DISA

# SUSTAINABLE REMEDIATION

## U.S. Nuclear Regulatory Commission Staff Public Meeting
## May 23, 2022

Disa Technologies, Inc.
Casper, Wyoming

# OVERVIEW

- HPSA Overview
- HPSA Technology
- Remediation and Analytical Results
- Applicability to UMTRCA
- HPSA and Waste Treatment
- Licensing Frameworks
- Proposed Solution

# DISA'S PROPOSED ACTION

- **Remediation of waste piles and contaminated materials at abandoned mines and other sites**
- Over 15,000 abandoned uranium mines (or waste piles) in the Western United States
- Many of these waste piles are on or near tribal locations
- Approximately 1 in 5 people in the West live within 50 miles from an abandoned uranium mine
- Most of these waste piles:

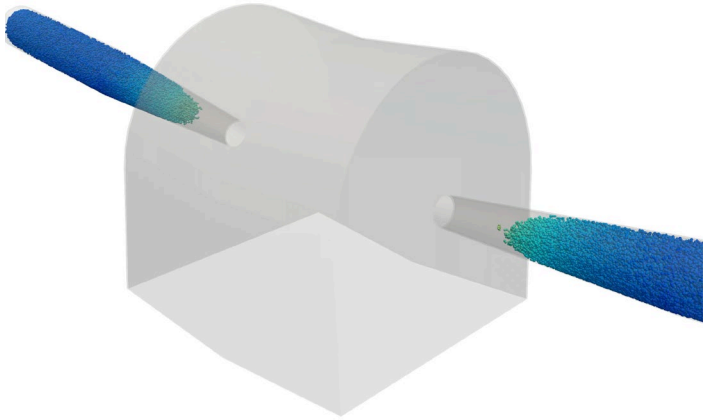
| | | | |
|---|---|---|---|
| Created over 4 decades ago | Sit on the surface where uranium has oxidized | Limits use of the land | May cause dose and contamination issues |

# HPSA OVERVIEW

A New Remediation Technology

**High-Pressure Slurry Ablation (HPSA)**

- Pre-conditioned Slurry
- Unique Application of Energy
- Mechanical Process
- Particle-Particle Collisions
- Physical Separation
- Modular Unit



**Inter-granular fracture**
**Phase boundary fracture**
**Grain-boundary fracture**

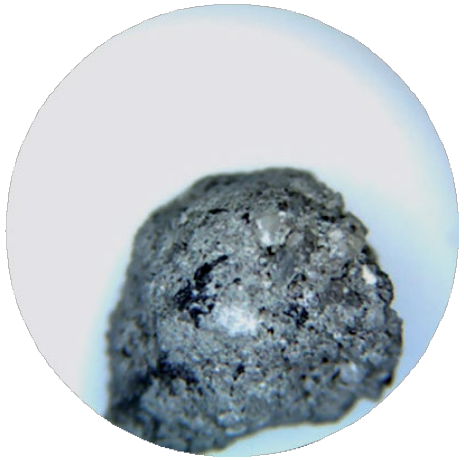
**Preferential fracture**
**Selective breakage**

**Massive fracture**
**Random fracture**

**Abrasion**
**Attrition**
**Chipping**

# THE HPSA SOLUTION

Novel system that reduces energy requirements and neutralizes waste that can be applied to multiple verticals



Sand grain is heavily coated with constituents of concern

Particle-particle collisions allow for efficient separation of targeted constituents

