Design of a Representative Volume Extraction System (RVES)

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Project Goal

- Design a system to reduce the time, effort, and cost required to analyze a solid-liquid mixture by taking a verifiable, representative volume from a larger sample.
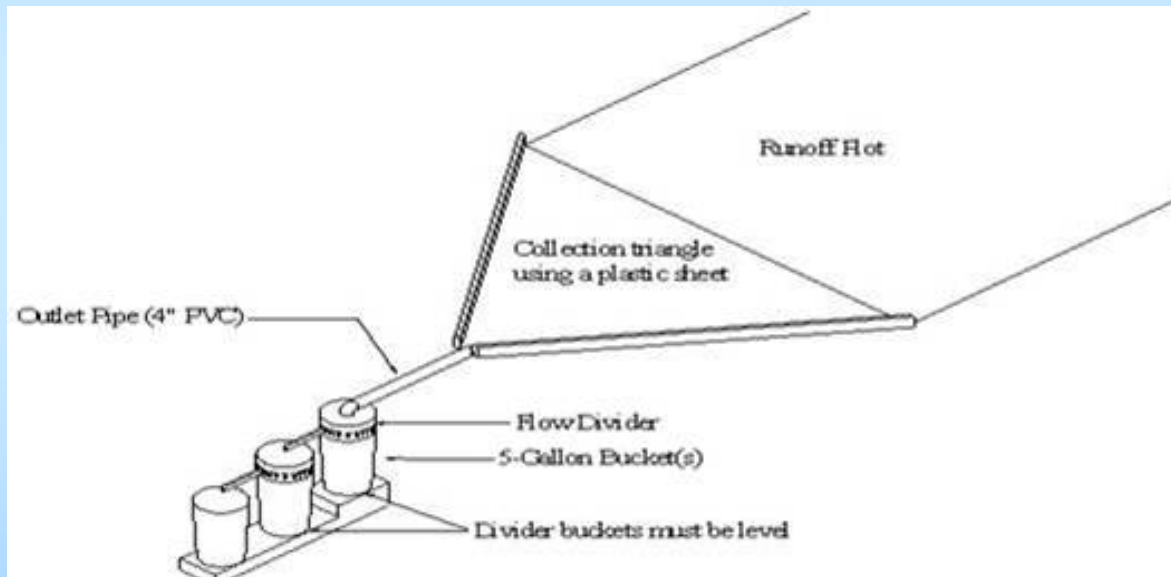
Sub-sample Specifications

- Same sediment concentration
- Same particle size distribution
- With a maximum of 10% error

Objectives and Constraints

- Be accurate and precise
- Cost less than $2500 to prototype
- Retail for approximately $2000
- Require less than 10 minutes per sample

Specific Application

Runoff Plot

Collection triangle using a plastic sheet

Outlet Pipe (4" PVC)

Flow Divider

5-Gallon Bucket(s)

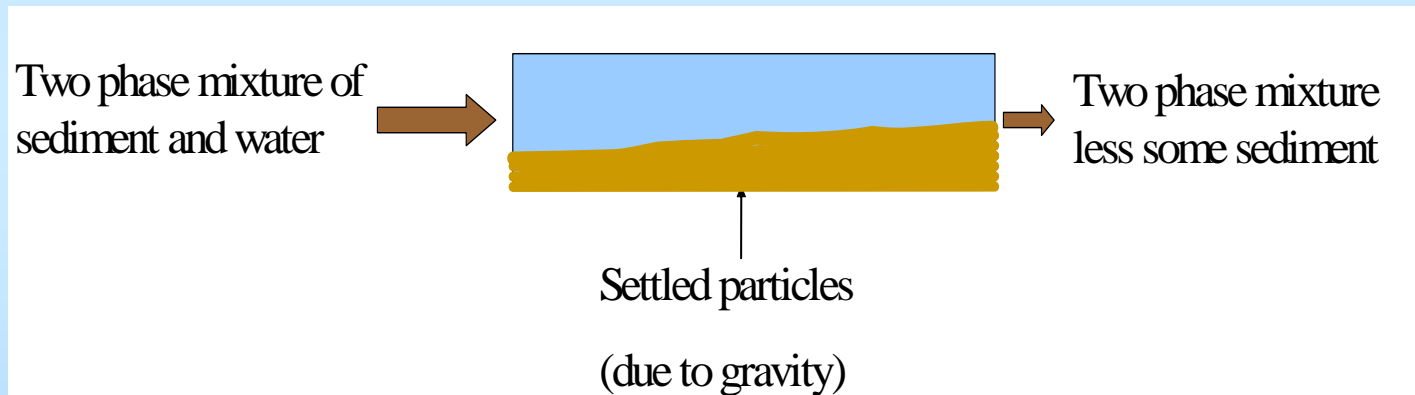Divider buckets must be level

Overview

- Theory behind vertical flow divider
- Prototype
- Resource and budget list
- Operation of system
- Testing and results

