QuillAudits

Audit Report
July, 2022

For

THE GAMBLE KINGDOM

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Executive Summary

Project Name	TGK Contract Initial Audit Report
Overview	The project is a NFT contract based on the ERC721A standard with the added advantage of batch minting with lesser gas as compared to ERC721 standard. On top of that TGK contract also adds the functionality of air dropping of NFTs by the owner.
Timeline	14 June,2022 - 6 July, 2022
Method	Manual Review, Functional Testing, Automated Testing etc.
Scope of Audit	The scope of this audit was to analyze TGK codebase for quality, security, and correctness.
Deployed at	*https://github.com/shrishtieth/TGK/blob/6a40f189280bea16572ac65a602870f58ac5dbf0/contracts/nft.sol*
Fixed In	*https://github.com/shrishtieth/TGK/commit/724123e9bd2cb02cd1370d1137055c74e0974bb2*

High Medium

Low Informational

	High	Medium	Low	Informational
Open Issues	0	0	0	0
Acknowledged Issues	0	0	0	4
Partially Resolved Issues	0	1	0	1
Resolved Issues	1	0	4	6

Types of Severities

High

A high severity issue or vulnerability means that your smart contract can be exploited. Issues on this level are critical to the smart contract's performance or functionality, and we recommend these issues be fixed before moving to a live environment.

Medium

The issues marked as medium severity usually arise because of errors and deficiencies in the smart contract code. Issues on this level could potentially bring problems, and they should still be fixed.

Low

Low-level severity issues can cause minor impact and or are just warnings that can remain unfixed for now. It would be better to fix these issues at some point in the future.

Informational

These are severity issues that indicate an improvement request, a general question, a cosmetic or documentation error, or a request for information. There is low-to-no impact.

Types of Issues

Open

Security vulnerabilities identified that must be resolved and are currently unresolved.

Resolved

These are the issues identified in the initial audit and have been successfully fixed.

Acknowledged

Vulnerabilities which have been acknowledged but are yet to be resolved.

Partially Resolved

Considerable efforts have been invested to reduce the risk/impact of the security issue, but are not completely resolved.

Checked Vulnerabilities

- Re-entrancy
- Timestamp Dependence
- Gas Limit and Loops
- Exception Disorder
- Gasless Send
- Use of tx.origin
- Compiler version not fixed
- Address hardcoded
- Divide before multiply
- Integer overflow/underflow
- Dangerous strict equalities
- Tautology or contradiction
- Return values of low-level calls
- Missing Zero Address Validation
- Private modifier
- Revert/require functions
- Using block.timestamp
- Multiple Sends
- Using SHA3
- Using suicide
- Using throw
- Using inline assembly

Techniques and Methods

Throughout the audit of smart contract, care was taken to ensure:

- The overall quality of code.
- Use of best practices.
- Code documentation and comments match logic and expected behaviour.
- Token distribution and calculations are as per the intended behaviour mentioned in the whitepaper.
- Implementation of ERC-20 token standards.
- Efficient use of gas.
- Code is safe from re-entrancy and other vulnerabilities.

The following techniques, methods and tools were used to review all the smart contracts.

Structural Analysis

In this step, we have analysed the design patterns and structure of smart contracts. A thorough check was done to ensure the smart contract is structured in a way that will not result in future problems.

Static Analysis

Static analysis of smart contracts was done to identify contract vulnerabilities. In this step, a series of automated tools are used to test the security of smart contracts.

Code Review / Manual Analysis

Manual analysis or review of code was done to identify new vulnerabilities or verify the vulnerabilities found during the static analysis. Contracts were completely manually analysed, their logic was checked and compared with the one described in the whitepaper. Besides, the results of the automated analysis were manually verified.

Gas Consumption

In this step, we have checked the behaviour of smart contracts in production. Checks were done to know how much gas gets consumed and the possibilities of optimization of code to reduce gas consumption.

Tools and Platforms used for Audit

Remix IDE, Truffle, Truffle Team, Solhint, Mythril, Slither, Solidity statistic analysis.