Coating is completely removed yet the clean sand grain remains intact

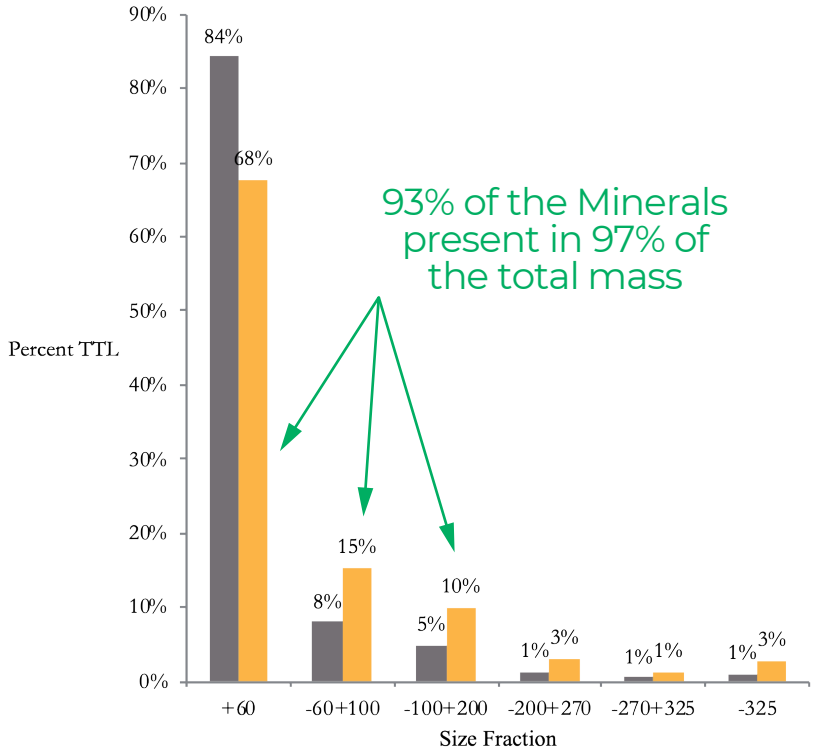
**Reduces overall project costs by up to 50%**

