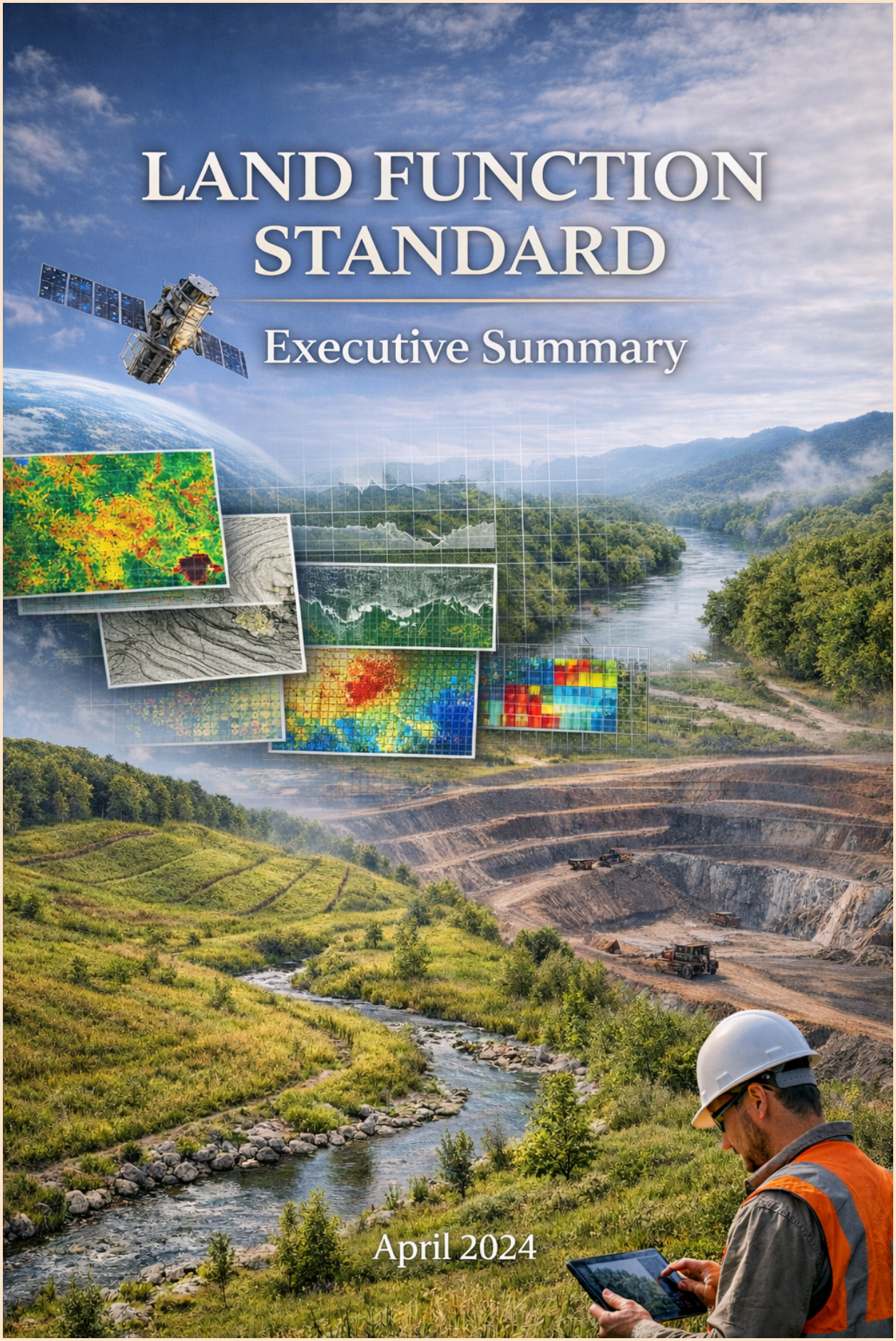
LAND FUNCTION STANDARD

Executive Summary



April 2024

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Executive Summary

Framework for Mine Reclamation, Landscape Stability, and Environmental Recovery

April 2026

LandFunction.org

Introduction

Land disturbance caused by mining alters terrain structure, disrupts hydrologic systems, exposes soil to erosion, and removes vegetation that stabilizes the landscape. When extraction ends, these systems may remain unstable long after mining operations have ceased.

