GL-MS-012 – QA/QC and Official Data

Version: 1.0
Date: September 2025
Developed by: Flávio Alfaro

Regulatory basis:

- Core Carbon Principles (ICCVCM)
- ICROA Code of Best Practice
- CORSIA
- ISO 14064-2

Methodological integrations:

- GL-M-001 — REDD Core (ex-post model for preserved stock)
- GL-MC-004 — Calculation/report (AGB→C→CO_2eT ; masks and traceability)
- Leakage Annex GL-MC-004 — Class → Leakage Risk Gate
- GL-MS-002 — Additionality and gates (condition/retain)
- GL-MS-005 — Accreditation and supervision of VVBs
- GL-MS-007 — Legal Compliance (SCJ-GC)
- GL-MS-011 — National requirements and Art. 6 (SBCE integration)

Co-benefits :

- Assessed on an opt-in basis according to the CCB (Climate , Community & Biodiversity Standards) standard.
- Operated exclusively by Greenline Institute (GLI)

GREENLINE CARBONSAT
September 2025

Document Information

Document Name:	*GL-MS-012 – QA/QC and Official Data*		
Technical Manager:	Flavio Alfaro	Document Version:	1.0
		Document version date:	September 30, 2025
Review Quality Method:			
Prepared by:	Flavio Alfaro	Preparation Date:	September 30, 2025
Reviewed by:		Revision Date:	

Distribution List

Of	**Date**	**E-mail**
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To	**Action***	**Delivery Date**	**E-mail**

** Types of Actions: Approve, Review, Inform, Archive, Action Required, Others*

Historical Version

Version No.	Data Version	Reviewed by	Description	File Name
1.0	September 15, 2025	Flavio Alfaro	Document Creation GL - MS -012	Official Data v1.doc

Summary

1. Objective and Scope

1.1 Objective

Establish Quality Assurance and Quality Control (QA/QC) requirements for official data used in projects under Core GL-M-001, ensuring integrity, reproducibility, and traceability through objective criteria (including FTC) and standardized metadata.

1.2 Scope of application (global methodology)

It applies globally to Greenline projects. Carbonsat , regardless of jurisdiction. The selection and use of official sources follow GL-GR-010 (Global Data Catalog) and its Country Packs, which specify requirements, parameters, and exceptions by country/region.

It covers global remote data (recognized international agencies and programs) and official public registries defined in the Country Packs. Raw data is not published; only auditable metadata.

1.3 Explanatory note about MRV (modular fitting)

The **GL-MS-012 integrates the** Monitoring and Reporting system . and Greenline 's MRV Verification , which regulates data quality and traceability, does not constitute the complete MRV. Additional information:

- GL-MS-004 (leakage appendix (calculations/report AGB→C→CO_2eT);
- GL-MS-002 (gates /additionality), GL-MS-004 (leakage);
- GL-MS-005 (VVBs) and GL-MS-007 (legal compliance);
- GL-MS-011 (national requirements/Art. 6) and GL-GR-010 + Country Packs (sources/parameters by country);
- GL-MS-003 (co-benefits , opt-in , GLI governance): socio-environmental indices and metrics remain in 003; 012 requires metadata and traceability when such metrics use official sources or public statistics.

1.4 Essential definitions

QA: activities to ensure that processes/data meet quality standards.
QC: operational controls per cycle.
FTC: objective index (coverage, update, accuracy/validation, consistency).
Minimum metadata: URI, version, hash , changelog , responsible party.

1.5 Principles transversals

Integrity (official and auditable sources); Reproducibility (URI/ hash / changelog);
Transparency (public metadata by cycle);
Independence (accredited VVBs , rotation/audits);
Forward-looking (changes applicable only to future cycles).

1.6 Methodological Box — Summary Flow (Global + Country Packs)

1. Selection of official sources via GL-GR-010 + applicable Country Pack
2. QA/QC application (GL-MS-012) and FTC calculation
3. Ex-post calculations (GL-MC-004)
4. Gates (GL-MS-002), Leakage (GL-MC-004 – Leakage Annex), Compliance (GL-MS-007)
5. Cycle report (GL-M-001)
6. Independent verification (GL-MS-005)
7. Digital record + metadata publication (Carbonsat)

   (If chosen) Co-benefits (GL-MS-003/GLI) → publish metadata of the corresponding sources and outputs

Captions and Abbreviations

- *MRV — Monitoring , Reporting and Verification : a modular system for monitoring, reporting, and verification.*
- *QA/QC — Quality Assurance / Quality Control : Data quality assurance and control.*
- *FTC — Technical Confidence Factor: an objective index of data quality.*

Greenline Global Data Catalog (with Country Packs).