**Reduces energy needs by up to 40%**

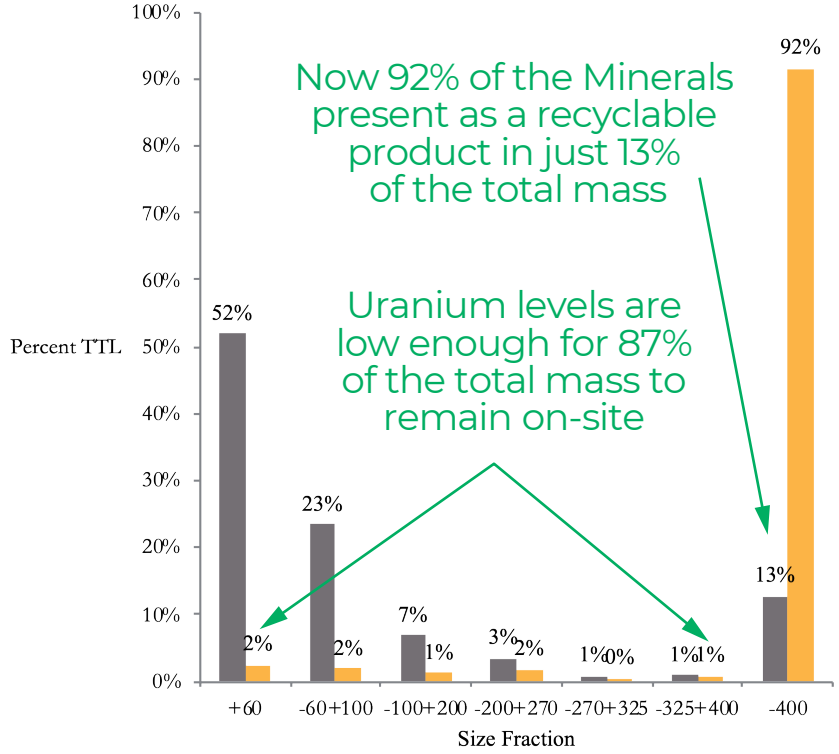
**Neutralizes waste by up to 100%**

# MINERAL DISTRIBUTION WITH HPSA

## Without HPSA




## With HPSA




VALIDATED AT LEADING LABS

Idaho National Laboratory

THE UNIVERSITY OF BRITISH COLUMBIA

MONTANA TECH

DUNDEE SUSTAINABLE TECHNOLOGIES

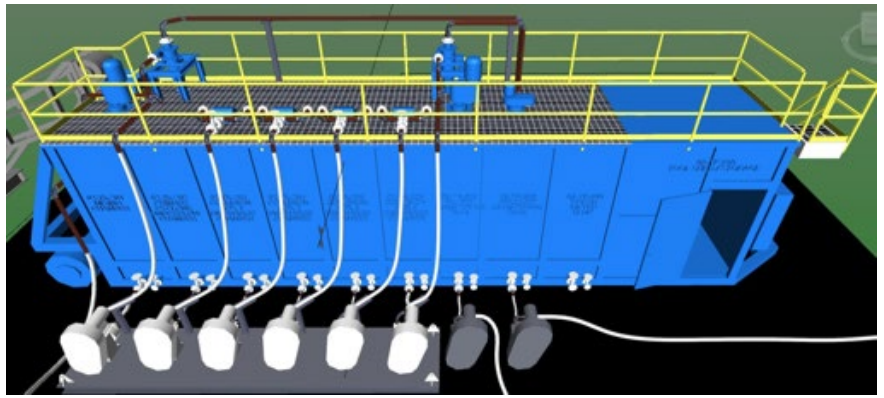
# MINE WASTE PHOTOGRAPHS

Site Location: Western Colorado


Residing on the surface since late 1970s

# TECHNOLOGY DEVELOPMENT

## TECHNOLOGY DEVELOPMENT TIMELINE



### Lab Units (4)

*Complete*

2018 Q3

### Gen Alpha – 20 TPH

*Complete*

2019 Q3

### Gen Bravo – 40 TPH

*Pending*

2022 Q3

# SUPPORTING ORGANIZATIONS

DISA®

CREATIVE DESTRUCTION LAB

TELLURIDE VENTURE NETWORK

MONTANA TECH
De Re Metallica
THE UNIVERSITY OF MONTANA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NEW MEXICO TECH
SCIENCE · ENGINEERING · RESEARCH UNIVERSITY

Mountain Studies Institute

UNIVERSITY OF WYOMING

TELLURIDE FOUNDATION

INL
Idaho National Laboratory
70 YEARS OF SCIENCE & INNOVATION

FORTE DYNAMICS

BITCO corporation

UBC

# REMEDIATION RESULTS

- Application of HPSA to the waste rock piles results in two streams of materials:
  - **Clean Coarse Fraction** – Post HPSA Treatment
    - Remains onsite and used for site reclamation (reduces transit cost and risk)
  - **Concentrated Mineral Fraction**
    - Vanadium
    - Source Material (Uranium or Thorium)
    - Other constituents of concern (e.g., RCRA metals)
- Concentrated Mineral Fraction is transported offsite (client dependent)
  - Offsite Treatment (alternative feed) – typical commercial client
  - Disposal as low-level waste – government clients

# RADIOLOGICAL & MINERALOGICAL COMPONENTS

| Parameter | Units | Waste Rock | Clean Coarse Fraction | Total Reduction | Percent Reduction |
|---|---|---|---|---|---|
| Lead 210 | pCi/g | 149 | 37.1 | 111.9 | **75.10%** |
| Radium 226 | pCi/g | 125 | 70.4 | 54.6 | **43.68%** |
| Radium 228 | pCi/g | 1.9 | 1 | 0.9 | **47.37%** |
| Thorium 230 | pCi/g | 153 | 74.7 | 78.3 | **51.18%** |
| Thorium 232 | pCi/g | ND | ND | NA | NA |
| Vanadium | mg/kg | 1,362 | 409 | 953 | **70%** |
| Uranium | mg/kg | 912 | 129 | 782 | **86%** |

HPSA Reduces the Overall Radiological Signature

# TOXICITY DATA

| Parameter | Units | Waste Rock | Clean Coarse Fraction | RCRA Standard |
|---|---|---|---|---|
| Arsenic | mg/L | 0.3 | **ND** | 5 |
| Barium | mg/L | 2.7 | **1.2** | 100 |
| Cadmium | mg/L | 0.08 | **ND** | 1 |
| Chromium | mg/L | ND | **ND** | 5 |
| Lead | mg/L | ND | **ND** | 5 |
| Mercury | mg/L | ND | **ND** | 0.2 |
| Selenium | mg/L | ND | **ND** | 1 |
| Silver | mg/L | ND | **ND** | 5 |