Manual Testing

A. Contract - TGK/NFT

High Severity Issues

A1. Wrong check of Total supply

Line	Function - airdropNft

```
1329  function airdropNft(address[] memory users, uint256[] memory quantity)
1330    external onlyOwner
1331
1332  {
1333   require(users.length == quantity.length,"Invalid Input");
1334   uint256 total = quantity.length;
1335   require(
1336      totalSupply() + total <= collectionSize,
1337      "Total Supply Reached"
1338    );
1339    for (uint256 i = 0; i < total; i++) {
1340      _safeMint(users[i], quantity[i]);
1341      emit NftsAirdropped(users[i], quantity[i]);
1342    }
1343
1344  }
```

Description

The sum of all quantities in the quantity array should be used to check if total supply is reached and not the length of the array

Remediation

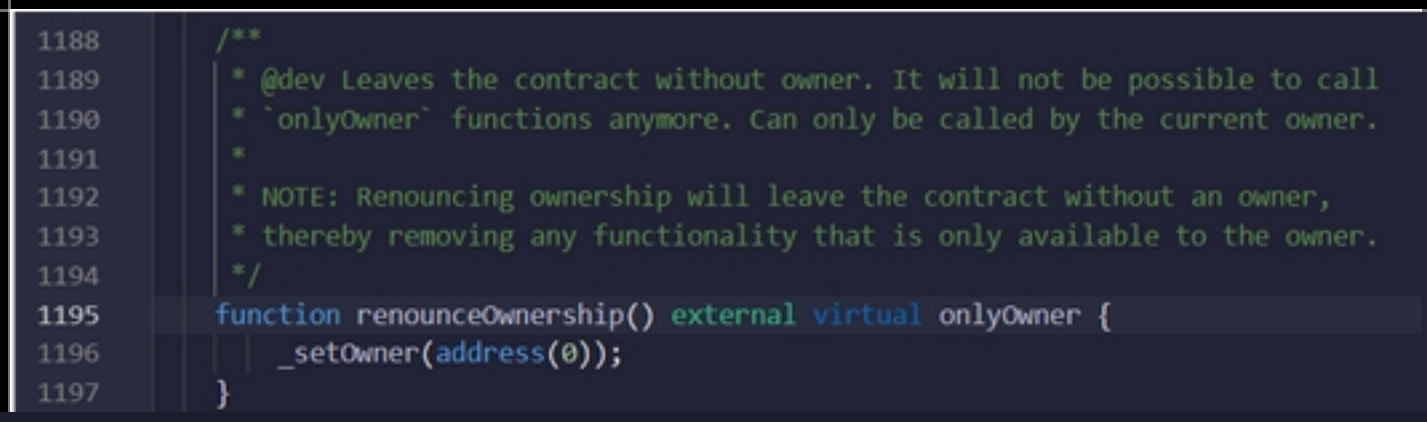
Inside the airdropNft, use a loop to calculate sum of all values in quantity array and check totalSupply() + sumOfQuantities <= collectionSize

Status

Resolved

Medium Severity Issues

A2. Withdraw before RenounceOwnership

Line	Function - renounceOwnership
1195	

```
1188    /**
1189     * @dev Leaves the contract without owner. It will not be possible to call
1190     * `onlyOwner` functions anymore. Can only be called by the current owner.
1191     *
1192     * NOTE: Renouncing ownership will leave the contract without an owner,
1193     * thereby removing any functionality that is only available to the owner.
1194     */
1195    function renounceOwnership() external virtual onlyOwner {
1196        _setOwner(address(0));
1197    }
```

Description

If renounceOwnership is called then all the ether in the contract will be locked and become inaccessible

Remediation

Inside renounceOwnership before calling _setOwner, withdrawMoney method should be called

Status

Partially Resolved

Auditors Comment: There is no need to remove the renounceOwnership function as it is part of standard OZ Ownable contract. You can just override the renounceOwnership function and call moneyWithdraw in it.

Client's comment: We don't need the function

Low Severity Issues

A3. Redundant Require check in refundIfOver

Line	Function - refundIfOver

1305	1305 function refundIfOver(uint256 price) private {
	1306 require(msg.value >= price, "Need to send more ETH.");
	1307 if (msg.value > price) {
	1308 payable(msg.sender).transfer(msg.value - price);
	1309 }
	1310 }

Description

The require statement at Line no. 1305 is not needed as the require statement in the function publicSaleMint does the same before calling refundIfOver.