- *Country Pack — Package of official parameters and sources by country/region for GL-GR-010.*
- *GL-M-001 — Methodological core of credits for preserved inventory.*
- *GL-MC-004 — Calculation Methodology (AGB→C→CO_2eT) and Leakage Appendix .*
- *GL-MS-002 / 005 / 007 / 011 / 003 — Gate modules , VVBs , legal compliance, national integration/Art. 6 and co-benefits (opt-in /GLI).*
- *AGB — Above-Ground Biomass : biomass above the ground.*
- *CO_2eT — Conserved stock of equivalent CO_2 (ex-post).*

2. Rules for using official data (version (adjusted)

2.1 Source selection (global rule)

a) The selection and eligibility of fonts follow the GL-GR-010 (Global Catalog) and Country Packs.
b) It is forbidden to use a font not listed in 010, except for inclusion via the 010 fast-track system itself.
c) Data should be publicly auditable and have accessible technical documentation.

2.2 Exclusivity and sealing

a) Exclusive use of official data: only official databases recognized in GL-GR-010.
b) Field inventory is prohibited for calculation and comparison ; only official data from GL-GR-010 are valid. eligible .
c) Third-party aggregators/derivatives: prohibited, except if officially recognized and listed in GL-GR-010.
d) Exclusivity : use only sources listed in GL-GR-010 / Country Pack, or Include via *fast-track* from 010.

2.3 Minimum required metadata

a) URI, version, hash (or checksum), changelog (release notes), and assignee.
b) Dates: collection/ingestion and official release.
c) CRS and unit of measurement.
d) License/Terms of Use.
e) FTC and uncertainty class published in the cycle metadata.

2.4 Versioning and provenance

a) Layers with immutable version (pin) and recorded hash .
b) Internal processes generate reproducible artifacts (scripts + checksums).
c) Forward-looking : new versions are only valid for future cycles.

2.5 Preprocessing and integrity

a) Allowed: clipping, reprojection , resampling , documented filtering, masks as per **GL-MC-004** .

b) Gaps/outliers: treat as per 3.3, with logarithm and justification.

c) Any alteration that changes the technical meaning of the variable is prohibited.

2.6 Reconciliation between sources

a) Priority as per GL-GR-010/Country Pack.

b) Residual conflicts require a technical note (diagnosis, impact, decision, evidence).

c) Preserve the temporal and spatial consistency of the package.

2.7 Publication and access

a) Raw data is not published.

b) Metadata is published: URI, version, hash , changelog , FTC, uncertainty, dates, responsible party.

c) Reproducible packages are made available to VVB under the scope of verification.

2.8 Security and document retention

a) Audit trail (logs) per cycle.

Greenline registration policy . Carbonsat (≥ audit period).

opt-in components , publish only metadata (in compliance with data protection regulations).

2.9 Inclusion fast -track new sources

a) Application via GL-GR-010 with documentation, tests and preliminary FTC.

b) Use in official cycle only after inclusion in the 010/Country Pack.

2.10 Requirements for support to Annex Leakage (GL-MC-004)

a) Layers that feed into Annex Leakage fully comply with 2.1–2.9.

b) Class 012 is responsible for quality and traceability; the class→gate is defined in GL-MC-004 – **Leakage Annex .**

Leakage Appendix when applicable.

2.11 Compliance and roadblocks

a) Metadata failures, FTC below threshold, or violation of 2.1–2.2 ⇒ conditioning or rejection (see 3.4 and 4.1/4.3).

b) The cycle only advances once the layer-by-layer decision framework is complete (Checklist D.2).

Captions and Abbreviations

• URI — Uniform Resource Identifier : Unique identifier of the resource.
• Hash — Cryptographic fingerprint of the file/data.
• Changelog — Change/version log.
• CRS — Coordinate Reference System: cartographic reference system.
• Pin — Immutable version fixing for traceability. • Fast-track — Agile procedure for including new sources in GL-GR-010. • VVB — Validation & Verification Body: independent verification/validation entity.

3. QA/QC: criteria objectives

3.1 Structure general QA/QC

Quality control follows a modular approach based on:

a) QA (Quality) Assurance): procedures to guarantee the integrity and traceability of sources, applied before use.
b) QC (Quality) Control): verification of data consistency and reliability in each cycle, with log records and sample audits.
c) FTC (Technical Confidence Factor): a quantitative quality index, calculated according to Annex B and published with the cycle metadata.

