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**Analysis –
Terraform Labs’
and Luna
Foundation Guard’s
Defense of the UST
Price Peg**

November 9, 2022

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I. Introduction

1. JS Held (“JSH” or “we”) has been retained by Dentons US LLP (“Counsel”) to conduct an analysis of trading and blockchain records and the efforts of Terraform Labs Pte. Ltd. (“TFL”), and Luna Foundation Guard (“LFG”), to defend the price of UST¹ from May 8th to 12th, when there was a large market selloff of the stablecoin.
2. JSH has provided financial analyses and expert testimony in various matters, including cryptocurrency, for over twenty years. See Exhibit 1 (Curriculum Vitae of Boris Richard). For its services related to this matter, JSH was compensated by TFL at an hourly rate of \$800 per hour. JSH’s compensation is not contingent upon its conclusions or opinions expressed herein, nor upon the outcome of any matter in which these conclusions are presented.
3. Utilizing our forensic investigative experience and knowledge of blockchain analytics and cryptocurrency exchanges, JSH determined the specific transactions and assets that LFG and TFL utilized between May 8th and May 12th, 2022, in TFL/LFG’s attempts to defend and support the 1:1 peg of TFL’s stablecoin UST to the U.S. Dollar (“UST Price Peg”). We relied upon various types of quantitative and qualitative information, which included on-chain data; analyzing trading records that we independently obtained from Binance, KuCoin, and Bitfinex; and consultations with the TFL business. At the time, TFL managed and executed accounting, finance, and tax-related operations and responsibilities of LFG along with any other administrative and operational functions LFG requested, pursuant to a master services agreement executed at the beginning of 2022.²
4. At Counsel’s request, our analysis evaluated the following activity:
 - (1) The specific transactions conducted by TFL and LFG to defend the UST Price Peg from May 8 to May 12.
 - (2) The accounting of LFG’s assets on May 7 through May 16, as reflected in the series of tweets posted by LFG on May 16, 2022 (“LFG May 16 Tweets”).
 - (3) The accuracy of the descriptions of the transactions undertaken by LFG to defend the UST Price Peg, as recounted in LFG’s May 16 Tweets, and an assessment of any deviations.

II. Executive Summary

5. Our review of trading records and blockchain data revealed that:
 - (1) **From May 8 to May 12, 2022, LFG and TFL used the following assets to defend the UST Price Peg.**
 - On May 8th, LFG directly sold into Curve Finance UST + 3Pool Metapool 26,281,671 USDT³ and 23,555,590 USDC⁴ from its reserves to buy 50,200,071 UST.⁵

¹ This report refers to what are now known as “USTC” and “LUNC” as “UST” and “LUNA”, respectively.

² Exchange information from OKX, Bittrex, and Huobi were not included in this report as API limitations prevented the retrieval of data for the relevant date ranges.

³ USDT (Tether) is a cryptocurrency stablecoin pegged to the U.S. dollar.

⁴ USDC (USD Coin) is a cryptocurrency stablecoin, tokenized and backed by the U.S. dollar.

⁵ See Exhibit 2.

- On May 9th, LFG transferred a total of 52,189 BTC⁶ from its reserves to Jump Trading for Jump to purchase UST.⁷
- We analyzed TFL's trade activity by reviewing (1) the total amount of UST purchased and (2) the net amount of UST purchased:⁸
 - Total amount of UST Purchased ("Total Basis") - From May 8th through May 10th, TFL purchased a total of 1,901,559,334 UST through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex) as well as through its TFL curve bots 1 and 2. These purchases had the contemporaneous market value of \$1,773,199,279 U.S. dollars.
 - Net amount of UST Purchased ("Net Basis") - From May 8th through May 10th, TFL purchased net total of 1,464,738,304 UST through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex)⁹ as well as through its TFL curve bots 1 and 2. These purchases had the contemporaneous market value of \$1,375,600,151 U.S. dollars.¹⁰

Also, on May 10, TFL received a total of 33,206 BTC from LFG as a reimbursement for a portion of the assets TFL spent defending the peg. LFG transferred 28,206 BTC to TFL's Binance account¹¹ and Jump transferred 5,000 BTC to the same account (313 BTC that had not been used was returned to LFG's wallet¹²). The total amount of 33,206 BTC had the contemporaneous market value of \$1,030,427,532 U.S. dollars. All of the BTC was transferred to the same TFL Binance account defending the peg and were commingled with the other digital assets in the account. Assets and trades were not segregated.

