T-Swap Audit Report

Version 1.0

0xBlockPay

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Prepared by: 0xBlockPay

Lead Security Researcher: - eth0x

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Protocol Summary

This project is meant to be a permissionless way for users to swap assets between each other at a fair price. You can think of T-Swap as a decentralized asset/token exchange (DEX). T-Swap is known as an Automated Market Maker (AMM) because it doesn't use a normal "order book" style exchange, instead it uses "Pools" of an asset. It is similar to Uniswap. To understand Uniswap, please watch this video: Uniswap Explained

Disclaimer

The 0xBlockPay team makes all effort to find as many vulnerabilities in the code in the given time period, but holds no responsibilities for the findings provided in this document. A security audit by the team is not an endorsement of the underlying business or product. The audit was time-boxed and the review of the code was solely on the security aspects of the Solidity implementation of the contracts.

Risk Classification

		Impact		
		High	Medium	Low
	High	H	H/M	M
Likelihood	Medium	H/M	M	M/L
	Low	M	M/L	L

We use the CodeHawks severity matrix to determine severity. See the documentation for more details.

Audit Details

Scope

The findings describe in this document correspond the following repository and commit hash:

```
1  git clone https://github.com/Cyfrin/5-t-swap-audit
```

```
1  Commit Hash: 1ec3c30253423eb4199827f59cf564cc575b46db
```

In Scope:

```
1  ./src/
2  |__ PoolFactory.sol
3  |__ TSwapPool.sol
```

- Solc Version: 0.8.20
- Chain(s) to deploy contract to: Ethereum

Roles

- Liquidity Providers: Users who have liquidity deposited into the pools. Their shares are represented by the LP ERC20 tokens. They gain a 0.3% fee every time a swap is made.
- Users: Users who want to swap tokens.

Executive Summary

*We spend 10 hours with 1 auditor using foundry, aderyn and slither tools.

Issues found

Severity	Number of issues found
High	5
Medium	0
Low	2
Info	4
Gas	0
Total	11

Findings

High

MysteryBox.sol

[H-1] TSwapPool::deposit is missing deadline check causing transactions to complete even after the deadline

Description: The deposit function accepts a deadline parameter, which according to the documentation is "The deadline for the transaction to be completed by". However, this parameter is never used. As a consequence, operationrs that add liquidity to the pool might be executed at unexpected times, in market conditions where the deposit rate is unfavorable.

Impact: Transactions could be sent when market conditions are unfavorable to deposit, even when adding a deadline parameter.

Proof of Concept: The deadline parameter is unused.

Recommended Mitigation: Consider making the following change to the function.

```
 1  function deposit(
 2    uint256 wethToDeposit,
 3    uint256 minimumLiquidityTokensToMint, // LP tokens -> if empty, we
          can pick 100% (100% == 17 tokens)
 4    uint256 maximumPoolTokensToDeposit,
 5    uint64 deadline
 6    )
 7    external
 8  + revertIfDeadlinePassed(deadline)
 9    revertIfZero(wethToDeposit)
10    returns (uint256 liquidityTokensToMint)
11  {
```

[H-2] Incorrect fee calculation in `TSwapPool::getInputAmountBasedOnOutput` causes protocll to take too many tokens from users, resulting in lost fees

Description: The getInputAmountBasedOnOutput function is intended to calculate the amount of tokens a user should deposit given an amount of tokens of output tokens. However, the function currently miscalculates the resulting amount. When calculating the fee, it scales the amount by 10_000 instead of 1_000.

Impact: Protocol takes more fees than expected from users.