3.2 Spatial and temporal coverage criteria

a) Data must cover 100% of the project area and the analysis radius defined in **GL-MC-004** .

b) Time series must be complete within the historical cycle window (36 months standard, as per GL-MS-002).

c) Absence of coverage or interruption exceeding 5% requires technical justification and may lead to cycle disruption.

3.3 Consistency and handling of gaps/outliers

a) Inconsistencies, null or anomalous values must be identified and documented in the QC log.

b) Gaps of less than 5% of the area or time can be interpolated using official methods described in **GL-GR-010** .

c) Gaps greater than 5% or failures in critical regions render the layer conditional (FTC < threshold).

d) Persistent outliers require a technical note justifying their exclusion or correction.

e) No data may be modified outside the limits of 010.

3.4 Decision framework — acceptance / conditioning / rejection

Each layer used in the cycle should be evaluated according to the matrix below , based on the **FTC** and the QA/QC criteria :

Observed condition	FTC calculated	Decision	Required evidence	Situation in the cycle
Full coverage and consistency; no gaps > 5%; complete documentation.	≥ 0.80	To accept	FTC spreadsheet + QC logs	Issue credits normally
Gaps ≤ 10%, localized inconsistencies; moderate FTC	0.65 – 0.79	Condition	Technical note + mitigation plan	Issue with reservation (5.4 of GL-MS-002)
Coverage < 90%, widespread inconsistency, low FTC.	< 0.65	Reject	QA/QC Opinion	Hold until next cycle

3.5 Audits and sampling

a) The minimum sampling for QA/QC audits is defined according to the risk of each layer, based on the FTC (the lower the index, the larger the sample).

b) VVBs may apply additional sampling when the FTC < 0.80.

c) Audited logs and samples must be archived by cycle in the QA/QC package.

3.6 Inconsistency and traceability reports

a) Each cycle must generate a QA/QC report containing: i) a summary of inconsistencies detected; ii) an FTC spreadsheet; iii) corrective actions; iv) evidence of reproducibility.

b) The report is archived in the Carbonsat registry and made available to VVB.

3.7 Relationship to Annex Leakage (GL-MC-004)

a) The risk layers used in the Leakage Annex fully comply with these criteria.

b) **GL-MS-012** is responsible for the quality and traceability of the data; risk classification (class → gate) is the responsibility of the Leakage Annex . c) The FTC and QA/QC status of these layers must be explicitly stated in the cycle metadata.

Captions and Abbreviations

• QC Log — Record of verifications, inconsistencies, and corrective actions.
• Leakage Annex — Section of GL-MC- 004 responsible for leak analysis. • FTC min — Minimum acceptable FTC value (0.65 by default). • Mitigation Plan — Technical document proposing corrections for conditioned layers. • Cycle — Official period for monitoring and verifying
Greenline data. Carbonsat .

4. Technical Confidence Factor (TCF)

SSOT (Single Source of Truth): GL-MS-012 is the single source of the FTC; other methodologies should not replicate the formula. The final FTC is published in the cycle metadata (Annex C).

4.1 Concept and purpose

The Technical Confidence Factor (TCF) is the quantitative index of the quality of official data used in each cycle under Greenline. Carbonsat . The FTC consolidates, by data layer, technical reliability based on coverage (COV), update (UPD), accuracy/validation (ACC), and consistency (CON).

The FTC guides the layered decision framework (see 3.4) — accept, condition, or reject — and supports the data quality gate in **GL-MS-002.**

4.2 Structure, components and formula

Each component receives a score between 0.00 and 1.00 (objective criteria detailed in Appendix B) and a fixed weighting:

Component	Symbol	Weight	Brief description
Coverage	COV	0.35	Effective spatial/temporal coverage of the project area and cycle window.
Update	UPD	0.25	Timeliness: difference between official release and ingestion, adherence to the official frequency.
Accuracy / Validation	ACC	0.25	Stated uncertainty, official validations/ intercomparisons , reported errors (e.g., RMSE/MAE).
Consistency	CON	0.15	Spatial/temporal and interlayer agreement; absence of unexplained anomalies.

General formula:

$$FTC = 0{,}35 \cdot COV + 0{,}25 \cdot UPD + 0{,}25 \cdot ACC + 0{,}15 \cdot CON$$

Assignment parameters for grades (0–1) per component and worked-out examples will be applied as per Appendix B (template spreadsheet).