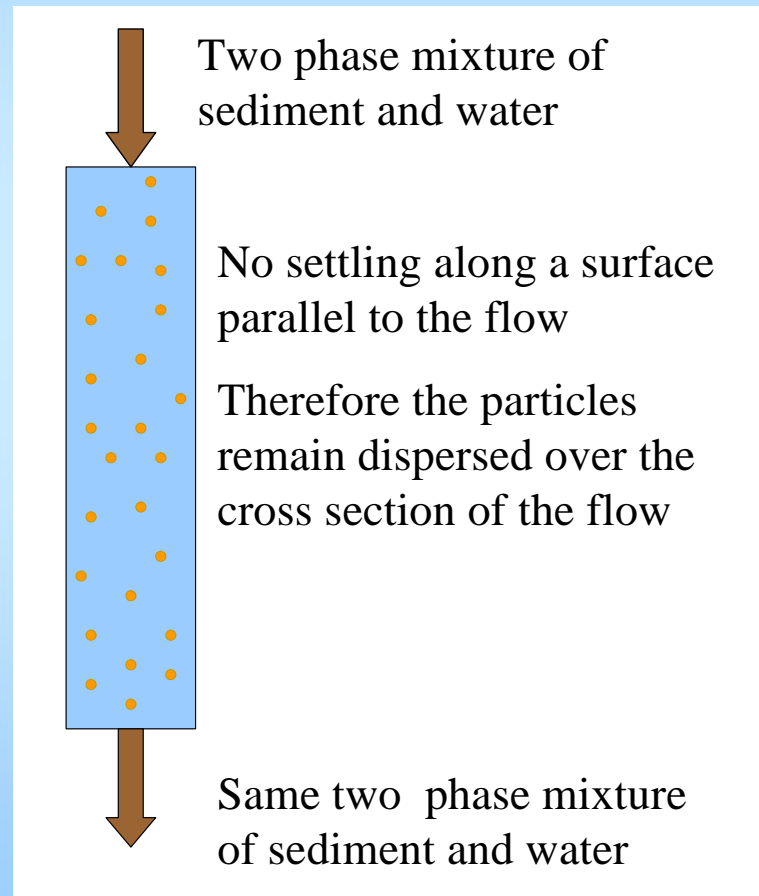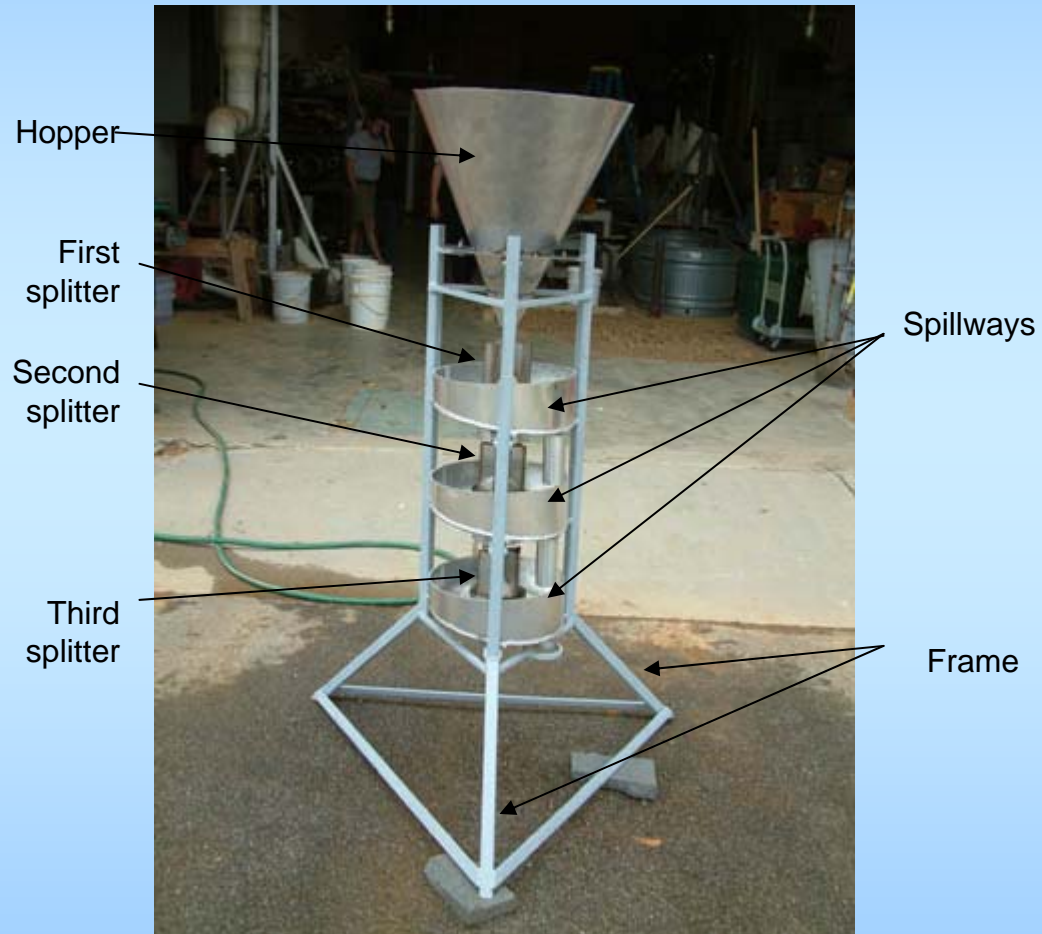# Theory behind vertical flow divider

