Quantstamp Security Assessment Certificate

December 2nd 2020 — Quantstamp Verified

Wrapped Filecoin

This security assessment was prepared by Quantstamp, the leader in blockchain security

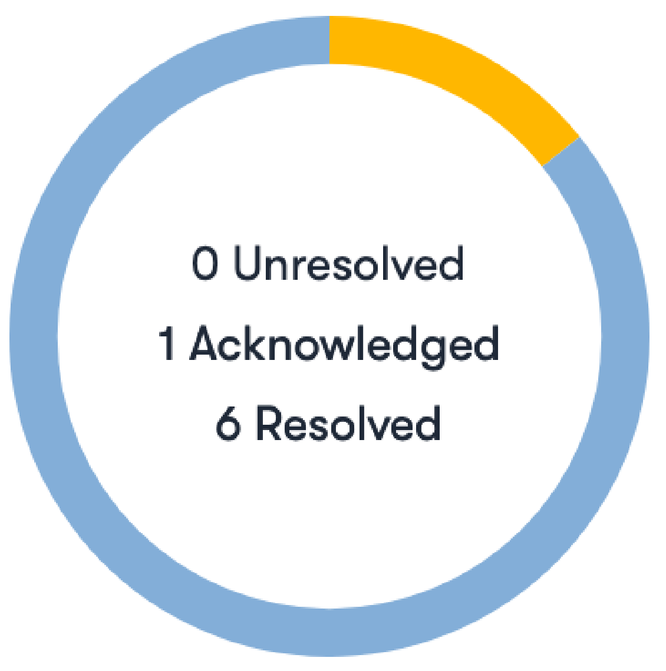
Executive Summary

Type	ERC20 token
Auditors	Kacper Bąk, Senior Research Engineer Leonardo Passos, Senior Research Engineer Luís Fernando Schultz Xavier da Silveira, Security Consultant
Timeline	2020-11-12 through 2020-12-02
EVM	Muir Glacier
Languages	Solidity, Javascript
Methods	Architecture Review, Unit Testing, Functional Testing, Computer-Aided Verification, Manual Review
Specification	None
Documentation Quality	High
Test Quality	High
Source Code	

Repository	Commit
wfil-contracts	964c30b

Goals
- Does wrapping and unwrapping work correctly?
- Does role setting work correctly?

Total Issues	7 (6 Resolved)
High Risk Issues	0 (0 Resolved)
Medium Risk Issues	0 (0 Resolved)
Low Risk Issues	5 (4 Resolved)
Informational Risk Issues	1 (1 Resolved)
Undetermined Risk Issues	1 (1 Resolved)



High Risk	The issue puts a large number of users' sensitive information at risk, or is reasonably likely to lead to catastrophic impact for client's reputation or serious financial implications for client and users.
Medium Risk	The issue puts a subset of users' sensitive information at risk, would be detrimental for the client's reputation if exploited, or is reasonably likely to lead to moderate financial impact.
Low Risk	The risk is relatively small and could not be exploited on a recurring basis, or is a risk that the client has indicated is low-impact in view of the client's business circumstances.
Informational	The issue does not post an immediate risk, but is relevant to security best practices or Defence in Depth.
? Undetermined	The impact of the issue is uncertain.

Unresolved	Acknowledged the existence of the risk, and decided to accept it without engaging in special efforts to control it.
Acknowledged	The issue remains in the code but is a result of an intentional business or design decision. As such, it is supposed to be addressed outside the programmatic means, such as: 1) comments, documentation, README, FAQ; 2) business processes; 3) analyses showing that the issue shall have no negative consequences in practice (e.g., gas analysis, deployment settings).
Resolved	Adjusted program implementation, requirements or constraints to eliminate the risk.
Mitigated	Implemented actions to minimize the impact or likelihood of the risk.

Summary of Findings

We have found few low-severity and informational issues in the reviewed code. We also provide ideas for further improvements in the code and documentation.
Update: the reaudit is based on commit `2bcacf3` in https://github.com/wfil/wfil-token. The team has addressed most of the issues.
Disclaimer: the contract relies on an external DAO contract. Such a contract and any external interaction with the DAO is outside of the scope of this audit.