4.3 FTC threshold and interpretation

You thresholds Standard settings (adjustable via the **GL-GR-010 Country Pack**) are :

FTC Strip	Classification	Action	Effect on the cycle
≥ 0.80	High reliability	To accept	This layer is fully valid for calculation/reporting.
0.65–0.79	Moderate reliability	Condition	Emission with qualification (see 5.4 of GL-MS-002) + mitigation plan.
< 0.65	Low reliability	Reject	Hold until replacement/reprocessing in a new cycle.

The data rules , FTC thresholds , and lists of GL-GR-010 do not retroactively apply , they only apply to cycles. futures

4.4 Calculation, evidence, and publication

a) The FTC is calculated per layer and recorded in a standard spreadsheet (Appendix B) with logs and justifications (when applicable).

b) The final FTC value is published in the cycle metadata (Annex C template) in the Greenline registry. Carbonsat .

c) VVBs verify the FTC based on evidence from the QA/QC Package (scripts, checksums , logs, and technical notes).

d) The QA/QC report for the cycle consolidates the FTCs and associated decisions.

4.5 Reviews , weights and forward-looking statements

a) Weights/thresholds may be adjusted prospectively by updating GL-GR-010 or by new requirements of international standards.

b) Changes apply only to future cycles (principle of prospectiveness) and are recorded in the GL-MS-012 changelog .

c) Any adjustment must preserve the reproducibility of previous results.

4.6 Integrations methodological (use of FTC)

a) **GL-MS-002** (gates): uses the FTC as input for the data quality gate (emit/condition/retain). b) **GL-MC-004 +** Leakage Appendix : consumes the FTC from the input layers (published in the metadata), without redefining the index.

c) **GL-MS-005** (VVB): uses the FTCs and corresponding evidence within the scope of verification.

d) **GL-MS-011 / GL-GR-010 (Country Packs): can parameterize local ranges/thresholds, maintaining the** prospectiveness rule .

4.7 Scope notes (SSOT and compliance)

a) SSOT Note: **GL-MS-012** is the single source reference. of Truth) for definition, formula, weights, thresholds, and calculation of the FTC. Other methodologies should not replicate the calculation; they should refer to this section and Appendix B.

b) Compliance (**GL-MS-007**): not integrated with the FTC. The FTC measures the technical-statistical quality of data; legal compliance is an independent gate assessed by **GL-MS-007** and considered in the final decision of **GL-MS-002** .

Captions and Abbreviations

• FTC — Technical Confidence Factor (data quality index).
• COV / UPD / ACC / CON — FTC components: Coverage, Update, Accuracy/Validation, Consistency. • QA/QC Package — Cycle evidence set (logs, spreadsheets, scripts, and checksums).
• QA/QC Report — Document that consolidates inconsistencies, FTCs , and decisions by layer.
• Country Pack (GL-GR-010) — Parameterizations/prioritizations by country/region.
• Greenline Carbonsat — Official registry/platform for publishing cycle metadata.
• VVB — Validation & Verification Body (independent verification/validation entity).
• Data quality gate — GL-MS-002 mechanism for issuing/conditioning/withholding data. • Prospectivity — Application of changes only to future cycles.

• SSOT (Single Source of Truth) — Single source of truth: defines GL-MS-012 as the exclusive normative repository for FTC calculation; other methodologies only reference this module.

5. Uncertainty (application) operational)

5.1 Concept and framework

Uncertainty represents the quantitative margin of error associated with the official data used in the cycle calculations.

At Greenline In Carbonsat , uncertainty is treated as a complementary component to FTC, but without interfering with its formula.

The objective is to ensure transparency and comparability between cycles, in accordance with the principles of the IPCC Guidelines (2006/2019) and the ISO 14064-2 / 14065 / 17029 standards.

5.2 Operational classification of uncertainty

Each data layer is classified according to standardized percentage ranges. The values are derived from technical documentation from the official source (metadata) or, in its absence, by intercomparison within **GL-GR-010.**

Category	Percentage range (1σ or 95% CI)	Meaning	Recommended action
Low	≤ 10%	Highly validated and consistent data.	Direct use, without reservations.
Average	> 10% and ≤ 20%	Moderate variability; acceptance with mitigation.	Require a technical report and control plan.
High	> 20%	Significant uncertainty; risk of distortion of results.	Condition or reject layer (see 3.4 and 4.3).

Note: *The percentage range must be explicitly recorded in the cycle metadata and in the QA/QC Report.*

5.3 Propagation and compatibility with GL-MC-004

a) The propagation of uncertainties between layers or variables follows the methodology defined in **GL-MC-004** (Calculation of Conserved Stock CO_2eT).
b) **GL-MS-012** provides the uncertainty values per layer; 004 consolidates the propagation in the CO_2eT results .
c) The consolidated result should indicate the total uncertainty of the cycle, published along with the QA/QC Report.
d) Changes to sources (or versions) that increase uncertainty above the "Average" range require formal justification and prospective review in **GL-GR-010** .