TCLP Demonstrates Clean Fraction is below RCRA standards

# POST-REMEDIATION CLEAN COARSE FRACTION DOSE

| Individual Type | Hours/ Day | Months | Total Days | Total Hours |
|---|---|---|---|---|
| Public | 8 | 6 | 180 | 1440 |

| Case | Type | Dose Rate (mrem/hr) | Annual Dose (mrem/yr) | Dose Limit (mrem/yr) | % of limit |
|---|---|---|---|---|---|
| Maximum[a] | Public | 0.006 | **8.8** | 25[b] | 35.2% |
| | [a] Maximum dose occurred at the closest modeled distance, 0.1 m, from the surface of the source volume.<br>[B] Unrestricted release limit | | | | |

Maximum Public Exposure to Clean Fraction is Well Below Regulatory Limits

# PURPOSE OF UMTRCA

- Purpose of UMTRCA
  - AEA Section 84:
    - ensure management of byproduct material appropriate to protect the public health, safety, and environment from radiological and non-radiological hazards
  - UMTRCA Section 2 –
    - stabilize and control tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public

# APPLICABILITY OF UMTRCA TO HPSA

Stated purpose of UMTRCA: Protect human health and the environment from the radiological and non-radiological hazards associated with byproduct material

## Does Disa's technology create such hazards?

**No** – HPSA technology remediates waste

Clean Coarse Fraction not hazardous waste per Toxicity Characteristic Leaching Procedure (TCLP)

Radiological signatures reduced compared to waste rock

## NRC staff must consider the stated purpose of UMTRCA

If that activity does not present any radiological and non-radiological hazard, then UMTRCA does not apply

Licensing HPSA as source material operation is most appropriate

# 11e.(2) BYPRODUCT MATERIAL

Definition of byproduct material in 10 CFR 40.4 – **primarily for its source material content**

- Activities that process ore primarily for its source material content:

  Conventional milling (involves chemicals) | In situ uranium recovery – mining underground (involves chemicals)

- Activities that **do not** process ore primarily for source material content (carve outs):

  Side stream recovery - other mineral processing operations (e.g., vanadium, rare earths etc.) *involves chemicals | IX water treatment (no chemicals) or pH adjustment water treatment (involves chemicals) – potable water or remediation | Wastewater treatment (involves chemicals) | Gamma soil sorting (no chemicals)

Disa's HPSA is similar to other remediation technologies included in the carve outs

# DESCRIPTION OF CARVE OUTS

## Side stream recovery- other mineral processing operations

Concentrates source material physically and chemically

Produce tailings with radiological and non-radiological hazards

Uranium is alternative feed; thorium generally disposed as low-level waste

## Water treatment

Concentrates source material

IX and RO removes uranium

Coagulation, flocculation, sedimentation, filtration, also concentrate uranium

Uranium is alternative feed, other radionuclides disposed as low-level waste

## Gamma soil sorting

Crushing waste

Concentrates source material or other radionuclides for remediation

Licensed for source material

# DESCRIPTION OF CARVE OUTS

## Wastewater Treatment

- Treats WASTE
- Similar process to water treatment
- Precipitation
  - Chemically separates uranium and other radionuclides
  - Mine water treatment, domestic wastewater treatment
  - Sludge – alternative feed stock at a uranium mill or disposed as waste

## NRC chose not to regulate incidental mineral operations as milling - ASLBP No. 98-748-03-MLA

- If material were processed primarily to remove some other substances and the extraction of uranium was incidental, this would not meet statutory test
- Would not be byproduct material pursuant to Atomic Energy Act

# HPSA FOR WASTE TREATMENT

- Primary purpose of Disa's HPSA is Waste Treatment
  - HPSA feed material is waste rock, i.e., discarded material
  - This material will remain waste regardless of uranium spot price
  - Uranium recovery is incidental to the remediation activity
  - Waste rock meets RCRA definition of waste – 40 CFR 261.2
    - Waste rock is a discarded material
    - Discarded materials are those that are:
      - abandoned, recycled (certain circumstances), considered inherently waste-like, a military munition

# HPSA FOR WASTE TREATMENT

- **Materials are abandoned if:**

  disposed of; burned or incinerated; accumulated, stored, or treated; sham recycled

- **Clearly waste rock is abandoned**

# LICENSING FRAMEWORK

Licensing options:

- **Source material – 10 CFR 40 (most relevant)**
- **Byproduct material – 10 CFR 40, Appendix A (least relevant)**
- **Source material with Appendix A exemption – Clean Coarse Fraction**
    - Exemption possible under 10 CFR 40.14