From May 8 to May 10, based on the total UST purchased, TFL spent \$742,771,747 U.S. dollars more than it received from LFG to purchase UST in defense of the UST Price Peg. For the same period, using a total net amount of UST purchased, TFL spent \$345,172,619 U.S. dollars more than it received from LFG to purchase UST in defense of the UST Price Peg.

- Additionally, we analyzed TFL's trade activity by reviewing (1) the total amount of LUNA purchased and (2) the net amount of LUNA purchased:
 - Total amount of LUNA Purchased - From May 8th through May 11th, TFL purchased

⁶ Bitcoin (BTC)

⁷ See Exhibit 3. Jump Trading has not provided TFL with any records of its trades.

⁸ JSH conducted its analysis in this manner to determine (1) the direct impact of how TFL's purchases of UST had in the market, and (2) TFL's trade strategy along with its peg defense.

⁹ During this period, TFL also sold smaller amounts of UST and LUNA for other purposes, so this report presents both the gross and net amounts of UST and LUNA purchased.

¹⁰ The net sales of UST resulted in the following UST coin purchase: ETH, BTC, LUNA, BUSD, BNB, ATOM, SOL, DOT, AAVE, MATIC, SNX, YFI, USDT, ANC.

¹¹ See Exhibit 3.

¹² TFL transferred the 313 BTC to LFGs wallet: *bc1q9d4ywgfnd8h43da5tpcxn6ajv590cg6d3tg6axemvljvt2k76zs50tv4q.*

a total of 23,053,022 LUNA through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex). These purchases had the contemporaneous market value of \$1,001,864,982 U.S. dollars.

- Net amount of LUNA Purchased - From May 8th through May 11th, TFL purchased net total of 7,780,065 LUNA through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex). These purchases had the contemporaneous market value of \$268,444,270 U.S. dollars.¹³

From May 8 to May 11, based on the total LUNA purchased, TFL spent \$1,001,864,982 U.S. dollars more than it received from LFG to purchase LUNA to defend the network from a governance attack. For the same period, using a total net amount of LUNA purchased, TFL spent \$268,444,270 U.S. dollars more than it received from LFG to purchase LUNA to defend the network from a governance attack.

- In total, TFL spent **\$1,744,636,729 U.S. dollars on a total purchase basis** or **\$613,616,889 U.S dollars on a net purchase basis** of its own in defense of the UST price peg.

(2) The LFG May 16 Tweets provided an accurate accounting of LFG’s assets balances.

- LFG (through TFL and Jump’s purchases on LFG’s behalf) used approximately 80,000 BTC, 26,281,671 USDT, and 23,555,590 USDC in the LFG Reserve to purchase the UST stablecoin and to defend the peg.
- We confirmed that the LFG balances on May 7th and May 16th, as reported in the LFG May 16 Tweets, are accurate.

Holding Name	Beginning Balance	Ending Balance
BTC	80,394	313
BNB	39,914	39,914
USDT	26,281,671	0
USDC	23,555,590	0
AVAX	1,973,554	1,973,554
UST	697,344	1,847,079,725
LUNA	1,691,261	222,713,007

(3) The peg defense transactions recounted in the LFG May 16 Tweets included estimates instead of actual transaction data, but the use of these estimates did not affect the accuracy of the reported LFG balances.

¹³ The net sales of LUNA resulted in the following LUNA coin purchase: USDT, BTC, Ethereum (ETH), USD, Binance USD (BUSD), Binance Coin (BNB), UST, EURO.

- Each of LFG’s May 16 Tweets about the details of the UST Price Peg defense operations are accurate, except for Tweets #6 and #7, which were based on estimate values.
- Tweet #6 listed the amount of UST LFG purchased as 1,164,018,521 UST.
 - The reported number was an estimate of UST that had been calculated as follows:

The 33,206 BTC that LFG transferred to TFL was multiplied by an average estimated BTC price of \$29,663 which equaled \$984,989,578 U.S. dollars.