- Horizontal Flow

Two phase mixture of
sediment and water →

Two phase mixture
less some sediment

Settled particles

(due to gravity)

Theory behind vertical flow divider

- Vertical flow

Two phase mixture of sediment and water

No settling along a surface parallel to the flow

Therefore the particles remain dispersed over the cross section of the flow

Same two phase mixture of sediment and water

Prototype

Hopper

First splitter

Second splitter

Third splitter

Spillways

Frame

Prototype

- Splitters
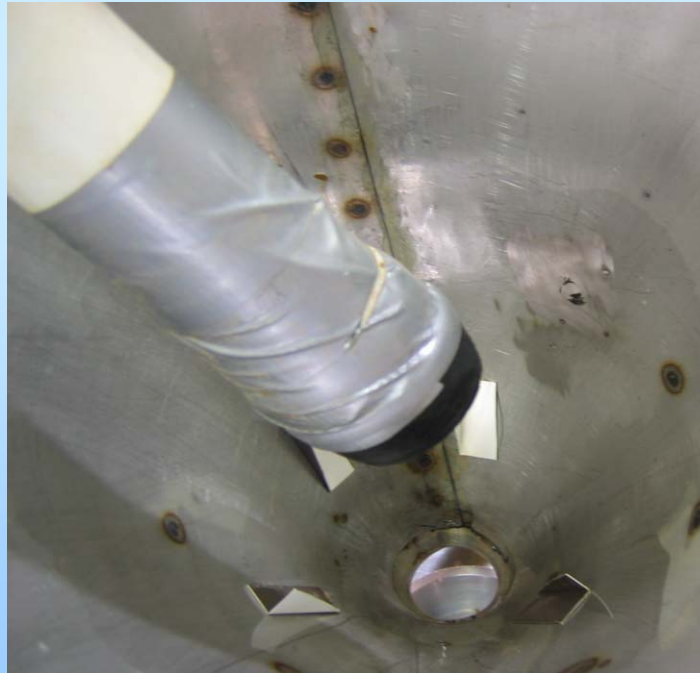
Prototype

- Funnels

Prototype

- Hopper

Prototype

- Valve
