CERTIK

Code Security Assessment

Sandbox - PR

Jan 26th, 2022

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Summary

This report has been prepared for Sandbox to discover issues and vulnerabilities in the source code of the Sandbox - PR project as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Static Analysis and Manual Review techniques.

The auditing process pays special attention to the following considerations:

- Testing the smart contracts against both common and uncommon attack vectors.
- Assessing the codebase to ensure compliance with current best practices and industry standards.
- Ensuring contract logic meets the specifications and intentions of the client.
- Cross referencing contract structure and implementation against similar smart contracts produced by industry leaders.
- Thorough line-by-line manual review of the entire codebase by industry experts.

The security assessment resulted in findings that ranged from critical to informational. We recommend addressing these findings to ensure a high level of security standards and industry practices. We suggest recommendations that could better serve the project from the security perspective:

- Enhance general coding practices for better structures of source codes;
- Add enough unit tests to cover the possible use cases;
- Provide more comments per each function for readability, especially contracts that are verified in public;
- Provide more transparency on privileged activities once the protocol is live.

Overview

Project Summary

Project Name	Sandbox - PR
Platform	polygon
Language	Solidity
Codebase	https://github.com/thesandboxgame/sandbox-smart-contracts-private
Commit	14034d0ebdee1d74f2fe402005e4e1a03532b972

Audit Summary

Delivery Date	Jan 26, 2022
Audit Methodology	Static Analysis, Manual Review
Key Components	LandSwap, ERC2771Handler, PausableWithAdmin

Vulnerability Summary

Vulnerability Level	Total	Pending	Declined	Acknowledged	Partially Resolved	Mitigated	Resolved
Critical	0	0	0	0	0	0	0
Major	0	0	0	0	0	0	0
Medium	0	0	0	0	0	0	0
Minor	1	0	0	1	0	0	0
Informational	4	0	0	4	0	0	0
Discussion	0	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum
ERC	solc_0.5/BaseWithStorage/ERC2771Handler.sol	6007170c2f9f1f26ab63b7429c54d6a15275675d10e6c63a5b592569209b271c
LSS	solc_0.5/Swap/LandSwap.sol	06f4e6c502f4e85acdf5403e5d9db8da84739d9b22d7211a43c5bede58c1eac0
PWA	solc_0.5/contracts_common/BaseWithStorage/PausableWithAdmin.sol	327869413f21a251d3a44262948f2081861742e2c3d7a53624f1b909554368da

Overview

The **Sandbox** implements a few contracts to interact with user `lands`:

- `ERC721BaseToken` : NFT representing a land. Users can transfer/burn their `lands`.
- `ERC2771Handler` : For compatibility with Meta Transactions (ERC2771).
- `landswap` : For swapping `lands` from an old Grid (`LandBaseToken`) to a new one.
- `PausableWithAdmin` : Extension of the `landswap` contract, allowing the `Admin` to pause contract if needed.

External Dependencies

The scope of the audit treats third-party entities as black boxes and assumes their functional correctness. However, in the real world, third parties can be compromised and this may lead to lost or stolen assets.

There are a few dependent injection contracts or addresses in the current project:

- `AddressUtils`, `ERC721TokenReceiver`, `ERC721Events`, `SuperOperators`, `MetaTransactionReceiver`, `ERC721MandatoryTokenReceiver` for the contract `ERC721BaseToken`;
- `LandBaseToken`, `ERC721MandatoryTokenReceiver` for the contract `landswap`;
- `Admin` for the contract `Admin`;

We assume these contracts or addresses are valid and non-vulnerable actors and implement proper logic to collaborate with the current project.