5.4 Minimum evidence criteria

For acceptance of data with declared uncertainty, the following must exist:

1. Official metadata with a numerical uncertainty value (%, 1σ or 95% CI).
2. Technical documentation of the validation methodology used by the source.
3. Registration of the unit of measurement and reference system (CRS).
4. Technical compatibility note (if using a combination of different fonts).
5. Mitigation plan in case of "Medium" or "High" classification.

Note, Accepted uncertainty formats:

The uncertainty should be included in the official metadata of the source in an auditable quantitative format.

- *percentage (%); or (ii) 1σ (standard deviation; ~68% confidence); or (iii) 95% CI (confidence interval).*
- *When given in 1σ or 95% CI, convert to relative % in the cycle metadata (see Appendix C).*
- *Qualitative metadata ("high", "medium") are not accepted.*

5.5 Relationship between uncertainty and decision-making in the cycle.

Uncertainty influences the issuance decision, but does not directly alter the FTC. The interaction between the two is handled in the quality gate **(GL-MS-002**):

Situation	FTC	Uncertainty	Recommended decision (002)
High quality (FTC ≥ 0.80) + Low uncertainty	≥ 0.80	≤ 10%	Accept and issue normally.
High quality + Medium uncertainty	≥ 0.80	10–20%	Issue with reservation and technical note.
Moderate reliability (FTC 0.65–0.79) + Medium or high uncertainty	0.65–0.79	> 10%	Condition and review in the next cycle.
FTC < 0.65 (any uncertainty)	< 0.65	—	Reject layer / reprocess data.

The final decision is formalized in Checklist D.2 ("Gates and Evidence — compliance with 5.4 of **GL-M-001/002** ").

5.6 Registration and publication

a) The declared uncertainty and its corresponding category are published in the cycle metadata and in the QA/QC Report.

b) The metadata must contain: percentage value, confidence level, validation method, source, and version.

c) A Greenline Carbonsat maintains a history of uncertainties per layer in each cycle, preserving traceability and longitudinal comparability.

Normative note : *You metadata minimum publication requirements they are defined in* ***Annex C*** *this methodology and constitute reference required for the Gate (GL-MS-002) and for the checks independent (GL-MS-005).*

Captions and Abbreviations

• Uncertainty (1σ / 95% CI) — Declared margin of error, according to statistical standards.

• • QA/QC Report — Cycle document with uncertainty values, FTC and logs. • Checklist D.2 — Decision framework and evidence for compliance with 5.4 of GL-M-001/002. • Quality Gate (GL-MS-002) — Decision mechanism for issuance/conditioning/retention.

6. Evidence , Reproducibility and Indicators (VVB)

6.1 QA/QC package by cycle (content) minimum)

a) QA/QC Report (summary of inconsistencies, decisions by layer).
b) FTC spreadsheet per layer (model in Annex B), with COV/UPD/ACC/CON notes and justifications.
c) Logs and trails (ingestion, pre -processing, gap/outlier handling).
d) Reproducible scripts and artifact checksums (version PIN + hash).
e) Metadata for publication (Annex C template) to be registered with Greenline Carbonsat .
f) Technical notes (when applicable): reconciliation of sources, impacts, mitigation.
g) Explicit reference when the layer is an input for **GL-MC-004 –** Leakage Annex .

This guide is mandatory for Gate decisions (GL-MS-002) and verifications (GL-MS-005); all evidence must have a URI and hash .

6.2 Audit trails and reproducibility

a) Every relevant operation (clipping, reprojection , resampling , masking) must generate a trail (log + script).
b) Checksums : input/output files and intermediate packages.
c) Immutable versioning (PIN) of sources and artifacts; documented changelog of the lifecycle.
d) Delivery to VVB: reproducible package with minimal execution instructions.

6.3 Publication of metadata (Greenline Carbonsat record)

a) Publish by layer: URI, version, hash , changelog , FTC, uncertainty (% + statistical basis), dates, CRS, unit, license, responsible party (see Appendix C template).
b) Raw data is not published.
c) Target deadline (KPI K14): make public metadata available within 10 days of the cycle closing.