Recommended Mitigation:

```
 1  function getInputAmountBasedOnOutput(
 2    uint256 outputAmount,
 3    uint256 inputReserves,
 4    uint256 outputReserves
 5    )
 6    public
 7    pure
 8    revertIfZero(outputAmount)
 9    revertIfZero(outputReserves)
10    returns (uint256 inputAmount)
11    {
12  -       return ((inputReserves * outputAmount) * 10_000) / ((
        outputReserves - outputAmount) * 997);
13  +       return ((inputReserves * outputAmount) * 1_000) / ((
        outputReserves - outputAmount) * 997);
14  }
```

[H-3] Lack of slippage protection in `TSwapPool::swapExactOutput` causes users to potentially receive way fewer tokens

Description: The swapExactOutput function does not include any sort of slippage protection. This function is similar to what is done in TSwapPool::swapExactInput, where the function specifies a minOutputAmount, the swapExactOutput function should specify a maxInputAmount.

Impact: If market conditions change before the transaciton processes, the user could get a much worse swap.

Proof of Concept:

The price of 1 WETH right now is 1,000 USDC User inputs a swapExactOutput looking for 1 WETH inputToken = USDC outputToken = WETH outputAmount = 1 deadline = whatever The function does not offer a maxInput amount As the transaction is pending in the mempool, the market changes! And the price moves HUGE -> 1 WETH is now 10,000 USDC. 10x more than the user expected The transaction completes, but the user sent the protocol 10,000 USDC instead of the expected 1,000 USDC Recommended Mitigation: We should include a maxInputAmount so the user only has to spend up to a specific amount, and can predict how much they will spend on the protocol.

```
 1  function swapExactOutput(
 2    IERC20 inputToken,
 3  + uint256 maxInputAmount,
 4    .
 5    .
 6    .
 7    inputAmount = getInputAmountBasedOnOutput(outputAmount, inputReserves
        , outputReserves);
```

```
 8  + if(inputAmount > maxInputAmount){
 9  +     revert();
10  + }
11    _swap(inputToken, inputAmount, outputToken, outputAmount);
```

[H-4] TSwapPool::sellPoolTokens mismatches input and output tokens causing users to receive the incorrect amount of tokens

Description: The sellPoolTokens function is intended to allow users to easily sell pool tokens and receive WETH in exchange. Users indicate how many pool tokens they're willing to sell in the poolTokenAmount parameter. However, the function currently miscalculaes the swapped amount.

This is due to the fact that the swapExactOutput function is called, whereas the swapExactInput function is the one that should be called. Because users specify the exact amount of input tokens, not output.

Impact: Users will swap the wrong amount of tokens, which is a severe disruption of protcol functionality.

Proof of Concept:

Recommended Mitigation:

Consider changing the implementation to use swapExactInput instead of swapExactOutput. Note that this would also require changing the sellPoolTokens function to accept a new parameter (ie minWethToReceive to be passed to swapExactInput)

```
 1  function sellPoolTokens(
 2    uint256 poolTokenAmount,
 3  + uint256 minWethToReceive,
 4    ) external returns (uint256 wethAmount) {
 5  -   return swapExactOutput(i_poolToken, i_wethToken, poolTokenAmount,
        uint64(block.timestamp));
 6  +   return swapExactInput(i_poolToken, poolTokenAmount, i_wethToken,
        minWethToReceive, uint64(block.timestamp));
 7      }
 8  Additionally, it might be wise to add a deadline to the function, as
        there is currently no deadline. (MEV later)
 9
10  ### [H-5] In `TSwapPool::_swap` the extra tokens given to users after
        every swapCount breaks the protocol invariant of x * y = k
11
12  Description: The protocol follows a strict invariant of x * y = k.
        Where:
13
14  x: The balance of the pool token
15  y: The balance of WETH
16  k: The constant product of the two balances
```

```
17  This means, that whenever the balances change in the protocol, the
        ratio between the two amounts should remain constant, hence the k.
        However, this is broken due to the extra incentive in the _swap
        function. Meaning that over time the protocol funds will be drained.
18
19  The follow block of code is responsible for the issue.
20
21  ```javascript
22  swap_count++;
23  if (swap_count >= SWAP_COUNT_MAX) {
24    swap_count = 0;
25    outputToken.safeTransfer(msg.sender, 1_000_000_000_000_000_000);
26  }
```

Impact: A user could maliciously drain the protocol of funds by doing a lot of swaps and collecting the extra incentive given out by the protocol.

