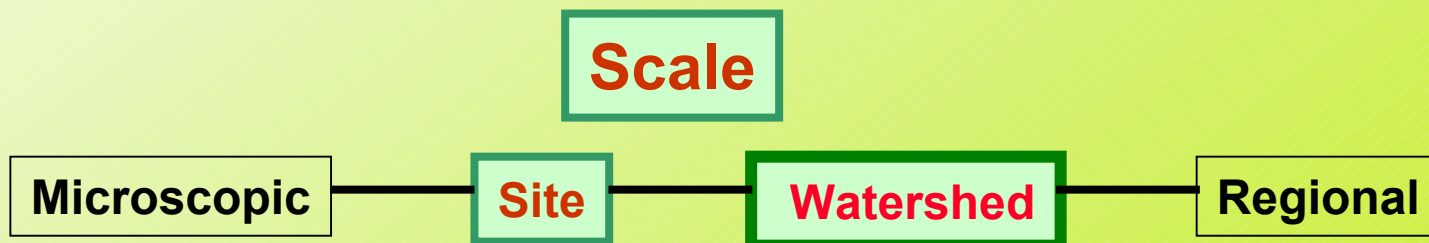
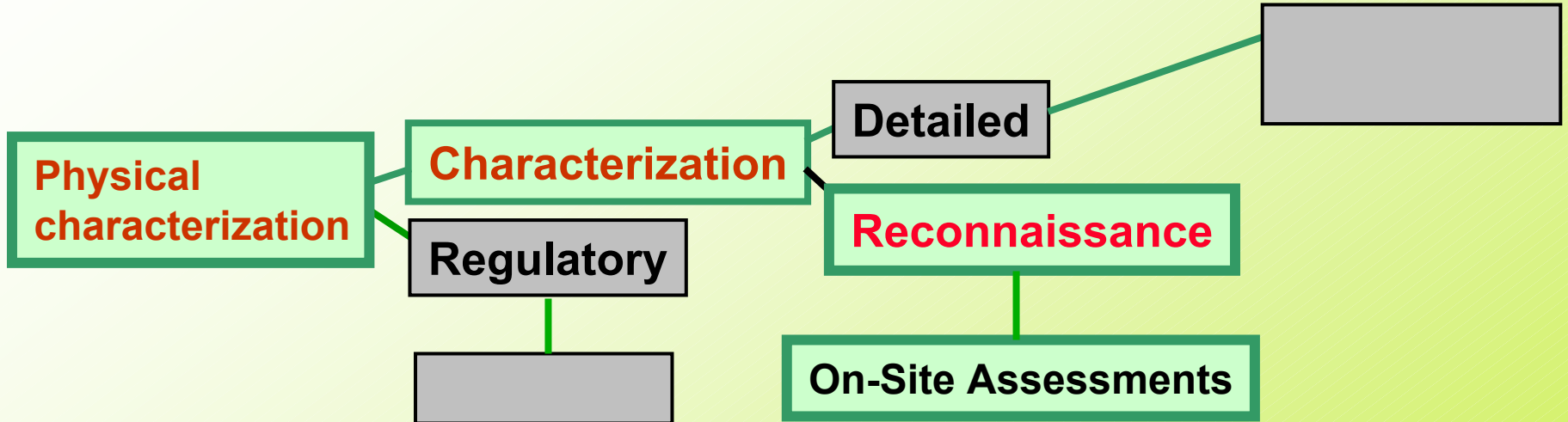