6.4 Governance and Verification Indicators (VVB)

Table of mandatory KPIs, with methodological reference:

Indicator (K)	What does it measure?	How is it evaluated?	Recommended target	Methodological reference
K1 – Official sources confirmed	Check if all the data used in the project is registered in the Global Catalog (GL-GR-010).	Verification of the list of data used with the official catalog sources.	100% of the sources must be in 010.	GL-GR-010
K2 – Complete and published metadata	It measures whether each dataset has complete metadata (version, source, quality, and author).	Verification that all required information is present in the form in Annex C.	95% or more with complete metadata.	GL-MS-012 (Annex C)
K3 – Data Quality (FTC)	Measures the percentage of datasets that achieved an FTC equal to or greater than the minimum value.	Calculation of the FTC for each source as per Section 4.	At least 90% with FTC ≥ threshold.	GL-MS-012 (Section 4, Annex B)
K4 – Current information	It assesses the time between the official publication of the data and its use in the cycle.	Counting the number of days between the date of the source and the date of use.	Up to 15 days difference.	GL-MS-012 §2 and §4
K5 – Reproducibility of results	It measures whether all calculations can be repeated with the same information.	Verification of the existence of technical reports and records that allow the result to be replicated.	95% or more with reproducible documentation.	GL-MS-012 §6.2
K6 – Nonconformities (NC) in QA/QC	Check for any serious or minor flaws in the quality reviews.	Evaluation of VVB audit and verification reports.	0 bass / up to 2 minor basses.	GL-MS-005

Indicator (K)	What does it measure?	How is it evaluated?	Recommended target	Methodological reference
K7 – Rework after verification	It measures how many corrections were needed after the VVB review.	Count of items that needed to be remade.	A maximum of 5% of the audited items.	GL-MS-005
K8 – Agreement between verifiers	Assess whether different VVBs (Very Valuable Entities) reached the same conclusions about the project.	Comparison of verification reports.	At least 85% agreement.	GL-MS-005
K9 – Response time to checks	It measures the speed at which VVBs respond to requests .	Average time (in days) between request and response sent.	Up to 5 business days.	GL-MS-005 / GL-MS-007
K10 – Credits conditional on data	It verifies the proportion of carbon credits issued with quality reservations.	Comparison between conditional loans and total loans issued.	Maximum of 10% conditional.	GL-MS-002
K11 – Qualification of VVBs	It measures whether all verification bodies meet the technical and independence requirements.	Conference on certificates and accreditation records of VVBs .	100% qualified and recognized.	ISO 14064-3 / GL-MS-005
K12 – QA/QC errors identified	It measures the frequency of errors found in quality reviews.	Number of errors divided by the total number of items checked.	Within the limits defined in the QA/QC plan.	IPCC QA/QC / GL-MS-012 §3
K13 – Post-publication revisions	It tracks how many times it was necessary to correct previously published data.	Count of revisions made after official publication.	A downward trend throughout the cycles.	GL-MS-012 §6
K14 – Time for public publication	It measures the time between the closing of the cycle and the publication of metadata on the platform.	Difference in days between closing and publication.	Up to 10 days.	ICVCM (transparency) / GL-MS-012 §6.3

Indicator (K)	What does it measure?	How is it evaluated?	Recommended target	Methodological reference
K15 – Integrity and double counting	It ensures that the credits were not registered more than once.	Automatic duplicate verification in Greenline Carbonsat .	0 duplicate cases.	GL-M-001 / GL-MS-012
K16 – Risk of reversal (Leakage)	It measures the percentage of credits with documented leakage control measures.	Verification of evidence as per Annex Leakage .	Value determined by Country Pack.	GL-MC-004 – Leakage Annex / GL-MS-002

Observations:

• Compliance (**GL-MS-007**) is a separate gate (not integrated into the FTC); its effects appear indirectly in K6–K9.
• Goals can be refined by Country Pack (**GL-GR-010**), always in a prospective manner.

6.5 Closing and interfacing with the checklist (5.4)

a) The layered decisions (accept/condition/reject) must be reflected in Checklist D.2 ("Gates and Evidence — compliance with 5.4 of **GL-M-001/002** "). b) The cycle only advances when the decision framework is complete, with metadata published on Greenline. Carbonsat and reproducible package available to VVB.

Captions and Abbreviations

• QR (VVB Query) — Formal request for clarification of the verification.
• NC — Non-conformity (classified by severity). • SSOT — Single Source of Truth (GL-MS-012 is the FTC's unique reference).
• KPI — Key Performance Indicator. • Reproducible Package — Scripts + checksums that allow replicating the cycle's result.
• Greenline Registry Carbonsat — Official platform for publishing metadata and public auditing.