ID	Description	Severity	Status
QSP-1	Privileged Roles and Ownership	⌄ Low	Acknowledged
QSP-2	No restrictions on the fees that can be set	⌄ Low	Fixed
QSP-3	The contract may receive `WFIL` tokens through minting	⌄ Low	Fixed
QSP-4	Race condition between `wrap/unwrap` and `setFee`	⌄ Low	Fixed
QSP-5	Function parameters lack sanity checks	⌄ Low	Fixed
QSP-6	Allowance Double-Spend Exploit	○ Informational	Mitigated
QSP-7	`false` returned from functions `addMinter()` and `removeMinter()` upon successful execution	? Undetermined	Fixed

Quantstamp Audit Breakdown

Quantstamp's objective was to evaluate the repository for security-related issues, code quality, and adherence to specification and best practices.

Possible issues we looked for included (but are not limited to):

- Transaction-ordering dependence
- Timestamp dependence
- Mishandled exceptions and call stack limits
- Unsafe external calls
- Integer overflow / underflow
- Number rounding errors
- Reentrancy and cross-function vulnerabilities
- Denial of service / logical oversights
- Access control
- Centralization of power
- Business logic contradicting the specification
- Code clones, functionality duplication
- Gas usage
- Arbitrary token minting

Methodology

The Quantstamp auditing process follows a routine series of steps:

1. Code review that includes the following
   i. Review of the specifications, sources, and instructions provided to Quantstamp to make sure we understand the size, scope, and functionality of the smart contract.
   ii. Manual review of code, which is the process of reading source code line-by-line in an attempt to identify potential vulnerabilities.
   iii. Comparison to specification, which is the process of checking whether the code does what the specifications, sources, and instructions provided to Quantstamp describe.
2. Testing and automated analysis that includes the following:
   i. Test coverage analysis, which is the process of determining whether the test cases are actually covering the code and how much code is exercised when we run those test cases.
   ii. Symbolic execution, which is analyzing a program to determine what inputs cause each part of a program to execute.
3. Best practices review, which is a review of the smart contracts to improve efficiency, effectiveness, clarify, maintainability, security, and control based on the established industry and academic practices, recommendations, and research.
4. Specific, itemized, and actionable recommendations to help you take steps to secure your smart contracts.

Toolset

The notes below outline the setup and steps performed in the process of this audit.

Setup

Tool Setup:

- Slither v0.6.12

Steps taken to run the tools:

1. Installed the Slither tool: `pip install slither-analyzer`
2. Run Slither from the project directory: `slither .`

Findings

QSP-1 Privileged Roles and Ownership

Severity: *Low Risk*

Status: Acknowledged

File(s) affected: `WFIL.sol`

Description: Smart contracts will often have an owner or other roles to designate entities with special privileges to govern the smart contract.

Recommendation: This centralization of power needs to be made clear to the users, especially depending on the level of privilege the contract allows to the owner.
Update: the team informed us that they plan on governing the contract via a multisig wallet.

QSP-2 No restrictions on the fees that can be set

Severity: Low Risk

Status: Fixed

File(s) affected: `WFIL.sol`

Description: Fee setters may set arbitrarily low or high fees through the function `_setFee()`. If set to zero, no fee will be charged; if set to be high, wrapping/unwrapping tokens will end up costing a lot.

Recommendation: We recommend either adding a hard-coded limit for the fees and/or informing users about this (lack of) limit.

QSP-3 The contract may receive `WFIL` tokens through minting

Severity: Low Risk

Status: Fixed

File(s) affected: `WFIL.sol`

Description: The contract may receive `WFIL` tokens accidentally through the `_mint` function in `wrap`.

Recommendation: To avoid this issue as well as accidental transfers to the contract, move the check in L180 to the `_beforeTokenTransfer()` function.

QSP-4 Race condition between `wrap/unwrap` and `setFee`

Severity: Low Risk

Status: Fixed

File(s) affected: `WFIL.sol`

Description: An actor with privilege to change the fee could set a new value (t2) while another transaction had already been sent to (un-)wrap tokens (t1); if t2 is mined before t1, the (un-)wrap function will collect a different fee than expected.

Recommendation: Since `setFee()` and `wrap()`/`unwrap()` are protected operations, coordinate their execution off-chain amongst `FEE_SETTER_ROLE` actors with `MINTER_ROLE` actors.

QSP-5 Function parameters lack sanity checks

Severity: Low Risk

Status: Fixed

File(s) affected: `WFIL.sol`

Description: Arguments passed to the contract functions do not have any sanity checks. For example, addresses could be set to `0x0`.