Then, the amount of \$984,989,578 U.S. dollars was divided by the average UST price of \$0.846197513 resulting in the 1,164,018,521 UST used in the Tweet.
- Tweet #7 reported that 883,525,674 UST was swapped to 221,021,746 LUNA to prevent a possible governance attack.
 - The estimate in the number of UST derives from the estimate in Tweet #6. The actual amount of LUNA is 220,694,577. The net difference is a small amount of LUNA staked to prevent a potential governance attack that did not involve UST/LUNA swaps.
- This estimated amount did not affect our analysis and confirmation that the beginning and ending balances of the LFG reserves were correct.
 - Jump transferred 1,515,689,462 UST to TFL on behalf of LFG.
 - TFL purchases combined with Jump’s transferred amount of UST equaled an estimated 2,601,740,975 UST.
 - TFL transferred 1,796,182,310 UST to LFG.
 - These transferred 1,796,182,310 UST, when added to LFG’s original balance of 697,344 UST and the 50,200,071 UST that LFG converted from USDT + USDC equals the ending balance of 1,847,079,725 UST.

III. Background

6. ***Terra Ecosystem.*** TFL supported the development of the Terra blockchain. LFG, a non-profit organization headquartered in Singapore, was established to act as a decentralized UST Reserve to support the pegged price of UST.¹⁴ Terra is a decentralized, open-source public blockchain built to support a suite of fiat-pegged, algorithmic stablecoins.¹⁵ Terra relied upon a dual token system: TerraUSD (UST) was an decentralized algorithmic stablecoin value-pegged to the US Dollar. UST could be used as a standalone token *or* in conjunction with LUNA (Terra's native non-stablecoin cryptocurrency) for the purposes of staking, governance, and reserves. LUNA operated as a stabilization mechanism to maintain the 1:1 UST price peg for Terra’s stablecoin by minting and burning tokens.

¹⁴ <https://lfg.org/missionandvision/>

¹⁵ <https://lfg.org/missionandvision/>

7. **How TerraUSD (“UST”) Works.** TerraUSD (UST) is pegged to the price of a US dollar (\$1 USD) and that peg is maintained by an arbitrage mechanism tied to LUNA. As an algorithmic stablecoin with a value pegged to a fiat currency via an arbitrage mechanism, the UST token has no guaranteed reserve support. Instead, the creation of UST is facilitated by burning LUNA tokens. To mint 1 TerraUSD, one must burn \$1 worth of LUNA. Simply put, \$1 USD worth of LUNA can be burned to mint 1 UST, and 1 UST can be burned to mint \$1 USD worth of LUNA. The price of LUNA is not fixed and can fluctuate. The UST peg to the US dollar is designed to be algorithmically achieved by means of regulating its supply and demand, specifically through the actions of arbitrageurs looking to make profits whenever UST might fall below or rise above \$1 USD. Transactionally, when the price of UST dropped below \$1 USD, it became attractive to buy UST at a price below \$1 USD, convert 1 UST into \$1 USD worth of LUNA and sell it, realizing a profit. Thus, arbitrageurs would push UST back up to parity by burning UST (reducing its supply) and minting LUNA, and vice versa whenever UST exceeds \$1 USD.
8. **Luna Foundation Guard, TFL, and UST Peg Defense.** LFG acted to ensure the stability of UST’s peg. It was determined that LFG could utilize crypto assets, including bitcoin (BTC), to provide additional protection against UST’s peg falling below the 1:1 USD peg, in particular, by means of buying UST on centralized cryptocurrency exchanges with BTC, or with other stablecoins (e.g., buying UST with Tether (USDT) or USDC, into which BTC would have been swapped first). LUNA’s value is not fixed, and, by design, users are financially incentivized to arbitrage LUNA and UST. Although the market price of UST fluctuated on May 7, on May 8, 2022, there was a significant drop in the market price of UST, and TFL began defending the peg by buying UST in the open market. Additionally, at TFL’s request, Jump Trading also purchased UST using funds provided by LFG.

IV. Information Considered

9. We relied upon various types of quantitative and qualitative information, including on-chain data; TFL and LFG trading records JSH obtained directly from the exchanges; and consultations with the TFL business.
10. The work performed is not an attest engagement as defined by the rules of the American Institute of Certified Public Accountants (“AICPA”), but rather conforms to the AICPA Statement on Standards for Forensic Services No. 1 (“SSFS No. 1”).
11. The opinions presented in this report are based on information and documents available as of the date of this report. The opinions are based on a standard of reasonable certainty.

V. Findings

12. On May 7th, prior to the UST depegging, LFG had a total reserve of 80,395 BTC.¹⁶ Over the next few days, this reserve was allocated to Jump and TFL to purchase UST in the open market to support the UST price and defend its 1:1 USD peg.