7. Remissions Essentials

7.1 GL-GR-010 — Global Catalog of Data and Country Packs

Basic document for selecting and prioritizing official sources used in any project under the Greenline standard. Carbonsat .

It defines the rules for including sources, metadata structure, *fast-track procedures* , and responsibilities by country or region.

All data used in **GL-MS-012** must be included in 010 or its corresponding Country Pack.

7.2 GL-MC-004 — Calculation Methodology (AGB → C → CO_2eT) and Leakage Appendix

Reference for ex-post quantification and conversion of aboveground biomass into conserved carbon.
Leakage Annex deals with the assessment and classification of leak risk (*class → gate*).
The **GL-MS-012** provides the data quality that feeds into the 004; the FTC of each layer is consumed, never recalculated.

7.3 GL-MS-002 — Additionality and Gates

It defines the decision-making mechanisms (issue/condition/withhold) that utilize the FTC, uncertainty, and compliance checks as inputs.

The **GL-MS-012** provides the technical parameters and QA/QC reports that support these decisions.

7.4 GL-MS-005 — Accreditation and Supervision of VVBs

It standardizes the independence, rotation, qualification, and sanctions applicable to verification entities.

Use the QA/QC reports and K1–K16 indicators from this methodology as evidence during audits.

7.5 GL-MS-007 — Legal Compliance (SCJ-GC)

Establishes the structure of due Legal, registration, and anti-corruption due diligence .

Although it is not part of the FTC, the result of 007 is considered an independent gate in the decision-making process (**GL-MS-002**).

The **GL-MS-012** maintains interoperability with the 007 through document traceability and audit logs.

7.6 GL-MS-011 — National Integration and Article 6

It deals with the convergence of Greenline. Carbonsat with regulated systems (SBCE, corresponding authorizations and official registrations).

It integrates the QA/QC data produced by 012 and harmonizes it with national or multilateral requirements.

7.7 GL-MS-003 — Co- benefits (opt-in, GLI governance)

This only applies to projects that opt for supplementary socio-environmental certification.

GL **-MS-012** ensures the traceability of the data and official sources used by 003, but does not evaluate or score its indices; that is the exclusive responsibility of Greenline. Institute (GLI).

7.8 Cross-functional relationships and modular integration

- QA/QC → 004: provides qualified data for risk calculation and analysis.
- QA/QC → 002: determines whether the cycle will be issued, conditional, or held.
- QA/QC → 005: allows tracking of independent checks and audits.
- QA/QC → 007: ensures document consistency and integrity in compliance checks.
- QA/QC → 011: ensures compatibility with national policies and systems.
- QA/QC → 003: certifies data traceability for co-benefits , when applicable.

7.9 Global foresight and traceability

All cross-references and integrations operate on the principle of prospectiveness : new versions of methodologies, source tables, or FTC thresholds apply only to future cycles.

A Greenline Carbonsat maintains a complete history of revisions and publicly available *changelogs* to ensure transparency, comparability, and environmental integrity.

Captions and Abbreviations

• SBCE — Brazilian Emissions Trading System. • SCJ-GC — Greenline Legal Compliance Seal Carbonsat .
• GLI — Greenline Institute (co-benefit management) • Opt-in .
• Foresight — Applying changes only to future cycles.
• Greenline Carbonsat — Official registry and infrastructure for data, audits, and

public publication of metadata.

• *Changelog — Historical record of methodological and* source changes.

Annex A — Matrix synthetic sources officials

source / database	scale / resolution	update frequency	country / region (country pack)	official URI	version	hash / pin	responsible / agency	observations

Captions and Abbreviations

• *This table is populated cyclically with the sources actually used;*

• *All sources must be listed in gl-gr-010 or the applicable country pack; • The " hash / pin" field records the immutable version of the database;*

• *Include the public link (official URI) and the resolution description (spatial and temporal).*

Annex B — Technical Confidence Factor (TCF): 28Formula and Example short

component	symbol	weight	value obtained	brief description
coverage	cov	0.35	0.90	spatial and temporal coverage ≥ 97%
update	update	0.25	0.80	20-day difference between data and usage.
accuracy / validation	acc	0.25	0.90	Uncertainty 12%, partial validation.
consistency	with	0.15	0.85	anomalies explained and documented

Calculation (example):

FTC = (0.35 × 0.90) + (0.25 × 0.80) + (0.25 × 0.90) + (0.15 × 0.85) = **0.8675** → **Accept**