Recommendation: Add checks verifying that the given input addresses are not `0x0`. If there is any expectation that any of those addresses should also be a contract, add a corresponding check. Additionally, consider checking that:

- `minter_ != address(0)` in the `constructor()`;
- `wfilFee` is at most 1000 in `_setFee()`;
- `amount > 0` in `wrap()` and `unwrap()`;
- `filaddress` is valid (or an approximation of that) in `unwrap()`;
- `account != address(0)` in `addMinter()` and `addFeeSetter()`.

QSP-6 Allowance Double-Spend Exploit

Severity: Informational

Status: Mitigated

File(s) affected: `WFIL.sol`

Description: As it presently is constructed, the contract is vulnerable to the allowance double-spend exploit, as with other ERC20 tokens.

Exploit Scenario:

1. Alice allows Bob to transfer `N` amount of Alice's tokens (`N>0`) by calling the `approve()` method on `Token` smart contract (passing Bob's address and `N` as method arguments)
2. After some time, Alice decides to change from `N` to `M` (`M>0`) the number of Alice's tokens Bob is allowed to transfer, so she calls the `approve()` method again, this time passing Bob's address and `M` as method arguments
3. Bob notices Alice's second transaction before it was mined and quickly sends another transaction that calls the `transferFrom()` method to transfer `N` Alice's tokens somewhere
4. If Bob's transaction will be executed before Alice's transaction, then Bob will successfully transfer `N` Alice's tokens and will gain an ability to transfer another `M` tokens
5. Before Alice notices any irregularities, Bob calls `transferFrom()` method again, this time to transfer `M` Alice's tokens.

Recommendation: The exploit (as described above) is mitigated through use of functions that increase/decrease the allowance relative to its current value, such as `increaseAllowance` and `decreaseAllowance`.
Pending community agreement on an ERC standard that would protect against this exploit, we recommend that developers of applications dependent on `approve()` / `transferFrom()` should keep in mind that they have to set allowance to 0 first and verify if it was used before setting the new value. Teams who decide to wait for such a standard should make these recommendations to app developers who work with their token contract.

QSP-7 `false` returned from functions `addMinter()` and `removeMinter()` upon successful execution

Severity: Undetermined

Status: Fixed

File(s) affected: `WFIL.sol`

Description: The functions `addMinter()` and `removeMinter()` always return `false` when the execution succeeds.

Recommendation: We recommend either changing function signatures to return nothing, or return `true` upon successful execution.

Automated Analyses

Slither

Slither reported no issues.

Adherence to Specification

1. It is unclear what the `_beforeTokenTransfer()` function override is attempting to achieve. It appears unnecessary since the contract inherits from `ERC20Pausable`. **Update:** fixed, the contract no longer inherits from `ERC20Pausable`.
2. The fee granularity is set to 1000. Is this intentional? The fee granularity can be increased without risking overflow problems. This may be important as currently the minimum fee is 0.1%, which may render the contract unable to compete with alternative solutions or forks. **Update:** fixed.
3. From the contract's event set, there is no way for an event listener to figure out who unwrapped the funds from an account, but that is important information as this is who should receive the FIL on the filecoin blockchain. Recommendation: add `msg.sender` to the `UnwrappedFrom` event.

Code Documentation

1. L160,167: not all the functions are impacted.
2. L106: typo "uwnrapOut". **Update:** fixed.
3. L108: typo "uwrap". **Update:** fixed.
4. There are some typos in `README.md`, e.g., `fist` (instead of `first`), `custodial` (instead of `custodian`), `they'll get automatically` (instead of `they will automatically get`), etc. **Update:** fixed.
5. 1. In `WFIL.sol` (L98, L112), `1000` is a magic constant. Document it properly. **Update:** fixed.
6. The `WFIL` token has the default 18 decimal places but, according to a web search, the filecoin token `FIL` has 8. Although not likely to become an issue, this is better documented.
7. In the updated repository, L44: remove "which send value".
8. In the updated repository, L49: replace "WFIL" by "FIL" or "filecoin".
9. In the updated repository, L64: replace "WFIl" by "WFIL".
10. In the updated repository, L101,108: replace "all functions" by "transfers".

Adherence to Best Practices

1. There is no need to inherit from both `ERC20` and `ERC20Pausable` as `ERC20Pausable` itself inherits from `ERC20`. **Update:** fixed.
2. Unless there is a strong reason not to, consider making the functions `setFee()`, `setFeeTo()`, `wrap()`, `unwrap()`, `addMinter()`, `removeMinter()`, `addFeeSetter()` and `removeFeeSetter()` return nothing. They always return `true` unless they revert.
3. Consider providing an error message in `L60`. **Update:** fixed.
4. The constructor uses a different argument naming convention than the rest of the code.
5. Consider indexing event parameters. **Update:** fixed.
6. Use unsigned integer type explicitly, i.e., replace all uses of `uint` by `uint256`. **Update:** fixed.
7. In `WFIL.sol`, the `filaddress` is not in lower camel case as in other parts of the code. The parameter is also misspelled. Follow the name conventions already in place. Typo: `filaddress` => `fileAddress`. **Update:** fixed.
8. In the updated repository, consider checking that `account` is a minter in `removeMinter()`.