Remediation

Removing the require statement at Line no. 1305

Status

Resolved

A4. Taking constructor arguments as input

Line	Constructor
1278	1278 constructor(1279 string memory baseURI 1280) ERC721A("Azuki", "AZUKI", 5, 5200) { 1281 _baseTokenURI = baseURI; 1282 } 1283

Description

The arguments of the constructor are hardcoded.

Remediation

Taking the values as user input and passing them to the constructor

Status

Resolved

A5. Missing require in owner update methods

Line	Function - airdropNft

1351	`function upadteMaxPerAddressDuringMint(uint256 max) external onlyOwner{`
	`  maxPerAddressDuringMint = max;`
	`  emit MaxPerAddressDuringMintUpdated(max);`
	`}`

Line	Function - upadteMaxBatchSize

1356	`function updateMaxBatchSize(uint256 size) external onlyOwner{`
	`  maxBatchSize = size;`
	`  emit maxBatchSizeUpdated(size);`
	`}`

Line	Function - upadteMaxBatchSize

1366	`function updateTeamNftStock(uint256 quantity) external onlyOwner{`
	`  amountForTeam = quantity;`
	`  emit AmountForTeamUpdated(quantity);`
	`}`

Description

There is no check(require statement) to ensure that these update values are less than the totalSupply.

Remediation

Using a require statement in all the functions

Status

Resolved

Auditor's Comment: The current implementation of require statements in updateMaxPerAddressDuringMint and updateMaxBatchSize is wrong In updateMaxPerAddressDuringMint,it is require(max + totalSupply() <= collectionSize,"Enter a valid value" but there is no use of totalSupply here. It is the maximum tokens an address can have In updateMaxBatchSize, it is require(size + totalSupply() <= collectionSize,"Enter a valid value") Here also there is no need of totalSupply.

A6. The events PublicSaleMinted and NftsAirdropped should be indexed

Line	Function - Event PublicSaleMinted & Event NtfsAirdropped
1271	1271 event PublicSaleMinted(address user, uint256 quantity); 1273 event NftsAirdropped(address user, uint256 quantity);

Description

The indexed parameters for logged events will enable searching of these events using the indexed parameters as filters

Remediation

Using indexed user in both the events like
event PublicSaleMinted(address indexed user, uint256 quantity);
event NtfsAirdropped(address indexed user, uint256 quantity);

Status

Resolved

Informational Issues

A7. Use of loops

Loops are used in teamMint and airDropNft methods. It is important to note that the looping has a limit in smart contracts. We cannot loop indefinitely as if we do that the gas consumed will be more than the block gas limit and the transaction will never be added in a block. Owner should perform a gas analysis before making these transactions.

Status

Acknowledged

A8. Avoid use of multiple zeros

Description

The public sale price is defined as 100000000000000000 wei.

Recommendation

Using ether keyword and rewriting as 1 ether increases code readability

Status

Resolved

A9. Following solidity naming conventions

Description

Event names should start with capital letters

Recommendation

Modifying maxBatchSizeUpdated event to MaxBatchSizeUpdated

Status

Resolved

A10. Enhanced teamMint functionality

Line	Function - teamMint
1329	

```
1312  // For marketing etc.
1313  function teamMint(uint256 quantity) external onlyOwner {
1314    require(
1315      totalSupply() + quantity <= amountForTeam,
1316      "too many already minted before dev mint"
1317    );
1318    require(
1319      quantity % maxBatchSize == 0,
1320      "can only mint a multiple of the maxBatchSize"
1321    );
1322    uint256 numChunks = quantity / maxBatchSize;
1323    for (uint256 i = 0; i < numChunks; i++) {
1324      _safeMint(msg.sender, maxBatchSize);
1325    }
1326    emit TeamMinted(quantity);
1327  }
```

Description

Currently, the teamMint function only mints when quantity is divisible by the maxBatchSize. It could be changed to mint any number of NFTs. If team minting should only be done in batches of maxBatchSize and is the required behavior please ignore this point

Remediation

By changing the functionality such that a loop runs (quantity / maxBatchSize) times calling _safeMint with maxBatchSize as quantity parameter and then calling _safeMint once again with quantity parameter as (quantity % maxBatchSize)

Status

Partially Resolved

Auditors comment: Please confirm functionality of teamMint method.
The current code will not work, say maxBatchSize is 5 and you pass 13 as quantity. Do you want it to be minted in multiples of maxBatchSize like 5+5+3.