¹⁶ Rounded.

13. TFL maintained certain balances in its Binance exchange account in BTC, ETH, BNB, USDT, BUSD, LUNA and UST as of May 8, 2022. These balances are reflected in the Table below.

Coin	Balance Beginning May 8th
BTC	4,742.51
ETH	761.32
BNB	63,810.89
USDT	177,429,599.14
LUNA	732,341.09
UST	796,368,008.78

1. From May 8 to May 12, 2022, LFG and TFL used the following assets to defend the UST Price Peg.

May 8th: LFG Sold 26,281,671 USDT and 23,555,590 USDC for 50,200,071 UST

14. As described above, on May 7, 2022, there was a significant drop in the market price of UST. In response, LFG and TFL began defending the peg on May 8 by deploying crypto assets to buy UST and LUNA in the open market.
15. Initially, LFG sold 26,281,671 USDT and 23,555,590 USDC to buy 50,200,071 UST as depicted in the table below. JSH confirmed these transactions using blockchain explorers including Etherscan and Terra Finder.¹⁷

Timestamp (UTC)	Asset Type	Controlling Entity	Wallet Address	Direction (In/Out)	Amount
5/8/2022 2:12	USDT	LFG	0x803c172c3202ab7d32159839306e335db745b025	Out	26,281,671
5/8/2022 2:19	USDC	LFG	0x803c172c3202ab7d32159839306e335db745b025	Out	23,555,590
5/8/2022 2:38	UST	Terra	terra1gr0xesnseevzt3h4nrx64sh5gk4dwrwgszx3nw	In	50,200,071

Source: Etherscan and Terra Finder

16. On May 8, 2022, LFG made the above purchase of UST through the following steps:¹⁸

(1) Step 1: LFG converts USDT to UST -

26,281,671 USDT are transferred from LFG Reserve
0xad41bd1cf3fd753017ef5c0da8df31a3074ea1ea to LFG address
0xe3011271416f3a827E25D5251d34A56d83446159.
~159 sends them to 0xCEAF7747579696A2F0bb206a14210e3c9e6fB269 (Curve UST metapool), which exchanges USDT for Wormhole UST via Curve 3pool
0xbebc44782c7db0a1a60cb6fe97d0b483032ff1c7, which sends 26,495,232 Wormhole

¹⁷ See Exhibit 2.

¹⁸ The Wormhole bridge facilitates transfers of tokens across multiple chains, including Ethereum, Solana, Terra, BNB Chain, Aurora, Polygon, Avalanche, Oasis, and Fantom.

UST back to ~159.

(2) Step 2: LFG converts USDC to UST –

23,555,590 USDC are transferred from ~1ea to LFG address 0xe3011271416f3a827E25D5251d34A56d83446159
~159 sends them to 0xCEAF7747579696A2F0bb206a14210e3c9e6fB269 (Curve UST metapool), which exchanges USDT for Wormhole UST via Curve 3pool 0xbebc44782c7db0a1a60cb6fe97d0b483032ff1c7, which sends 23,704,838 UST back to ~159.

(3) Step 3: Converted UST is transferred to LFG address –

~159 sends UST to terra10nmmwe8r3g99a9newtqa7a75xfgs2e8z87r2sf via UST Wormhole portal.

On the Terra blockchain, on May 8, 2022, terra1cymh5ywn4azak74h4gsrnakqgel4y9ssersvx sends 50,200,071.081424 UST to terra1gr0xesnseevzt3h4nrx64sh5gk4dwrwgsz3nw. (~svx received 50,200,071 UST from terra10nmmwe8r3g99a9newtqa7a75xfgs2e8z87r2sf which is a wormhole token bridge for Terra on the Terra side.)

From May 8th through May 10th: TFL Purchases 1,901,559,334 UST on a Total Basis / 1,464,738,304 UST on a Net Basis to defend the UST price peg.¹⁹

17. Using its Binance, KuCoin, and Bitfinex cryptocurrency trading accounts, TFL began purchasing UST in the open market on May 8, 2022 and continued to do so through May 10, 2022.²⁰ Utilizing the aforementioned Total Basis and Net Basis methodology, TFL purchased a total of 1,514,667,392 UST, and 1,077,846,362 UST, respectively. JSH confirmed these purchases through data received directly from the cryptocurrency exchange APIs.
18. Additionally, TFL purchased UST utilizing the following 2 TFL accounts:

1. **TFL curve bot 1**: 0xE88080c85b11DBf4DD772fc6dE6dDB73de76BfdC, which was funded by TFL using its Binance account and another TFL account (0x61f2f664fec20a2fc1d55409cfc85e1baeb943e2) using USDT. TFL exchanged USDT for wrapped UST WUST using the UST+3Pool on Curve.fi and exchanged for USDT.