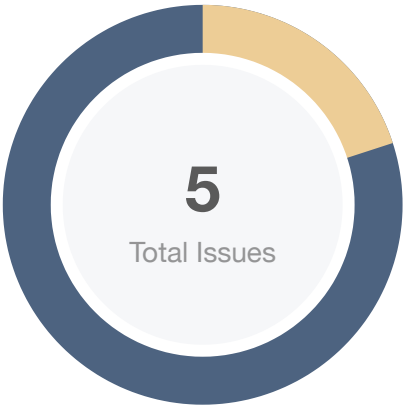
Privileged Functions

The contract `PausableWithAdmin` contains the following privileged functions that are restricted by the `admin`:

- `PausableWithAdmin.pause()`: Pause the contract;
- `PausableWithAdmin.unpause()`: Unpause the contract;

To improve the trustworthiness of the project, dynamic runtime updates in the project should be notified to the community. Any plan to invoke the aforementioned functions should be also considered to move to the execution queue of `Timelock` contract.

Findings



Critical	**0** (0.00%)
Major	**0** (0.00%)
Medium	**0** (0.00%)
Minor	**1** (20.00%)
Informational	**4** (80.00%)
Discussion	**0** (0.00%)

ID	Title	Category	Severity	Status
GLOBAL-01	Unlocked Compiler Version	Language Specific	Informational	Acknowledged
ERC-01	Unknown Implementation of Meta Transaction Contract	Control Flow	Informational	Acknowledged
LSS-01	Missing Input Validation	Volatile Code	Minor	Acknowledged
LSS-02	Third Party Dependencies	Volatile Code	Informational	Acknowledged
LSS-03	Lack of Access Control for `burn` Function	Control Flow	Informational	Acknowledged

GLOBAL-01 | Unlocked Compiler Version

Category	Severity	Location	Status
Language Specific	Informational	Global	Acknowledged

Description

The `PausableWithAdmin` contract has an unlocked compiler version. An unlocked compiler version in the source code of the contract permits the user to compile it at or above a particular version. This, in turn, leads to differences in the generated bytecode between compilations due to differing compiler version numbers. This can lead to ambiguity when debugging as compiler-specific bugs may occur in the codebase that would be hard to identify over a span of multiple compiler versions rather than a specific one.

Additionally, it has been noticed that all contracts are compiled with the compiler version over `0.5.2`, which dates from March 2019. It is recommended to update the compiler versions in the contracts, so they are not exposed to potential security issues related to old compiler versions.

Recommendation

In the short term, lock the compiler version.

In the long term, if the contracts are compatible with the version `v0.8.0`, they are recommended to use `v0.8.0`.

Alleviation

[Sandbox]: The team acknowledged the issue and decided to avoid updating the compiler version for all dependent contracts. Unless there is a specific bug in the current version, the contract will keep it as is.

ERC-01 | Unknown Implementation of Meta Transaction Contract

Category	Severity	Location	Status
Control Flow	Informational	solc_0.5/BaseWithStorage/ERC721BaseToken.sol	Acknowledged

Description

The implementation of `_metaTransactionContracts[msg.sender]` is unknown.

In the case that `metaTransaction` contracts are public and propose a `call()` feature, users could call a `metaTransaction` contract, having their call being forwarded to `ERC721BaseToken`.

In this scenario, `msg.sender` received by `ERC721BaseToken` would be the address of `metaTransaction`, which would verify the condition `require(_metaTransactionContracts[msg.sender]`.

If the check can be bypassed through this way, this would be problematic in the functions using this check:

- `ERC721BaseToken.approveFor()`;
- `ERC721BaseToken._checkTransfer()`;
- `ERC721BaseToken._batchTransferFrom()`;
- `ERC721BaseToken.setApprovalForAllFor()`;
- `ERC721BaseToken.burnFrom()`.

For example,

```
301     function setApprovalForAllFor(
302         address sender,
303         address operator,
304         bool approved
305     ) external {
306         require(sender != address(0), "Invalid sender address");
307         require(
308             msg.sender == sender ||
309             _metaTransactionContracts[msg.sender] ||
310             _superOperators[msg.sender],
311             "not authorized to approve for all"
312         );
313 
314         _setApprovalForAll(sender, operator, approved);
315     }
```

The above function will successfully triggered if the caller is from meta transaction contract (i.e., `_metaTransactionContracts[msg.sender]` is `true`).