A11. Follow same pattern of transfer/call

Line	Function - withdrawMoney
1383	1383 function withdrawMoney() external onlyOwner nonReentrant { 1384 uint256 amount = address(this).balance; 1385 (bool success,) = msg.sender.call{value: amount}(""); 1386 require(success, "Transfer failed."); 1387 emit MoneyWithdrawn(amount); 1388 }

Line	Function - publicSaleMint

1285	1285 function publicSaleMint(uint256 quantity)
	1286 external
	1287 payable
	1288
	1289 {
	1290 require(
	1291 publicSaleStarted,
	1292 "public sale has not begun yet"
	1293);
	1294 require(totalSupply() + quantity <= collectionSize, "reached max supply");
	1295 require(
	1296 numberMinted(msg.sender) + quantity <= maxPerAddressDuringMint,
	1297 "can not mint this many"
	1298);
	1299 require(msg.value >= quantity * publicSalePrice,"Enter correct Amount"); // we
	1300 _safeMint(msg.sender, quantity);
	1301 refundIfOver(publicSalePrice * quantity);
	1302 emit PublicSaleMinted(msg.sender, quantity);
	1303 }

Description

The withdrawMoney method uses call with reentrancy guard, and publicSaleMint function uses transfer. Both are safe options with no possibilities of a reentrancy attack but still for better code readability we would suggest using one of them at both the places.