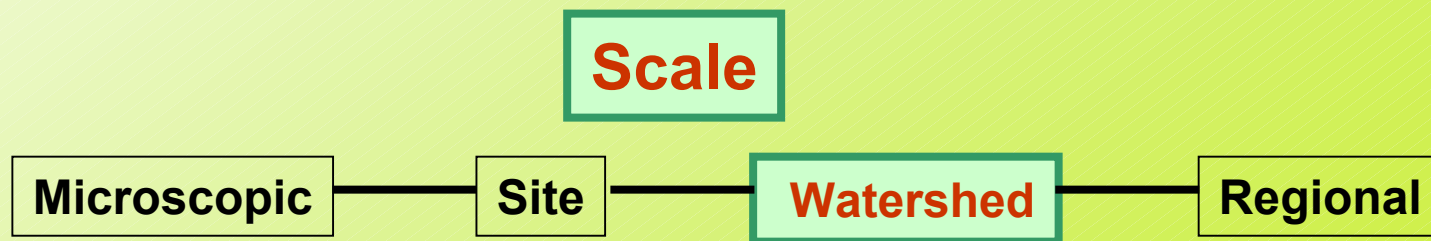
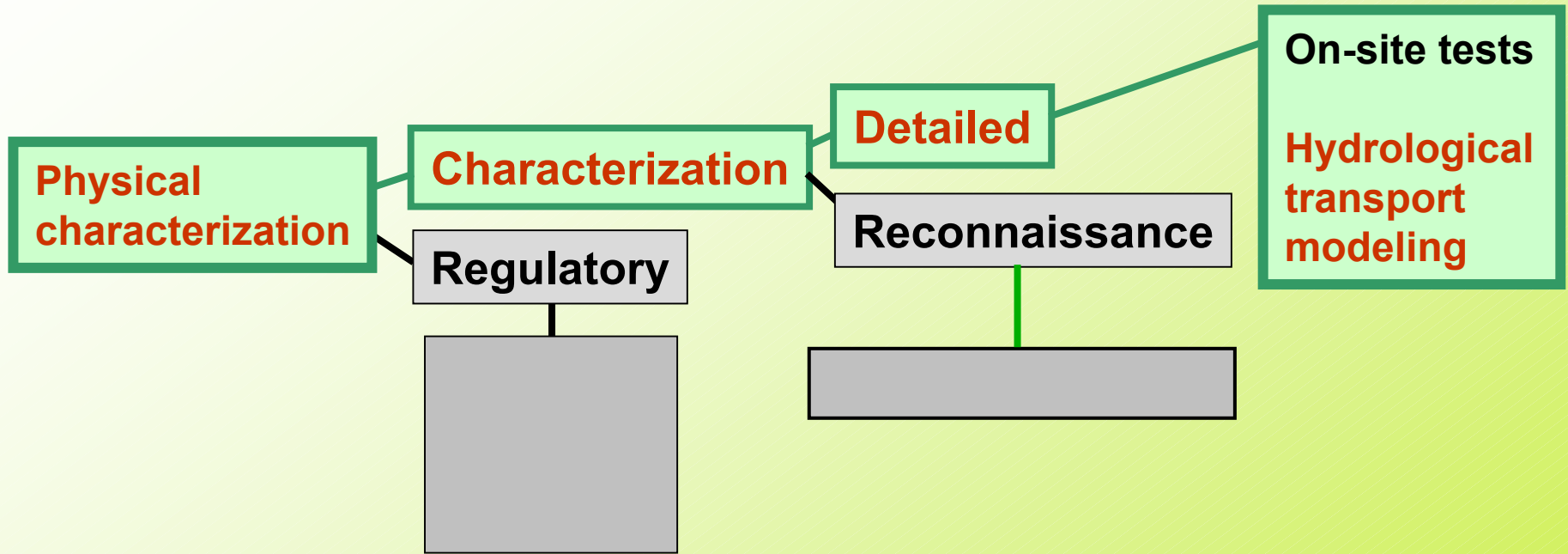
**PHYSICAL  
CHARACTERIZATION  
OF  
MINE WASTE PILES**

**TOM WILDEMAN  
COLORADO SCHOOL of MINES  
AND  
ROSALIA ROJAS  
COLORADO STATE UNIVERSITY**

# Flow Chart for Ranking and Prioritization (THOMAS WILDEMAN)



# Flow Chart for Ranking and Prioritization (ROSALIA ROJAS)



## **OUR GOAL**

- **PROVIDE TOXICITY ASSESSMENT & RANKING OF MINE WASTE PILES**
  - **PHYSICAL & CHEMICAL ASSESSMENT**
  - **SIMPLE ASSESSMENT TESTS**

# MINE WASTE DECISION TREE

## CHEMICAL CRITERIA

PASTE pH, ALKALINITY

< 5

> 5

Assume Toxicity.  
Check with TCLP  
& CDMG  
extraction tests.

Toxicity Uncertain

TCLP, CDMG, & USGS  
extraction tests are  
necessary.

Develop a simple  
bioavailability test to  
confirm toxicity.