# SOURCE MATERIAL LICENSING (MOST RELEVANT)

| Criterion | Regulation | Manner of Compliance |
|---|---|---|
| 10 CFR 40.32(b) | Training | Training program will be addressed by Disa's application |
| 10 CFR 40.36 | Decommissioning and Financial Assurance | Disa's decommissioning plan is to demobilize all equipment, scan for contamination, ship contaminated soil off with source material. Financial assurance to cover demobe, final scans, soil cleanup, water disposal, and transportation to recycling facility. |
| 10 CFR 40.41(c) | Confine possession and use of source or byproduct material to the locations and purposes authorized in the license. | Source material is confined to equipment and roll-off containers. |
| 10 CFR 40.42 | Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas. | Disa's process automatically complies with this regulation, because its equipment is dismantled and demobilized after each project. Post operational scanning ensures that outdoor areas are not contaminated. |
| 10 CFR 40.51 | Transfer of source or byproduct material. | Disa will transfer source material to those authorized by a specific license to possess the source material. |
| 10 CFR 40.60 | Reporting requirements | Disa will comply with all reporting requirements |
| 10 CFR 20 Subpart B | Radiation protection program | Disa has developed a radiation protection program. |
| 10 CFR 20 Subparts C and D | Occupational and public dose limits, respectively | Disa's dose modeling indicates that occupational and public doses will be significantly below the limits. |
| 10 CFR 20 Subpart E | Radiological criteria for license termination | Disa's dose modeling demonstrates that its activities will result in doses that are significantly below 20.1402 unrestricted release. |
| 10 CFR 20 Subpart F | Surveys and monitoring | Disa's radiation protection program and includes the necessary surveys to demonstrate compliance with Subparts C – E. |
| 10 CFR 20 Subpart L | Storage and control of licensed material | Disa's operational plans incorporate the control of source material as its generated during the process. |
| 10 CFR 20 Subpart K | Waste Disposal | Source material will be recycled, clean coarse material will be reused, water will be disposed per limits allowed in 10 CFR 20, App B and treatment plant |

# BYPRODUCT MATERIAL LICENSING (LEAST RELEVANT)

- **Would require exemptions or alternatives to most of the Appendix A criteria and certain part 40 regulations.**
- **Justification for exemptions or alternatives:**
  - No radiological or non-radiological hazards associated with the clean coarse fraction
  - No long-term storage of tailings
  - Equipment is mobile and job sites are temporary
  - No potential for groundwater contamination
  - No potential for surface water contamination

# BPM EXEMPTIONS OR ALTERNATIVES

| Criterion | Regulation | Applicability to Disa | Request Exemption | Proposed Alternative Language |
|---|---|---|---|---|
| 3 | The "prime option" for disposal of tailings is placement below grade | None. Clean fraction does not pose any radiological or non-radiological hazard | This would be the best option. | Propose onsite placement with spreading. |
| 4 | Site and design criteria for whether tailings or wastes are disposed of above or below grade. | None. No onsite disposal in a cell would be required for the clean fraction. | Only option; seeking an exemption or an alternative to the Criterion 3. | |
| 5A | Primary groundwater protection standard: design standard for surface impoundments | None. No onsite disposal in a cell would be required for the clean fraction. | Only option; seeking an exemption or an alternative to the Criterion 3. | |
| 5B | Secondary groundwater protection standard: limits on hazardous constituents entering groundwater, defining a hazardous constituent, and excluding a hazardous constituent, defining groundwater. Includes a groundwater monitoring requirement. | None. Analytical data demonstrates that groundwater contamination would not occur. | Only option; analytical data shows reduced radiological signature and clean fraction is not hazardous. Groundwater monitoring requirement would be unsustainable. | |
| 5D | Groundwater remediation requirements if a groundwater protection standard is exceeded | None | NA. Only applicable when a groundwater protection program is required. | NA. Only applicable when a groundwater protection program is required. |
| 5E | Tailings management requirements to protect groundwater | None. Groundwater will not be impacted from Disa's operations. Disa's operations will not produce tailings. | Only option, as Disa will not manage any tailings, and won't be constructing tailings impoundments | |
| 5G | Information required to support a tailings disposal system | 5G(1) requires chemical and radioactive characteristics of waste solutions | Potential exemption because no tailings solutions will be disposed in an impoundment | Provide radiological and TCLP for clean reject fraction. Request the deletion of the geologic and hydrogeologic information requirements |