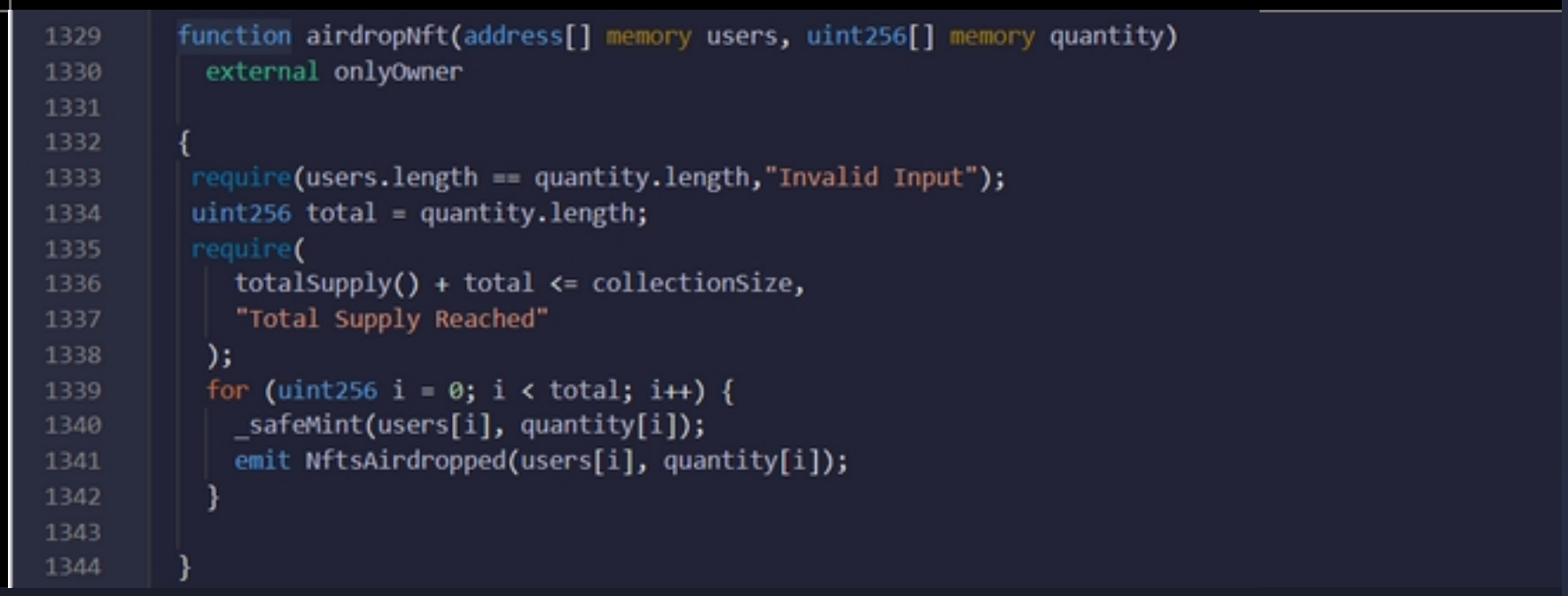
Remediation

Using either transfer OR call with reentrancy guard, at both the places.

Status

Resolved

A12. Improper variable name in airdropNft

Line	Function - airdropNft
1329	

```
1329  function airdropNft(address[] memory users, uint256[] memory quantity)
1330    external onlyOwner
1331
1332  {
1333   require(users.length == quantity.length,"Invalid Input");
1334   uint256 total = quantity.length;
1335   require(
1336      totalSupply() + total <= collectionSize,
1337      "Total Supply Reached"
1338    );
1339    for (uint256 i = 0; i < total; i++) {
1340      _safeMint(users[i], quantity[i]);
1341      emit NftsAirdropped(users[i], quantity[i]);
1342    }
1343
1344  }
```

Description

The parameter array quantity should be renamed to quantities

Status

Resolved

A13. Functionality of teamMint

Line	Function - teamMint

```
1312  // For marketing etc.
1313  function teamMint(uint256 quantity) external onlyOwner {
1314    require(
1315      totalSupply() + quantity <= amountForTeam,
1316      "too many already minted before dev mint"
1317    );
1318    require(
1319      quantity % maxBatchSize == 0,
1320      "can only mint a multiple of the maxBatchSize"
1321    );
1322    uint256 numChunks = quantity / maxBatchSize;
1323    for (uint256 i = 0; i < numChunks; i++) {
1324      _safeMint(msg.sender, maxBatchSize);
1325    }
1326    emit TeamMinted(quantity);
1327  }
```

Line	Function - updateTeamNftStock

```
1366  function updateTeamNftStock(uint256 quantity) external onlyOwner{
1367    amountForTeam = quantity;
1368    emit AmountForTeamUpdated(quantity);
1369  }
```

Description

Need to confirm that the owner won't be able to mint more NFTs for the dev team after the amountForTeam number of NFTs have been minted.

If this is the required behavior of the contract then why is there a updateTeamNftStock function, which can be used by the owner to update amountForTeam at any time.

Status

Acknowledged

Client's Comment: Owner can update it and mint more if he wishes

B. Contract - ERC721A

High Severity Issues

No issues found

Medium Severity Issues

No issues found

Low Severity Issues

No issues found

Informational Issues

B1. Downside of ERC721A

Description

Although ERC721A saves gas fees on minting but transferFrom and safeTransferFrom transactions cost more gas, which means it may cost more to gift or sell an ERC721A NFT after minting on secondary markets.

Status

Acknowledged

Client's Comment: We are aware of this, but want to have lesser gas fees while minting.

B2. Unnecessary underflow/overflow checks

Description

Each time a loop is run, underflow/overflow conditions are checked when incrementing/decrementing loop variables. In some cases there is no possibility of an underflow or overflow and in those cases using unchecked scoping to perform computations saves a significant amount of gas. The functions that can make use of unchecked keyword are:-

Line	Function - ownershipOf
726	

```
726     for (uint256 curr = tokenId; curr >= lowestTokenToCheck; curr--) {
727       TokenOwnership memory ownership = _ownerships[curr];
728       if (ownership.addr != address(0)) {
729         return ownership;
730       }
731     }
```