## PHYSICAL CRITERIA

### A. ON-SITE ASSESSMENTS

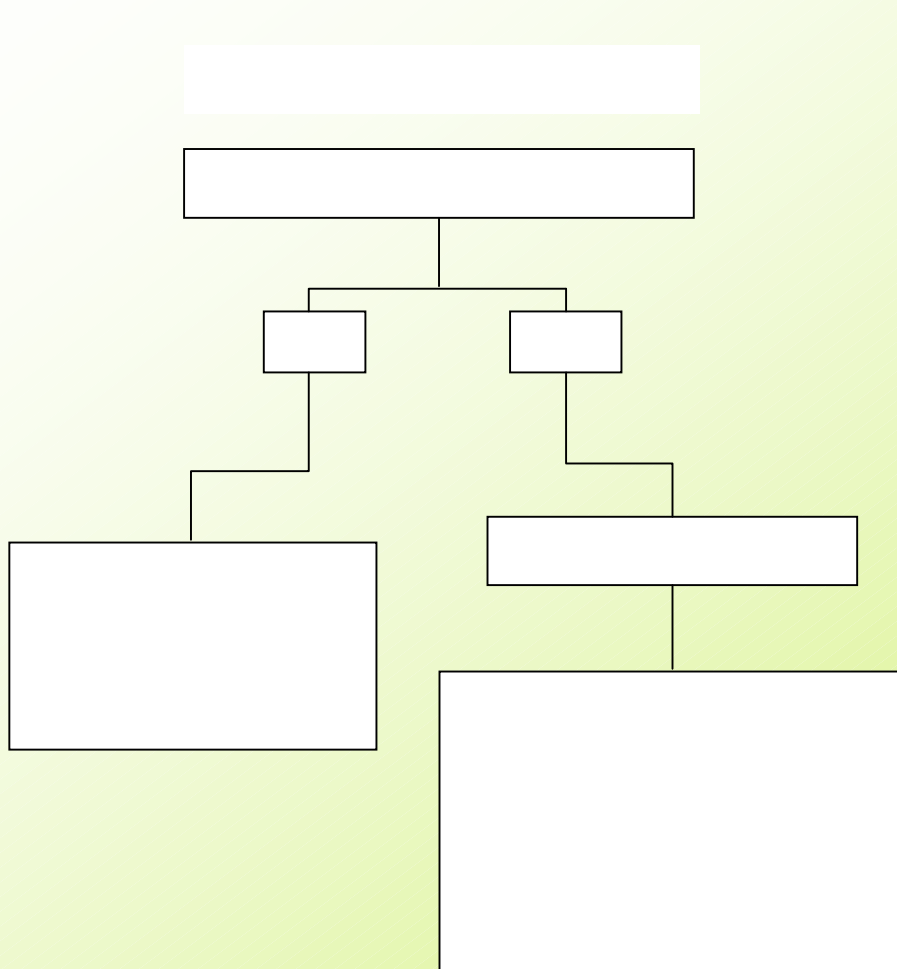
1. Proximity to year-round or ephemeral stream or gulch.
2. Size of waste-rock pile.
3. Extensiveness of erosion features.
4. Presence of cementation crusts.
5. Presence of a kill zone.
6. Presence of vegetation.

### B. ON-SITE TESTS

1. Develop a settling test.

Concerning the tests and observations within the criteria, only the paste pH test can be used as an either/or criterion for determining toxicity. For the other tests, ratings will have to be developed for which the aggregate score will determine the degree of hazard of a waste-rock pile.

# MINE WASTE DECISION TREE



## PHYSICAL CRITERIA

### A. ON-SITE ASSESSMENTS

1. Proximity to year-round or ephemeral stream or gulch.
2. Size of waste-rock pile.
3. Extensiveness of erosion features.
4. Presence of cementation crusts.
5. Presence of a kill zone.
6. Presence of vegetation.