Traditional reclamation evaluation methods often rely on visual inspections, regulatory documentation, or short-term vegetation establishment. While these methods can confirm administrative closure, they do not always demonstrate whether the landscape has regained functional environmental stability.

The Land Function Standard establishes a framework for evaluating reclaimed landscapes based on observable environmental behavior.

Rather than defining success through appearance or compliance documentation, the Land Function Standard evaluates whether disturbed landscapes recover the ability to regulate terrain stability, water movement, sediment transport, and vegetation persistence over time.

Advances in geospatial monitoring now allow these environmental processes to be observed and measured across entire landscapes. Platforms such as Google Earth Engine provide access to decades of satellite imagery, terrain data, and environmental datasets that allow professionals to monitor landscape behavior through time.

By combining field observation with geospatial analysis, the Land Function Standard transforms reclamation monitoring into a repeatable and evidence-based environmental verification process.

The objective of the framework is simple:

Reclaimed land should behave like stable land again.

The Land Function Approach

The Land Function Standard evaluates reclamation through the performance of interacting environmental systems rather than isolated engineering features.

Landscape recovery is assessed through four core indicators:

Terrain Integrity

Stable slopes and landforms that resist erosion and maintain consistent structure.

Hydrologic Function

Water movement through predictable drainage pathways without concentrated runoff or persistent instability.

Sediment Stability

Reduced sediment transport and decreasing erosion activity across reclaimed terrain.

Vegetation Persistence

Plant communities capable of stabilizing soil and surviving across seasonal cycles without repeated intervention.

These indicators represent the fundamental components of landscape stability.

When terrain, water, soil, and vegetation systems function together in a stable manner, the landscape begins to regulate itself naturally. This self-regulation represents the ultimate indicator of environmental recovery.

The Evidence-Based Monitoring Model

A central feature of the Land Function Standard is the use of measurable environmental evidence.

Rather than relying solely on written reports or periodic field inspections, the framework requires the creation of a Land Function Evidence Pack.

The Evidence Pack documents landscape behavior through:

• terrain analysis

• vegetation recovery monitoring

• watershed behavior evaluation

• erosion trend analysis

• long-term satellite imagery comparisons

These materials provide transparent documentation of landscape stability and environmental recovery.

Integration of Google Earth Engine

The Land Function Standard integrates Google Earth Engine (GEE) as a primary geospatial monitoring platform.

Google Earth Engine provides cloud-based access to large environmental datasets and satellite imagery archives that allow practitioners to analyze landscape behavior across multiple decades.

Using GEE, practitioners can:

• define project Areas of Interest

• establish baseline landscape conditions

• analyze terrain structure using elevation models

• monitor vegetation recovery using spectral indices

• detect erosion patterns through time-series imagery

• evaluate watershed behavior and drainage stability

These analyses produce measurable indicators of environmental recovery and create a reproducible monitoring record for reclamation projects.

By integrating geospatial monitoring with field observation, reclamation outcomes can be evaluated through observable environmental evidence rather than subjective interpretation.

Applications

The Land Function Standard may be applied across a wide range of environmental restoration and monitoring contexts.

These include:

• active mine reclamation programs

• restoration of historic mining disturbances

• watershed stabilization initiatives

• environmental monitoring programs

• academic research in landscape recovery

Because the framework focuses on landscape behavior rather than prescriptive engineering specifications, it can be adapted to a variety of environmental conditions and restoration approaches.

Training and Implementation

The Land Function Standard is supported by a structured educational program designed to train practitioners in the principles and monitoring methods required to apply the framework.