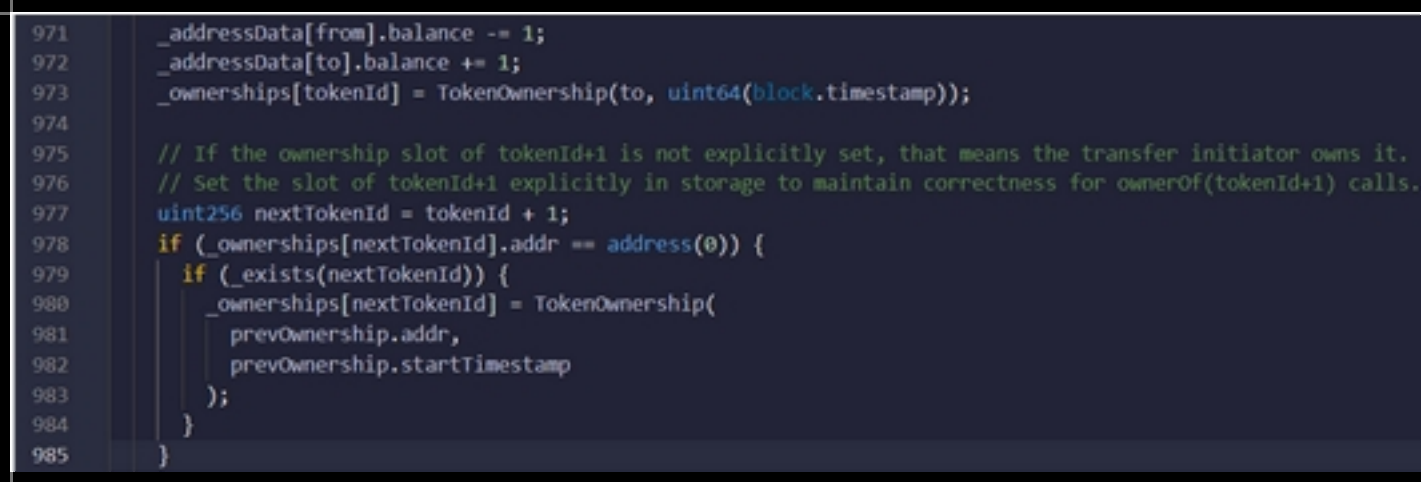
curr can never be lower than zero so loop at line 726 can be put in an unchecked scope.

Line	Function - _safeMint
912	

```
912     AddressData memory addressData = _addressData[to];
913     _addressData[to] = AddressData(
914       addressData.balance + uint128(quantity),
915       addressData.numberMinted + uint128(quantity)
916     );
917     _ownerships[startTokenId] = TokenOwnership(to, uint64(block.timestamp));
918
919     uint256 updatedIndex = startTokenId;
920
921     for (uint256 i = 0; i < quantity; i++) {
922       emit Transfer(address(0), to, updatedIndex);
923       require(
924         _checkOnERC721Received(address(0), to, updatedIndex, _data),
925         "ERC721A: transfer to non ERC721Receiver implementer"
926       );
927       updatedIndex++;
928     }
929
930     currentIndex = updatedIndex;
```

unchecked can be used from line 912 to line 930 as overflows are very unrealistic here because

- At line 914, overflow will occur if, balance + quantity > 3.4e38 (2**128) - 1
- At line 915, overflow will occur if, numberMinted + quantity > 3.4e38 (2**128) - 1
- At line 921, overflow will occur if, i > 1.56e77 (2**256) - 1
- At line 930, overflow will occur if, currentIndex + quantity > 1.56e77 (2**256) - 1

Line	Function - _transfer
971	

```
971     _addressData[from].balance -= 1;
972     _addressData[to].balance += 1;
973     _ownerships[tokenId] = TokenOwnership(to, uint64(block.timestamp));
974
975     // If the ownership slot of tokenId+1 is not explicitly set, that means the transfer initiator owns it.
976     // Set the slot of tokenId+1 explicitly in storage to maintain correctness for ownerOf(tokenId+1) calls.
977     uint256 nextTokenId = tokenId + 1;
978     if (_ownerships[nextTokenId].addr == address(0)) {
979       if (_exists(nextTokenId)) {
980         _ownerships[nextTokenId] = TokenOwnership(
981           prevOwnership.addr,
982           prevOwnership.startTimestamp
983         );
984       }
985     }
```

unchecked can be used from line 971 to line 985

At line 971,Underflow of the sender's balance is impossible because we check for ownership at line 951

At line 972,Overflow will occur if balance > 3.4e38 (2**128) - 1 which is unrealistic

At line 977, nextTokenId overflow is incredibly unrealistic as tokenId would have to be 2**256.

