)

Gravel will be used in the following locations: (circle all that apply)

Upper Surface Lower Surface Upper Inside Lower Inside

We are putting gravel here because:

- ☐ It is resistant to rain or normal erosion
- ☐ It helps hold water back
- ☐ It is cheap
- ☐ It is expensive
- ☐ Other:_____

17) We will use **sand** in our levee: yes no (if no, skip to clay)

Sand will be used in the following locations: (circle all that apply)

Upper Surface Lower Surface Upper Inside Lower Inside

We are putting sand here because:

- ☐ It is resistant to rain or normal erosion
- ☐ It helps hold water back
- ☐ It is cheap
- ☐ It is expensive
- ☐ Other:_____

18) We will use **clay** in our levee: yes no (if no, skip to grass)

Clay will be used in the following locations: (circle all that apply)

Upper Surface Lower Surface Upper Inside Lower Inside

We are putting clay here because:

- ☐ It is resistant to rain or normal erosion
- ☐ It helps hold water back
- ☐ It is cheap
- ☐ It is expensive
- ☐ Other:_____

19) We will use **grass** in our levee: yes no

Grass will be used in the following locations: (circle all that apply)

Upper Surface Lower Surface Upper Inside Lower Inside

We are putting grass here because:

- ☐ It is resistant to rain or normal erosion
- ☐ It helps hold water back
- ☐ It is cheap
- ☐ It is expensive
- ☐ Other:_____

20) Use the checklist below to verify your group has materials for each section of the levee. If not, go back and modify questions 15-19.

Inside Levee

The **Upper Inside** of the levee will be made from (check all that apply) :

☐ rocks ☐ gravel ☐ sand ☐ clay ☐ grass

The **Lower Inside** of the levee will be made from (check all that apply) :

☐ rocks ☐ gravel ☐ sand ☐ clay ☐ grass

Outside Levee

The **Upper Outside** of the levee will be made from (check all that apply):

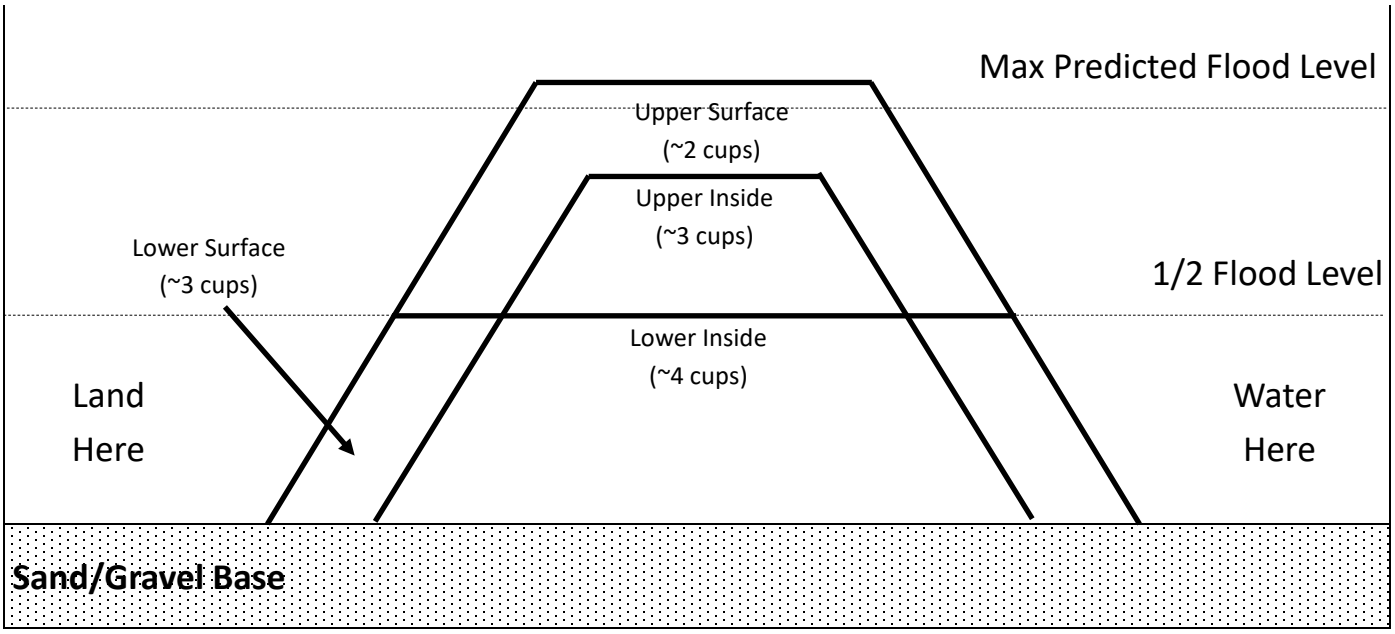
☐ rocks ☐ gravel ☐ sand ☐ clay ☐ grass

The **Lower Outside** of the levee will be made from (check all that apply) :

☐ rocks ☐ gravel ☐ sand ☐ clay ☐ grass

21) Draw a picture of your levee using the following symbols

● Rock ○ Gravel Sand Clay Grass



22) Will you be able to afford your levee? Keep in mind that you only have $400. Yes NO*

*If you answered no go back and modify questions 15-20.

Part 3: *Building Levees*

Levee Evaluation

As a class, fill out the levee evaluation tool, so that all levees will be evaluated the same after they are constructed.

Building Your Levee

As a group, construct your levee. You must follow the union rules below during construction.