Most simply put, the protocol's core invariant is broken.

Proof of Concept:

A user swaps 10 times, and collects the extra incentive of 1_000_000_000_000_000_000 tokens That user continues to swap untill all the protocol funds are drained Proof Of Code Recommended Mitigation: Remove the extra incentive mechanism. If you want to keep this in, we should account for the change in the x * y = k protocol invariant. Or, we should set aside tokens in the same way we do with fees.

```
1  swap_count++;
2  // Fee-on-transfer
3  if (swap_count >= SWAP_COUNT_MAX) {
4  - swap_count = 0;
5  - outputToken.safeTransfer(msg.sender, 1_000_000_000_000_000_000);
6  - }
```

Low

[L-1] `TSwapPool::LiquidityAdded` event has parameters out of order

Description: When the LiquidityAdded event is emitted in the TSwapPool::_addLiquidityMintAndTransfer function, it logs values in an incorrect order. The poolTokensToDeposit value should go in the third parameter position, whereas the wethToDeposit value should go second.

Impact: Event emission is incorrect, leading to off-chain functions potentially malfunctioning.

Recommended Mitigation:

```
1  - emit LiquidityAdded(msg.sender, poolTokensToDeposit, wethToDeposit);
```

```
2  + emit LiquidityAdded(msg.sender, wethToDeposit, poolTokensToDeposit);
```

[L-2] Default value returned by `TSwapPool::swapExactInput` results in incorrect return value given

Description: The swapExactInput function is expected to return the actual amount of tokens bought by the caller. However, while it declares the named return value ouput it is never assigned a value, nor uses an explicit return statement.

Impact: The return value will always be 0, giving incorrect information to the caller.

Recommended Mitigation:

```
1  {
2    uint256 inputReserves = inputToken.balanceOf(address(this));
3    uint256 outputReserves = outputToken.balanceOf(address(this));
4
5  - uint256 outputAmount = getOutputAmountBasedOnInput(inputAmount,
      inputReserves, outputReserves);
6  + output = getOutputAmountBasedOnInput(inputAmount, inputReserves,
      outputReserves);
7
8  - if (output < minOutputAmount) {
9  - revert TSwapPool__OutputTooLow(outputAmount, minOutputAmount);
10 + if (output < minOutputAmount) {
11 + revert TSwapPool__OutputTooLow(outputAmount, minOutputAmount);
12 }
13
14 -   _swap(inputToken, inputAmount, outputToken, outputAmount);
15 +      _swap(inputToken, inputAmount, outputToken, output);
16 }
```

Informational

[I-1] `PoolFactory::PoolFactory__PoolDoesNotExist` is not used and should be removed

```
1  - error PoolFactory__PoolDoesNotExist(address tokenAddress);
```

[I-2] Lacking zero address checks

```
1  constructor(address wethToken) {
2  + if(wethToken == address(0)) {
3  + revert();
4  + }
5    i_wethToken = wethToken;
6  }
```

[I-3] PoolFacotry::createPool should use .symbol() instead of .name()

```
1  -          string memory liquidityTokenSymbol = string.concat("ts",
       IERC20(tokenAddress).name());
2  +          string memory liquidityTokenSymbol = string.concat("ts",
       IERC20(tokenAddress).symbol());
```

[I-4] Event is missing indexed fields

Index event fields make the field more quickly accessible to off-chain tools that parse events. However, note that each index field costs extra gas during emission, so it's not necessarily best to index the maximum allowed per event (three fields). Each event should use three indexed fields if there are three or more fields, and gas usage is not particularly of concern for the events in question. If there are fewer than three fields, all of the fields should be indexed.

Found in src/TSwapPool.sol: Line: 44 Found in src/PoolFactory.sol: Line: 37 Found in src/TSwapPool.sol: Line: 46 Found in src/TSwapPool.sol: Line: 43