# BPM EXEMPTIONS OR ALTERNATIVES

| Criterion | Regulation | Applicability to Disa | Request Exemption | Proposed Alternative Language |
|---|---|---|---|---|
| 5H | Requirements for ore stockpiling | Applicable. Disa will comply by storing source material in rolloff containers, which will be isolated from the environment. | | |
| 6(1) – 6(6) | Requirement for covers over tailings disposal facilities and the radon flux standard, radium in soil rule, radium benchmark dose | None | Need exemption because no tailings disposal facilities will be constructed | |
| 6(7) | Requirements to address non-radiological hazards | Yes. These are addressed the TCLP analyses. | | |
| 6A(1) – 6A | Timeframe for completing final radon barrier, extensions, continued byproduct material disposal | None | Need exemption because no tailings created, and no disposal facilities constructed | |
| 7 | Requirement for 1 year of preoperational monitoring | Partially | | Need an alternative. Preoperational monitoring inappropriate. However, Disa to perform gamma scans prior to setting up equipment to ensure that it does not contaminate mine sites. Would need clear exemption from the 1-year timeframe as well. |
| 8 | Requirements for minimizing airborne effluent releases | Yes; not for tailings. RPP has already been developed for HPSA process. Meets 10 CFR 20. | | Some alternative language may be required to eliminate the requirements for mill-specific issues (i.e., stacks) |
| 8A | Requirements for daily inspections of tailings and waste retention systems | Partially | | Need an alternative as Disa will not have waste systems, but daily inspections of the equipment will be performed. |

# SOURCE MATERIAL WITH EXEMPTION

- Source Materials License w/ exemption from Appendix A
- **10 CFR 40.14 – Commission may grant exemptions:**
  - as are authorized by law
  - will not endanger life, property, common defense, and security
  - are otherwise in the public interest
- **Justification for exemptions:**
  - No radiological or non-radiological hazard from the clean coarse fraction
  - No long-term storage of tailings
  - No potential for groundwater or surface water contamination
  - Waste minimization is in the public interest

# LICENSING FRAMEWORK - CONCLUSIONS

## Source materials framework

- Fully protective of human health and the environment
- Simpler approach to byproduct materials license
- Can be coupled with a request to exempt clean coarse fraction from Appendix A requirements

## Byproduct materials framework

- Unnecessary considering data and intent of process
- Requires many exemptions and alternative requests
- Provides no commensurate benefit to protect human health and the environment

# PUBLIC POLICY AND BENEFIT

- **Source Materials License Framework most effectively achieves environmental remediation benefits and protection of public health**

- **Waste remediation**
  - Return mine sites to useable recreational areas
  - Reduce radiological signatures to ALARA
  - Alternative feed or disposal of concentrated materials addresses long-standing environmental justice concerns

- **HPSA is consistent with the purpose of UMTRCA, as stated in IUSA case:**
  - Regulate mill tailings at active mill operations and after operations
  - Stabilize and control tailings in a safe and environmentally sound manner
  - Minimize or eliminate radiation hazards to the public

# HPSA IS A SOLUTION

## HPSA is a highly effective Remediation SOLUTION:

15,000 waste rock piles sitting at mine sites for decades

Even record high uranium prices did not result in waste rock processing

Contaminated soils and other wastes can be treated using HPSA

- **Reducing the quantity and hazard of waste is a responsibility of the NRC**
- **Current byproduct material definition introduces ambiguity**
- **NRC staff has opportunity to approve a remediation technology**
- **Failure to approve HPSA as a source material activity inhibits other Federal remedial programs**