The training program consists of a twelve-module course that guides participants through the full reclamation lifecycle:

Observe → Predict → Act → Verify → Steward → Prove → Lead

Participants learn to evaluate landscape behavior, interpret environmental indicators, and apply geospatial monitoring techniques to verify reclamation outcomes.

Training is supported through the Land Function Institute and delivered through instructor-guided coursework and supporting publications.

Partnerships and Pilot Projects

The Land Function Standard is designed to support collaboration between environmental professionals, academic institutions, industry organizations, and technology partners.

Pilot monitoring projects provide opportunities to apply the framework in real-world reclamation settings and demonstrate how geospatial evidence improves transparency and confidence in environmental restoration outcomes.

Collaborative initiatives may include:

• reclamation monitoring pilots

• geospatial research collaborations

• watershed monitoring programs

• environmental education initiatives

These partnerships will support the continued refinement and practical application of the Land Function Standard.

Conclusion

The Land Function Standard provides a modern framework for evaluating reclaimed landscapes based on environmental performance rather than administrative closure.

By focusing on observable land behavior and integrating geospatial monitoring technologies such as Google Earth Engine, the framework establishes a transparent and evidence-based approach to reclamation evaluation.

The goal of the Land Function Standard is not simply to restore disturbed land to an acceptable appearance.

The goal is to ensure that reclaimed landscapes regain the stability and resilience required to function as self-regulating environmental systems.

The Land Function Evidence Pipeline

The Land Function Standard introduces an evidence-based monitoring model known as the Land Function Evidence Pipeline.

The Evidence Pipeline connects reclamation practices with geospatial monitoring technologies to create a transparent and measurable record of environmental recovery.

Traditional reclamation evaluation often relies on field inspections or written reports that describe site conditions at a specific moment in time. While these observations remain valuable, they do not always capture how landscapes behave over longer time periods.

The Evidence Pipeline addresses this limitation by combining field observation with continuous geospatial monitoring.

Through this approach, environmental professionals can observe how reclaimed landscapes evolve across seasons and years.

The Evidence Pipeline follows a structured progression:

Mining Disturbance

Mining activities alter terrain structure, disrupt hydrologic systems, and remove vegetation that stabilizes the landscape.

Reclamation Implementation

Reclamation efforts reshape terrain, restore drainage pathways, rebuild soil systems, and establish vegetation to stabilize disturbed land.

Environmental Indicators

Landscape recovery is evaluated through four core indicators defined in the Land Function Standard: terrain integrity, hydrologic function, sediment stability, and vegetation persistence.

Geospatial Monitoring

Platforms such as Google Earth Engine allow practitioners to analyze satellite imagery, terrain models, and vegetation indices to monitor environmental indicators across time.

Evidence Pack Generation

Geospatial analysis and field observations are compiled into a Land Function Evidence Pack that documents landscape behavior through maps, trend analyses, and monitoring records.

Verified Landscape Stability

When environmental indicators demonstrate stable performance across multiple seasonal cycles, the reclaimed landscape can be considered to have regained functional environmental stability.

Why the Evidence Pipeline Matters

The Land Function Evidence Pipeline transforms reclamation monitoring from a subjective evaluation into a measurable environmental verification process.

By integrating geospatial analysis with field observation, the framework allows environmental professionals to demonstrate reclamation outcomes through observable data rather than interpretation alone.

This approach improves transparency, strengthens public confidence in reclamation efforts, and provides decision-makers with clear evidence that disturbed landscapes are recovering as intended.

THE LAND FUNCTION EVIDENCE PIPELINE

MINING DISTURBANCE

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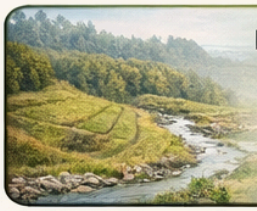
RECLAMATION IMPLEMENTATION



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Terrain Integrity Hydrologic Function, Sediment Stability Vegetation Persistence

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Why This Framework Matters Now

Across the world, mining operations are increasingly expected to demonstrate responsible land stewardship. Governments, communities, and environmental organizations are asking the same fundamental question:

Has the land actually recovered?