1) Workers (you) cannot touch the soil with their hands.
2) Workers can only use one tool at a time.

Any time that your firm does not obey the rules you will be fined $10, which will come out of your $400 levee budget.

Buying Materials

To get materials you will need to give the store the correct amount of money.

You can buy full cups or half cups of materials. Grass must be bought in 5 cm x 5 cm pieces. Unused, unmixed materials can be returned to the store for credits, if needed.

Levee Statistics

Levee Material	Price per Unit	Amount Used	
		Full Cups	Half Cups
Rocks:	$20 per cup		
Gravel:	$20 per cup		
Sand:	$20 per cup		
Clay:	$100 per cup		
		Number of Squares	
Grass:	$10 per square		
Total Cost: $400 -$_____=$_____ Money Left			

Part 4: *Levee Testing and Evaluation*

Levee Ratings

Fill out the form below as you test your levee and 2 others levees. Make sure that you use the evaluation tool to give a score (1-4) for the cost and the performance.

	Firm 1	Firm 2	Firm 3
Levee Cost:	$_____	$_____	$_____
Cost Score:			
Performance: (Check box if test is passed)	☐Rain ☐½ Flood ☐Flood	☐Rain ☐½ Flood ☐Flood	☐Rain ☐½ Flood ☐Flood
Performance Score:			
Total Score:			
Observations:			

Part 4: *Discussion Questions*

- Think about how your levee performed in Test 1 (rain).
- Discuss with your firm how your levee held up to **rain and normal erosion**.

23) How could you change your levee to better withstand rain and erosion?_____

_____

_____

- Think about how your levee performed in Test 2 (half flood) and Test 3 (full flood).
- Discuss with your firm how your levee held up to **flooding**.

24) How could you change your levee to better withstand flooding?_____

_____

_____

25) Are levee cost and levee performance equally important why or why not?_____

_____

_____

_____

26) Do you think that all people will agree with this (circle one)? Yes No

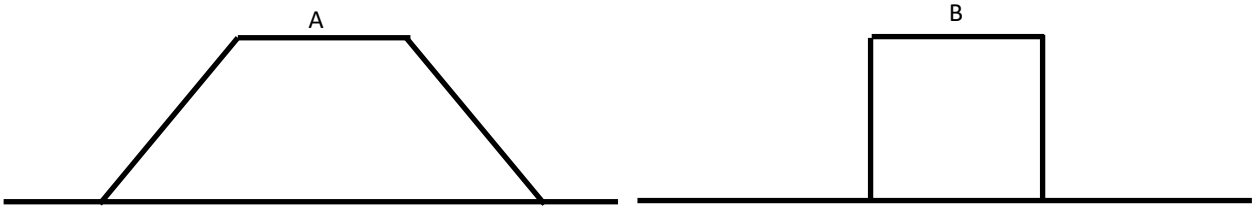
27) I think firm (1 2 3) deserves the contract because_____
Circle One

_____

_____

_____

_____

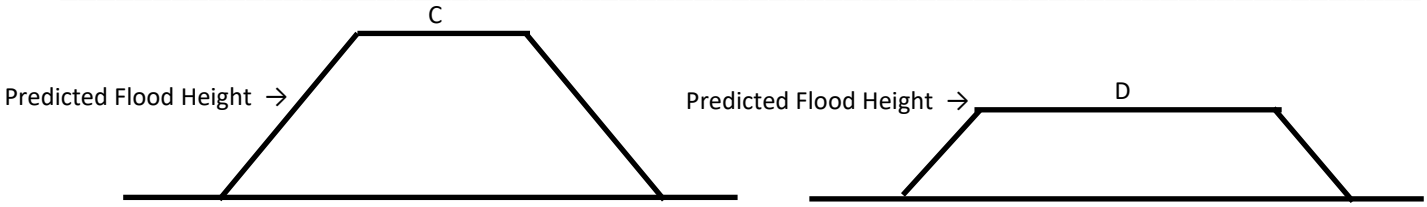


28) The structural difference between levee A and levee B is _____

29) The function of this feature is _____

30) Levee ____ is the better design because _____

_____

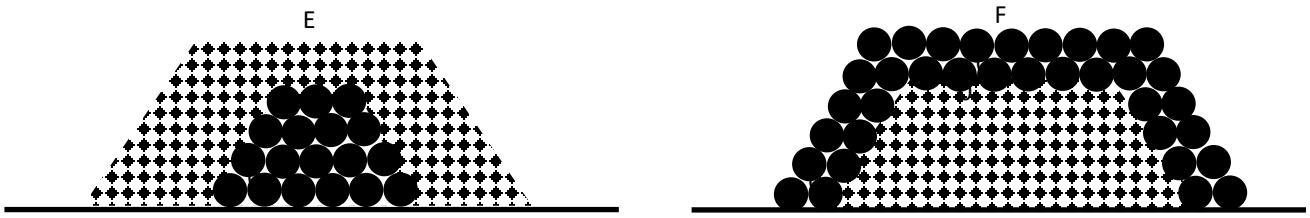


31) The structural difference between levee C and levee D is _____

32) The function of this structure is _____

33) Levee ____ is the better design because _____

_____



34) The structural difference between levee E and levee F is _____

_____

35) The function of this structure is _____

_____

36) Levee ____ is the better design because _____

_____

37) What is the purpose of a levee?_____

_____

Before answering the next question watch the levee video.

38) Are there any negative impacts to building levees, if so what are they?_____

_____