### B. ON-SITE TESTS

1. Develop a settling test.



# VIRGINIA CANYON STUDY

- **Longitude / Latitude**
- **Mineralogy & presence of sulfides**
- **Degree of erosion (0 – 4)**
- **Volume of pile**
- **Texture**
  - **Related to Terrestrial & Aquatic Toxicity**
- **Distance from drainage channel**
- **Vegetation kill zone**
- **Vegetation on pile**

**USED IN AN OVERALL ASSESSMENT**

# RUSSELL GULCH PROJECT

- **PERFORMED SEPARATE PHYSICAL & CHEMICAL ASSESSMENTS.**
- **USED SIX DIFFERENT ON-SITE MEASURES TO MAKE AN OVERALL RATING.**



# SAMPLING IN AND AROUND RUSSELL GULCH

- **29 TOTAL LOCATIONS**
- **27 WASTE ROCK SAMPLES TESTED FROM 23 LOCATIONS**
- **12 WATER SAMPLES TESTED FROM 6 LOCATIONS**

# SITE RANKING

- **BASED ON A FIVE POINT SYSTEM**
- **POINTS FOR FOUR PHYSICAL CRITERIA AND FOUR CHEMICAL CRITERIA**
- **POINTS AVERAGED FOR TOTAL PHYSICAL, CHEMICAL, AND OVERALL RANK**

# PHYSICAL CRITERIA

## A. ON-SITE ASSESSMENTS

1. Size of waste rock pile.
2. Extensiveness of erosion features.
3. Presence of cementation crusts.

Related to Terrestrial & Aquatic Toxicity

4. Proximity to year round or ephemeral stream or gulch.
5. Presence of a Kill Zone.
6. Presence of Vegetation

## B. ON-SITE TESTS

1. Develop a settling test.

**SITES CAN BE PHYSICALLY DETRIMENTAL  
AND CHEMICALLY BENIGN**

# PHYSICAL RATING CRITERIA

<b>EROSION</b>	<b>DISTANCE TO CHANNEL</b>	<b>VEGETATION ON PILE</b>	<b>VEGETATIVE KILL ZONE</b>
<b>1 = none</b>	<b>1 = &gt; 300 yds</b>	<b>1 = lots</b>	<b>1 = no kill zone</b>
<b>2 = sheet wash</b>	<b>2 = &gt; 100 yds</b>	<b>2 = yes</b>	
<b>3 = rills &lt; 6" deep</b>	<b>3 = &gt; 100 ft</b>	<b>3 = little</b>	<b>3 = very little kill zone</b>
<b>4 = rills 6" – 12" deep</b>	<b>4 = &lt; 100 ft</b>		<b>4 = trees but not underbrush</b>
<b>5 = gullies &gt; 12"</b>	<b>5 = &lt; 10 ft</b>	<b>5 = no</b>	<b>5 = yes</b>

# CHASE MINE IN ILLINOIS GULCH



# CHASE MINE PHYSICAL RATING

- **EROSION – 3 (rills 6” – 12”)**
- **DISTANCE TO CHANNEL - 2**  
**(>100 yds)**
- **VEGETATION – 5 (NONE)**
- **KILL ZONE – 3 (little kill zone)**
- **OVERALL PHYSICAL - 3.8 OUT OF 5**
- **OVERALL CHEMICAL - 3.1 OUT OF 5**



# GOLDEN WONDER WASTE PILE





# PHYSICAL CRITERIA PITTSBURG MILL TAILINGS





# PITTSBURGH PHYSICAL RATING

- **EROSION - 5 - (gullies > 12")**
- **DISTANCE TO CHANNEL - 5**  
**(> 10 feet)**
- **VEGETATION – 5 (NONE)**
- **KILL ZONE – 5 (big kill zone)**
- **OVERALL PHYSICAL – 5 OUT OF 5**
- **OVERALL CHEMICAL – 1.5 OUT OF 5**

# TONY STANDING IN GULLY AT PITTSBURGH



# OBSERVATIONS

- **THERE IS LITTLE CORRELATION BETWEEN CHEMICAL AND PHYSICAL RATINGS.**
- **VEGETATION AND KILL ZONES ARE NOT NECESSARILY CONNECTED TO CHEMICALLY BAD SITES.**
- **CHEMICALLY BAD SITES DO NOT CONCLUSIVELY HAVE THE WORST IMPACT ON AREA WATER.**
- **PHYSICALLY BAD SITES DO NOT CONCLUSIVELY HAVE THE WORST IMPACT ON AREA WATER.**

# BOTH CRITERIA ARE IMPORTANT

- **CHEMICAL**
  - Ranks availability of contaminants
- **PHYSICAL**
  - Ranks ability to deliver contaminants