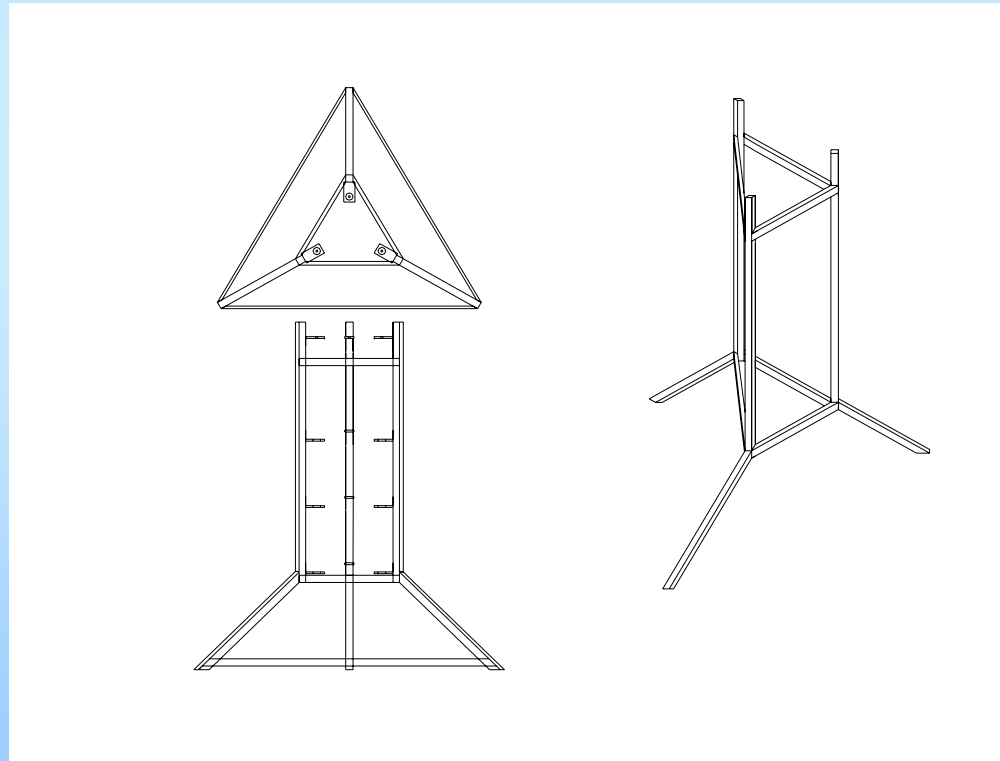 - rubber stopper attached to a piece of 2 in. PVC pipe, 24 in. long

Prototype

- Spillways

Prototype

- Frame
  - 16 lb tipping force

Resource and budget list

Component	Materials cost ($)	Labor Costs ($)	Fabrication cost ($)
splitters (3)	NA	NA	804
funnels (3)	61	60	121
spillways (3)	NA	NA	645
frame	56	100	156
hopper	55	60	115
Grand total			**$1841**

Operation of System

- Insert valve

- Transfer liquid/solid mixture to hopper

- Rinse bucket with mixture until there is no sediment

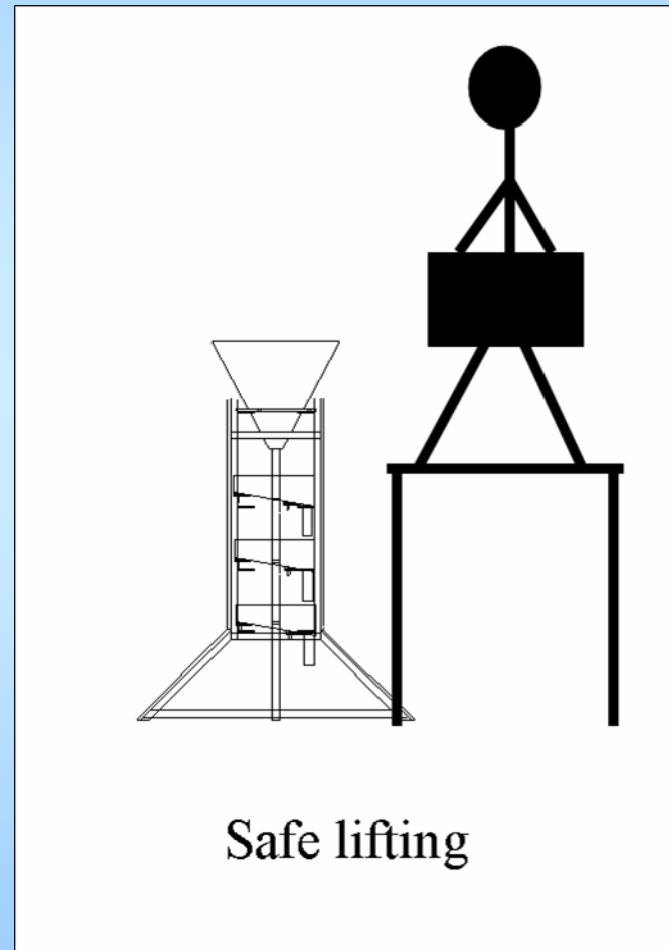- Lift valve 1 in. to allow mixture to flow through system