Traditional reclamation reporting methods often focus on documentation, engineering specifications, or visual inspection of revegetation efforts. While these approaches confirm that reclamation activities were completed, they do not always provide clear evidence that disturbed landscapes have regained long-term environmental stability.

At the same time, modern geospatial technologies now allow environmental professionals to observe landscape behavior across entire regions and across decades of environmental change.

Platforms such as Google Earth Engine provide access to global satellite imagery archives and environmental datasets that can reveal patterns of vegetation recovery, erosion activity, and watershed behavior across time.

These capabilities make it possible to move beyond descriptive reclamation reports toward measurable environmental verification.

The Land Function Standard was developed to bridge this gap.

By integrating environmental indicators, field observation, and geospatial monitoring, the framework provides a transparent method for evaluating whether reclaimed landscapes have regained the ability to function as stable environmental systems.

This approach supports:

• improved transparency in reclamation monitoring

• stronger public confidence in environmental restoration efforts

• better long-term stewardship of disturbed land

• collaboration between environmental professionals, researchers, and technology partners

The Land Function Standard represents an opportunity to bring modern geospatial science into the evaluation of environmental recovery.

Its goal is not only to improve how reclamation is measured, but also to encourage a broader understanding of how landscapes recover and how responsible resource development can coexist with long-term environmental stability.

Technology and Research Partnership Opportunity

The Land Function Standard creates an opportunity for collaboration between environmental professionals, research institutions, and technology providers working to improve how land restoration is measured and monitored.

Modern environmental monitoring technologies—including satellite imagery, cloud-based geospatial platforms, and large environmental datasets—are rapidly expanding the ability to observe landscape behavior across large geographic areas and long time periods.

The Land Function Standard integrates these technologies into a practical monitoring framework designed specifically for land reclamation and environmental recovery.

This creates opportunities for collaboration with organizations involved in:

• geospatial analysis and satellite monitoring

• environmental data science

• watershed and landscape restoration research

• mining reclamation and land stewardship initiatives

• environmental education and training

Technology partners may contribute to pilot monitoring projects, develop analytical workflows that support environmental indicators, and participate in research that advances the science of landscape recovery monitoring.

Platforms such as Google Earth Engine play a central role in enabling this work by providing scalable access to satellite imagery, terrain data, and environmental datasets.

Through collaborative projects, partners can help demonstrate how geospatial monitoring technologies can improve transparency and accountability in environmental restoration efforts.

Pilot Monitoring Projects

Pilot projects represent an important step in demonstrating how the Land Function Standard can be applied in real-world environments.

These projects provide opportunities to evaluate reclaimed landscapes using both field observation and geospatial monitoring techniques.

Pilot initiatives may involve:

• monitoring reclaimed mine sites

• analyzing historic mining disturbances

• evaluating watershed recovery following land restoration

• testing geospatial workflows that support the Land Function Evidence Pipeline

The results of these projects will contribute to the continued refinement of the Land Function Standard and expand the knowledge base supporting landscape recovery monitoring.

Institutional Development

The Land Function Standard is supported by the Land Function Institute, which serves as a platform for education, research, and collaboration in the field of land restoration and environmental stewardship.

The Institute maintains:

• educational training programs

• published reference materials

• research documentation and case studies

• geospatial monitoring workflows

• a growing library of environmental analysis resources

Through collaboration with environmental professionals and research partners, the Institute seeks to improve how reclaimed landscapes are evaluated and how environmental recovery is understood.

Invitation for Collaboration

Organizations interested in participating in the development or application of the Land Function Standard are encouraged to collaborate through research partnerships, pilot monitoring initiatives, and technology development efforts.

By combining field expertise with modern geospatial monitoring tools, the Land Function community aims to advance the science of environmental recovery and promote responsible stewardship of disturbed landscapes.