# THANK YOU

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ECONOMIC

SUSTAINABLE

EFFICIENT



30

# APPENDIX

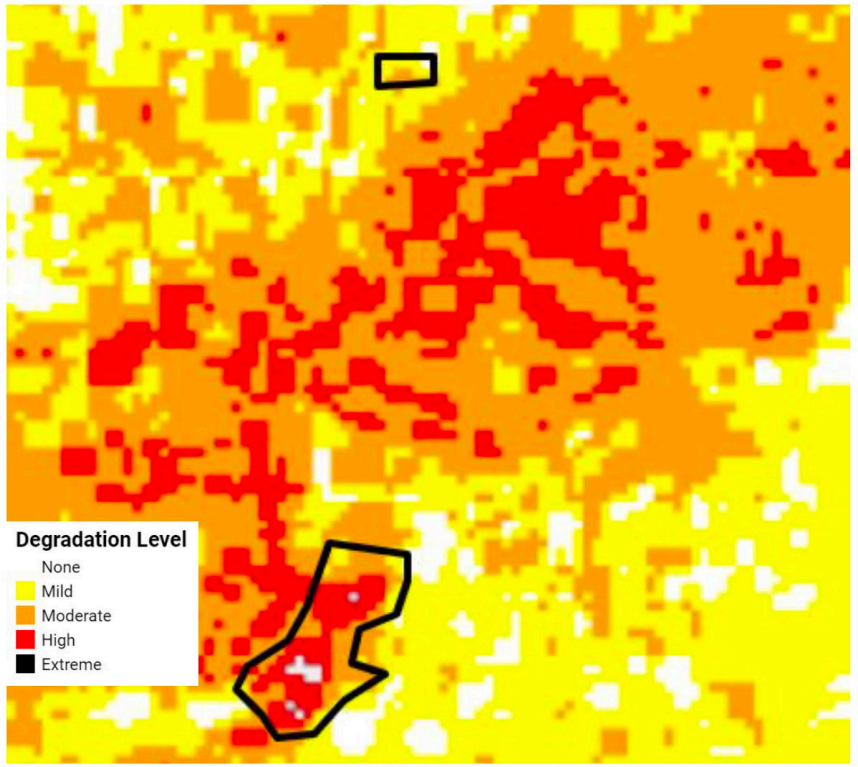
# CULTIVO LAND PBC EXAMPLE

## Land degradation

Our tool assesses the local range of variability in biomass productivity/performance (using NDVI as a proxy), then compares the productivity level on each pixel to maximum productivity measured from similar land units (i.e. pertaining to the same biome) across the study area in the assessment year. Depending on the land unit's performance relative to the maximum, we may estimate if the land is degraded.

| | Area (ha) | % |
|---|---|---|
| Not degraded (ha) | 0.01 | 0% |
| Mildly degraded (ha) | 0.27 | 13.5% |
| Moderately degraded (ha) | 0.73 | 36.5% |
| Highly degraded (ha) | 0.69 | 34.5% |
| Extremely degraded (ha) | 0.07 | 3.5% |