Recommendation

Recommend carefully setting the `_metaTransactionContracts` array and ensure its correctness.

Alleviation

[Sandbox]: The `basedToken` contract accepts calls from another contract supporting meta-transaction. This was implemented this way to handle meta-transaction from another contract. The team implemented the ERC2771 in the LandSwap contract for this purpose.

LSS-01 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	Minor	solc_0.5/Swap/LandSwap.sol: 24	Acknowledged

Description

In `LandSwap.sol`, no checks are performed on input parameters to ensure that those are ones that are valid.

In the `LandSwap` contract, in the `initialize()` function :

- `admin` and `trustedForwarder` addresses should be non-zero addresses;
- `oldLand` should not be the same address as `newLand`;
- `admin` should not be the same address as `trustForwarder`.

Recommendation

It is recommended to check the passed-in values to prevent unexpected error

Alleviation

[Sandbox]: The team will cross-check with PR to review the parameters when deploying the contracts. There is no need the further check this on the contract side, as the code depends on those parameters to be correct beside the proposed checks.

LSS-02 | Third Party Dependencies

Category	Severity	Location	Status
Volatile Code	Informational	solc_0.5/Swap/LandSwap.sol: 14	Acknowledged

Description

The contract serves as the underlying entity to interact with the following third-party protocols.

- `_oldLand`
- `_newLand`
- `trustedForwarder`

The scope of the audit treats third-party entities as black boxes and assumes their functional correctness. However, in the real world, third parties can be compromised, which may lead to lost or stolen assets. For instance, if the `trustedForwarder` is initialized to a malicious address, it could cause unexpected errors during the land-swapping process.

Recommendation

Recommend providing the deployed and verified contract. The status of this issue will be updated after contract deployment upon request.

Alleviation

[Sandbox]: The contracts detail are as below:

- _oldLand = 0x50f5474724e0ee42d9a4e711ccfb275809fd6d4a
- _newLand = to be deployed (Audited with Certik)
- trustedForwarder = Check the contract addresses here - deployed smart contract addresses for all networks

LSS-03 | Lack of Access Control for `burn` Function

Category	Severity	Location	Status
Control Flow	Informational	solc_0.5/Swap/LandSwap.sol: 50	Acknowledged

Description

In the current implementation, when the `LandSwap` contract is not in the pause condition, the `burn()` function allows everyone to burn `oldLand` tokens with given `ids`. The `LandSwap` contract receives `oldLand` tokens during the `swap()` invocation and those tokens are supposed to be burnt immediately.

The concern is if those `_oldland` tokens are still valuable to some extent (f.e., causing market fluctuation), a user might call this function at a certain time for his own profit.

Recommendation

If calling `burn()` could cause some unexpected consequence to users/projects, it is recommended to apply an authorized modifier to enforce the access control of this function.

Alleviation

[Sandbox]: The team acknowledged the issue. The point is that even if Sandbox put the burn for Admin, only the `oldLand` token _burn function could be called without any checks (this is the actual vulnerability that triggers this token swap). Eventually, the team thought of burning all the `oldLand` tokens.

Appendix

Finding Categories

Control Flow

Control Flow findings concern the access control imposed on functions, such as owner-only functions being invoke-able by anyone under certain circumstances.

Volatile Code

Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases that may result in a vulnerability.

Language Specific

Language Specific findings are issues that would only arise within Solidity, i.e. incorrect usage of private or delete.

Checksum Calculation Method

The "Checksum" field in the "Audit Scope" section is calculated as the SHA-256 (Secure Hash Algorithm 2 with digest size of 256 bits) digest of the content of each file hosted in the listed source repository under the specified commit.

The result is hexadecimal encoded and is the same as the output of the Linux "sha256sum" command against the target file.

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