Status

Resolved

B3. Variables declared anywhere in between

Line
1005

```
1005    uint256 public nextOwnerToExplicitlySet = 0;
```

Description

The variable nextOwnerToExplicitlySet should be declared at the top along with other variable declarations and not between functions

Remediation

Declaring nextOwnerToExplicitlySet at the top along with other functions

Status

Resolved

B4. Use of _setOwnersExplicit

Line	Function _setOwnersExplicit
1010	

```
1010    function _setOwnersExplicit(uint256 quantity) internal {
1011      uint256 oldNextOwnerToSet = nextOwnerToExplicitlySet;
1012      require(quantity > 0, "quantity must be nonzero");
1013      uint256 endIndex = oldNextOwnerToSet + quantity - 1;
1014      if (endIndex > collectionSize - 1) {
1015        endIndex = collectionSize - 1;
1016      }
1017      // We know if the last one in the group exists, all in the group exist, due to serial ordering.
1018      require(_exists(endIndex), "not enough minted yet for this cleanup");
1019      for (uint256 i = oldNextOwnerToSet; i <= endIndex; i++) {
1020        if (_ownerships[i].addr == address(0)) {
1021          TokenOwnership memory ownership = ownershipOf(i);
1022          _ownerships[i] = TokenOwnership(
1023            ownership.addr,
1024            ownership.startTimestamp
1025          );
1026        }
1027      }
1028      nextOwnerToExplicitlySet = endIndex + 1;
1029    }
```

Description

_setOwnerExplicit funcion sets the owner in the _ownerships mapping.
Need to confirm that this functionality is needed or not as this will cost the owner to update the _ownerships array which need not to be updated and is the whole point of using ERC721A over ERC721.

Status

Acknowledged

Functional Testing

Some of the tests performed are mentioned below

- Should be able to mint the token
- Should revert on minting token by sending less amount, minting when public sale isn't started, when maximum supply is reached or address minting more than allowed for one address
- Extra amount sent should be refunded after minting
- Owner should be able to airdrop NFTs to the entered addresses
- Should be able to transfer tokens
- Should be able to transfer ownership and revert for a zero address.
- Should be able to approve address for a specific token or all the tokens for an address
- Owner should be able to withdraw Ether from the contract
- Owner should be able to start and stop the minting functionality
- Owner should be set to 0 address after RenounceOwnership
- Should revert if token transferred to non ERC721Receiver Implementer
- Owner should get the contract's ether on using withdrawMoney
- Owner should be able to change the publicSalePrice, BaseURI, maxBatchSize, maxPerAddressDuringMint, teamNftStock

Automated Tests

No major issues were found after using Slither and Mythril. Some false positive errors were reported by the tools. All the other issues have been categorized above according to their level of severity.

Closing Summary

In this report, we have considered the security of the TGK Nft contract. We performed our audit according to the procedure described above.

Some issues of High, Medium, Low and informational severity were found, Some suggestions and best practices are also provided in order to improve the code quality and security posture. At the end, The Gamble Kingdom Team Resolved most of the issues and Acknowledged others.

Disclaimer

Quillhash smart contract audit is not a security warranty, investment advice, or an endorsement of the The Gamble Kingdom Platform. This audit does not provide a security or correctness guarantee of the audited smart contracts.

The statements made in this document should not be interpreted as investment or legal advice, nor should its authors be held accountable for decisions made based on them. Securing smart contracts is a multistep process. One audit cannot be considered enough. We recommend that the The Gamble Kingdom Team put in place a bug bounty program to encourage further analysis of the smart contract by other third parties.

About QuillAudits

QuillAudits is a secure smart contracts audit platform designed by QuillHash Technologies. We are a team of dedicated blockchain security experts and smart contract auditors determined to ensure that Smart Contract-based Web3 projects can avail the latest and best security solutions to operate in a trustworthy and risk-free ecosystem.

500+
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$15B
Secured

500K
Lines of Code Audited

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Audit Report
July, 2022

For

THE GAMBLE KINGDOM

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