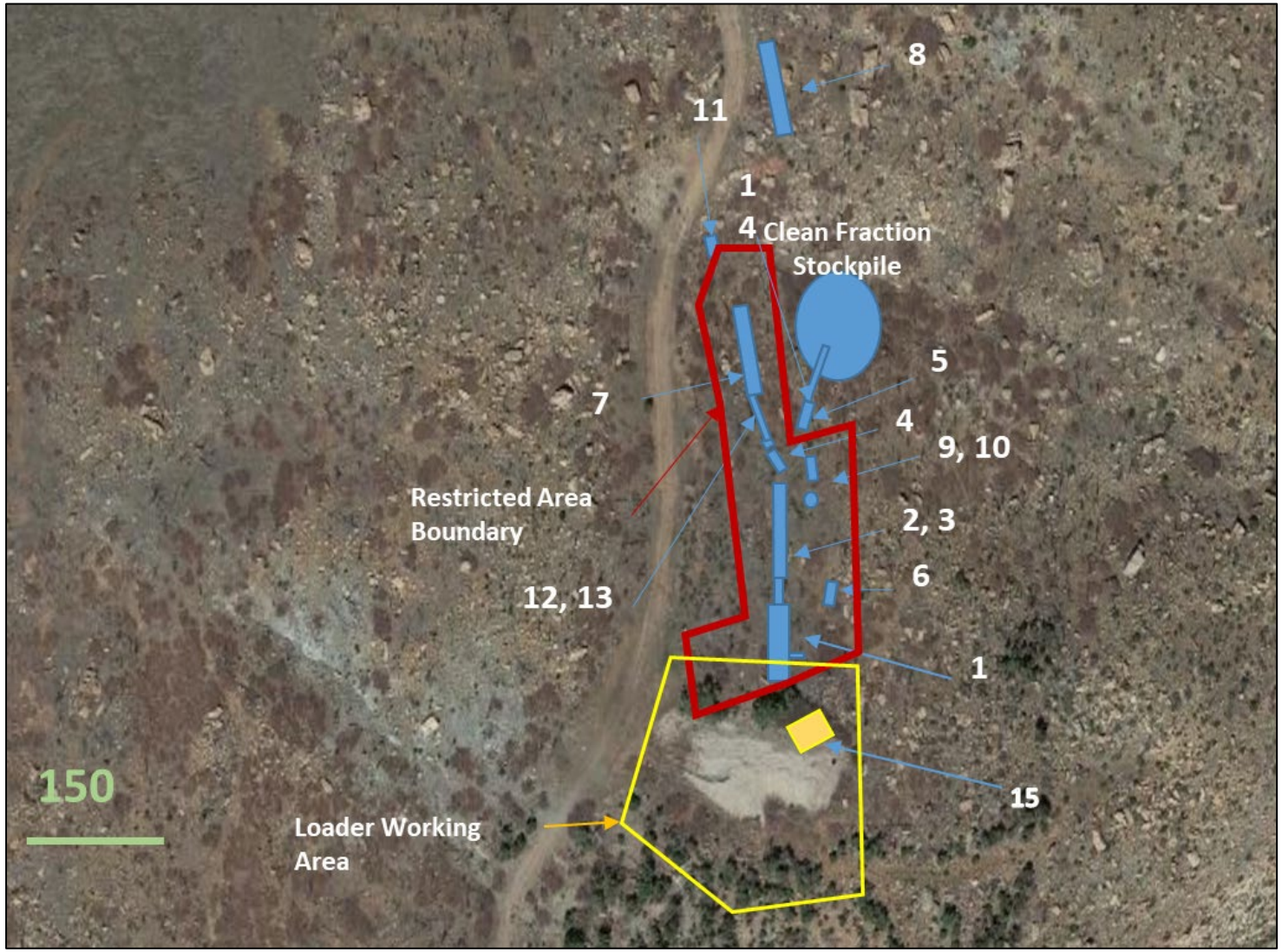
**Degradation State Map 2019 (Sentinel2, 10 m resolution)**




*LandSat 8 has a 30m resolution, Sentinel 2 has a 10m resolution and MODIS has a 250m resolution.*

# OPERATIONAL COMPONENTS

| Feature Number | Equipment Description |
|---|---|
| 1 | Crusher and 0.25" Screen |
| 2 | HPSA Processing Unit |
| 3 | HPSA Unit Containment Berm |
| 4 | Product Centrifuge |
| 5 | Clean Fraction Centrifuge |
| 6 | Analytical Trailer |
| 7 | Loaded Transportation Truck |
| 8 | Unloaded Transportation Truck |
| 9 | Process Water Tank |
| 10 | Process Water Treatment Unit |
| 11 | Office Trailer/Lavatory |
| 12 | Product Centrifuge Hopper |
| 13 | Product Centrifuge Auger Conveyor |
| 14 | Reject Centrifuge Stacker |
| 15 | Front-end Loader |



# SYNTHETIC PRECIPITATION

| Parameter | Units | Waste Rock | Clean Coarse Fraction | % Difference |
|---|---|---|---|---|
| Arsenic | mg/L | 0.664 | 0.148 | **78%** |
| Lead | mg/L | 0.014 | 0.006 | **57%** |
| Selenium | mg/L | 0.020 | 0.006 | **70%** |
| Uranium | mg/L | 0.10 | 0.06 | **40%** |
| Vanadium | mg/L | 0.57 | 0.14 | **75%** |
| Lead 210 | pCi/L | 9.9 | 6.2 | **37%** |
| Radium 226 | pCi/L | 20.0 | 9.8 | **51%** |
| Radium 228 | pCi/L | ND | ND | NA |
| Thorium 230 | pCi/L | 7.4 | 4.0 | **46%** |
| Thorium 232 | pCi/L | ND | ND | NA |

SPLP Demonstrates HPSA Reduces the Leachability