Test Results

Test Suite Results

All tests executed successfully.

```
WFIL
  Setup
      ✓ dao has the default admin role (63ms)
      ✓ dao has the pauser role (51ms)
      ✓ pauser is the default admin
  fallback()
      ✓ should revert when sending ether to contract address
  WFIL metadata
      ✓ has a name
      ✓ has a symbol
  wrap()
```

```
      ✓ factory can mint tokens (58ms)
      ✓ should emit the appropriate event when wfil is wrapped (38ms)
      ✓ should revert when amount is less than zero (72ms)
      ✓ other accounts cannot wrap tokens
    unwrap()
      ✓ wfil merchant should be able to burn wfil (50ms)
      ✓ should emit the appropriate event when wfil is unwrapped
      ✓ should revert when amount is less than zero
      ✓ other accounts cannot unwrap tokens
    unwrapFrom()
      ✓ wfil burner should be able to burn wfil (53ms)
      ✓ should emit the appropriate event when wfil is unwrappedFrom
      ✓ should revert when amount is less than zero
      ✓ other accounts cannot unwrapFrom tokens
    addMinter()
      ✓ default admin should be able to add a new minter (48ms)
      ✓ should emit the appropriate event when a new minter is added
      ✓ should revert when account is set to zero address
      ✓ other address should not be able to add a new minter
    removeMinter()
      ✓ default admin should be able to remove a minter (49ms)
      ✓ should emit the appropriate event when a minter is removed
      ✓ other address should not be able to remove a minter
    pausing
      ✓ owner can pause (56ms)
      ✓ owner can unpause (71ms)
      ✓ cannot wrap while paused (102ms)
      ✓ cannot transfer while paused (119ms)
      ✓ cannot unwrap while paused (112ms)
      ✓ other accounts cannot pause
    ERC20 _beforeTokenTransfer hook
      ✓ check wrap() for revert when trying to mint to the token contract
      ✓ check transfer() for revert when trying to transfer to the token contract (41ms)
      ✓ check transferFrom() for revert when trying to transfer to the token contract (60ms)


  34 passing (7s)
```

Appendix

File Signatures

The following are the SHA-256 hashes of the reviewed files. A file with a different SHA-256 hash has been modified, intentionally or otherwise, after the security review. You are cautioned that a different SHA-256 hash could be (but is not necessarily) an indication of a changed condition or potential vulnerability that was not within the scope of the review.

Contracts

`4828e656ac83c0ae86223e4350ddffb6947804d32ec8b19f59950641f551e02e ./contracts/WFIL.sol`

`8a6b38936c738a0e612391ee231f39352cc8878f4a5b41c05f0895fb662b3fd6 ./contracts/Migrations.sol`

Tests

`2ca7e444a187a86f92347b3370c2f6ee7d1c37699279ded5b752f16ab69c6198 ./test/WFIL.test.js`

Changelog

- 2020-11-18 - Initial report
- 2020-12-02 - reaudit based on commit `2bcacf3` in https://github.com/wfil/wfil-token

About Quantstamp

Quantstamp is a Y Combinator-backed company that helps to secure blockchain platforms at scale using computer-aided reasoning tools, with a mission to help boost the adoption of this exponentially growing technology.

With over 1000 Google scholar citations and numerous published papers, Quantstamp's team has decades of combined experience in formal verification, static analysis, and software verification. Quantstamp has also developed a protocol to help smart contract developers and projects worldwide to perform cost-effective smart contract security scans.

To date, Quantstamp has protected $5B in digital asset risk from hackers and assisted dozens of blockchain projects globally through its white glove security assessment services. As an evangelist of the blockchain ecosystem, Quantstamp assists core infrastructure projects and leading community initiatives such as the Ethereum Community Fund to expedite the adoption of blockchain technology.

Quantstamp's collaborations with leading academic institutions such as the National University of Singapore and MIT (Massachusetts Institute of Technology) reflect our commitment to research, development, and enabling world-class blockchain security.