Operation of System

- Ergonomic considerations
  - Transfering mixture to hopper
  - Revised NIOSH Lifting equation – worst case 25 lbs
  - Alternative transfer methods:
    - Platform method
    - Dipping method

Unsafe lifting
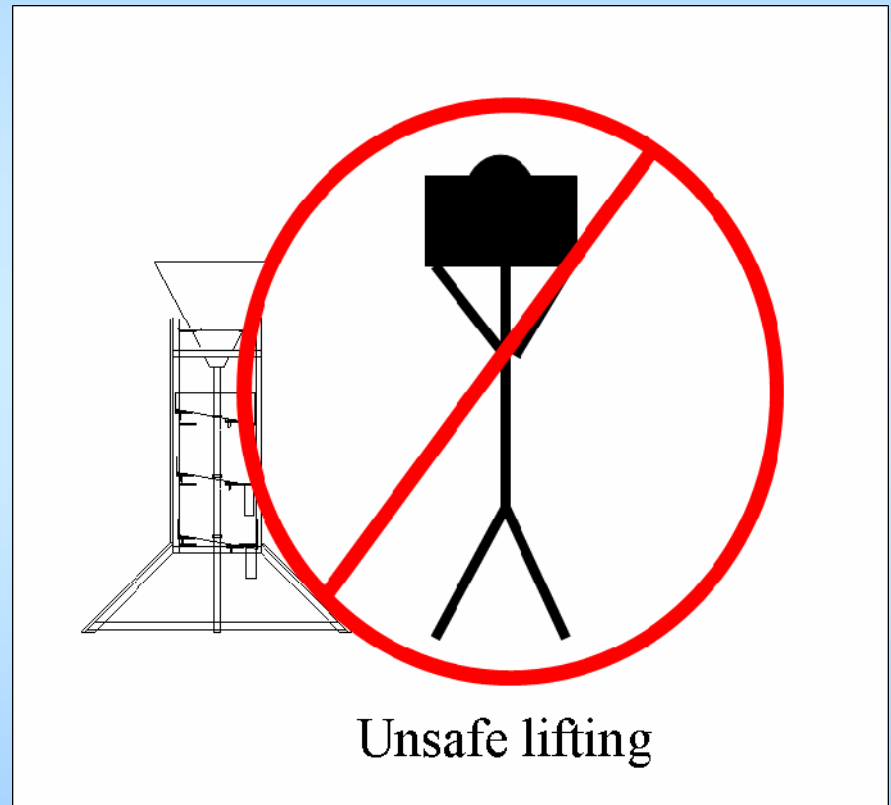
Operation of System

- Ergonomic Considerations
  - Platform method

Safe lifting

Operation of System

- Ergonomic Considerations
  - Dipping method

Safe lifting

Operation of System

System Utilization

- Volume of water
- Mass of sediment
- Sediment adsorbed particles

Testing and Data Analysis

- Explanation and justification of testing procedure
- Method of Testing
- Results

Explanation and Justification of Testing Procedure

- Mass measure
  - Volume of water
  - Mass of sediment
- Particle Size Distribution Analysis (PSDA)
  - Hydrometer method
  - Wet sieve

Method of Testing

- 10% sand, 50% sand, 80% sand soil types
- 1 kg/8 L water, 3.5 kg/8 L water
- 4 reps of each
- Each sample measured before and after going through RVES

Results

- Volume of water

% Error by Mass			
	10%	50%	80%
1 kg sediment	6.7	6.6	13
3.5 kg sediment	11	14	9.0

Results

- Mass of sediment

% Error by Mass			
	10%	50%	80%
1 kg sediment	8.8	16	18
3.5 kg sediment	18	23	18

Results

- SSA

% Error by Mass			
	10%	50%	80%
1 kg sediment	3.6	15	17
3.5 kg sediment	1.4	11	22

Sources of error

- Fabrication tolerances
- PSDA variation
  - ~12% hydrometer
  - ~4% wet sieve
- Human error

Recommendations for a second generation

- Splitter design
  - Center rod
  - Less fabrication time
- Spillway design
  - Should not support funnels

Questions?