Captions and Abbreviations

- *Detailed scoring criteria in the body of section 4;*
- *Ranges and weights may be adjusted prospectively by country pack;* • *GL-MS-012 is the SSOT (single source) of (truth) of the FTC calculation ;*
- *other methodologies should not replicate the formula, only refer to this annex.*

Annex C — Metadata model for the cycle (publication)

field	description / example of completion
official source name	e.g.: NASA gedi v2a
official URI / link	https://gedi.gsfc.nasa.gov/data
version / release	v2a – Mar/2025
hash / pin	3b7a9f5c-… (sha-256)
official release date	March 10, 2025

field	description / example of completion
date of use in the cycle	March 20, 2025
coverage (%)	97.2% of the total area
uncertainty (%)	8.5
statistical basis	1σ (68%)
calculated ftc	0.87
uncertainty category	low
crs / unit	wgs84 / t co_2e ha^{-1}
license / terms	cc-by-4.0 – NASA Open Data
technical manager	issuing agency or validator
reference to the leak annex	Yes / No (when applicable)
observations	technical notes or justifications

Captions and Abbreviations

- *Minimum template for publication in the Greenline registry carbonsat ;*
- *all required fields must be completed before closing the loop; • the field "reference to the leakage attachment " is mandatory when feeding data to gl-mc-004 – leakage attachment .*

Annex D — Quick QA/QC Checklist

verification question	evidence / link	status (ok / conditional / on .)
Are the fonts listed in gl-gr-010 / country pack?		
Is the source documentation attached (official metadata)?		

verification question	evidence / link	status (ok / conditional / on .)
Is the coverage ≥ 95% of the area and 100% of the cycle period?		
the calculated FTC ≥ 0.80 (accept)?		
Is the uncertainty ≤ 10% (low)?		
Is there a technical note and mitigation plan for conditional data?		
QA / QC logs and scripts archived?		
The metadata was published on Greenline. carbonsat ?		
leakage annex (when applicable)?		
Have all fields in the metadata template (appendix c) been completed?		

D.2 — Gates and evidence — compliance with 5.4 of GL-M-001/002

gate / evidence	document / record	result (issue / condition / retain)
data quality (ftc ≥ 0.80)	FTC spreadsheet / QA / QC report	issue
low uncertainty (≤ 10%)	metadata / QA / QC report	issue
legal compliance (gl-ms-007)	scj-gc / legal opinion	issue
risk of leakage (gl-mc-004 – annex)	leak report	condition / retain if critical
vvb conformance (gl-ms-005)	verification report	issue / condition
publication of metadata (012 – Annex c)	greenline registration carbonsat	required before closing

Captions and Abbreviations

- *Consolidated checklist for auditors, VVBS , and managers;*
- *Block d.2 fulfills requirement 5.4 of GL-M-001 and GL-MS-002;* • *All items must be "OK" or justified before the cycle is issued.*

Annex E — QA/QC and VVB KPI Framework

indicator (k)	brief description / what it measures	suggested goal	methodological remission
k1	Exclusive use of fonts registered under gl-gr-010	100%	gl-gr-010
k2	full publication of metadata (appendix c)	≥ 95%	gl-ms-012 / annex c
k3	FTC compliance ≥ threshold	≥ 90%	gl-ms-012 §4 / annex b
k4	Information update ≤ 15 days	≤ 15 days	gl-ms-012 §2 / §4
k5	reproducible results (documentation + records)	≥ 95%	gl-ms-012 §6.2
k6	serious nonconformities in QA / QC	0	gl-ms-005
k7	rework after vvb verification	≤ 5%	gl-ms-005
k8	agreement between vvbs	≥ 85%	gl-ms-005
k9	average response time to vvb	≤ 5 days	gl-ms-005 / gl-ms-007
k10	credits conditional on data	≤ 10%	gl-ms-002
k11	qualified vvbs according to requirements	100%	ISO 14064-3 / GL-MS-005
k12	QA / QC errors detected	within the limit	IPCC qa / qc / gl-ms-012 §3
k13	post-publication data reviews	downward trend	gl-ms-012 §6
k14	Time for metadata publication	≤ 10 days	icvcm (transparency) / gl-ms-012 §6.3
k15	record integrity and double counting	0 cases	gl-m-001 / gl-ms-012
k16	documented leakage control	as per country pack	gl-mc-004 – annexoleakage /gl-ms-002

Legend of Abbreviations

- *Standardized indicators for monitoring by VVBS and governance;*
- *Targets can be adjusted by country pack (GL-GR-010); • Legal compliance (GL-MS-*

007) acts as a separate gate , not forming part of the FTC ; •
Greenline registration carbonsat maintains a public history of KPIs per cycle.