TFL purchased 277,888,825 UST using 276,000,000 USDT.²¹

2. **TFL curve bot 2**: 0x6b671B51258dB0316Dd89BC0075D6113488Be5E8, which was funded through TFL's staking of the ethereum derivative (bETH) in the Anchor protocol. TFL moved bETH from Anchor to Curve and exchanged to ETH and subsequently to USDT. TFL then swapped the obtained ETH for USDT using the Curve.fi USDT/WBTC/WETH pool.

¹⁹ See Exhibit 5.

²⁰ May 8, 2022, 2:00:03 AM through May 10, 2022, 11:58 AM.

²¹ TFL began this set of transactions late in the evening on May 7th and concluded on May 8th. As such, this transaction has been considered a May 8th transaction.

TFL purchased 109,003,117 UST using 108,644,140 USDT.

19. The below table combines the UST purchase activity within the Binance, KuCoin, and Bitfinex cryptocurrency trading accounts with the purchases using TFLs curve bot accounts broken down by day showing both the Total Basis and Net Basis.

Date	UST Purchased (Total)	USD Equivalent (Total)	UST Purchased (Net)	USD Equivalent (Net)
May 8th	691,167,741	\$686,766,346	610,255,271	\$606,349,287
May 9th	341,312,506	\$321,648,208	187,346,237	\$176,328,179
May 10th	869,079,087	\$764,784,725	667,136,796	\$592,922,685
Total	1,901,559,334	\$1,773,199,279	1,464,738,304	\$1,375,600,151

Source: Binance Exchange API, Bitfinex Exchange API, KuCoin Exchange API. USD Equivalent based on hourly pricing from cryptocompare.com

Between May 9th and May 10th: LFG Transferred 52,189 BTC to Jump Trading, and 28,206 BTC to TFL, for the purpose of buying UST and defending the UST Price Peg.²²

20. On May 9th, LFG sent a total of 52,189 BTC to Jump (bc1qlyfrxkwp2xg39cd6usx6aw45u5rlcg13sygu2w), in a series of on-chain transfers. The BTC transferred was to be used by Jump to purchase UST in the open market.

Timestamp (UTC)	Asset Type	Controlling Entity	Wallet Address	Direction (In/Out)	Amount
5/9/2022 3:45	BTC	LFG	bc1q0wgz9gt8tyac5ct94czvyuu4v264fclrxlq8su4s2kk6u8nmwy9swjp6t7	Out	22,189
5/9/2022 3:45	BTC	Jump	bc1qlyfrxkwp2xg39cd6usx6aw45u5rlcg13sygu2w	In	22,189
5/9/2022 18:42	BTC	LFG	bc1qwuwyt0q83gr4cvawgdwdqem0y2mfkx44hlzd7ke2syg3vddql8scn63rm	Out	30,000
5/9/2022 18:42	BTC	Jump	bc1qlyfrxkwp2xg39cd6usx6aw45u5rlcg13sygu2w	In	30,000

Source: BitInfoCharts.com

21. Jump later transferred 5,000 BTC to the TFL Binance cryptocurrency exchange account on May 10.
22. Separately, Jump transferred 1,515,689,462 UST to TFL on May 11 both via on-chain transactions and internally on Binance. TFL then transferred these UST coins to LFG's blockchain address. The following chart displays both the off-chain and on-chain transfers from Jump to TFL. The off-chain transfers occurred via Binance.

Timestamp (UTC)	Asset Type	Controlling Entity	From	Transaction ID	Wallet Address	Direction (In/Out)	Amount
5/10/2022 2:42	UST	TFL	Jump	105880695932 (Internal)		In	878
5/11/2022 13:54	UST	TFL	Jump	105881369092 (Internal)		In	100,000,000
5/11/2022 13:54	UST	TFL	Jump	105881221734 (Internal)		In	100,000,000
5/11/2022 13:54	UST	TFL	Jump	105881968273 (Internal)		In	100,000,000
5/11/2022 13:55	UST	TFL	Jump	105882955998 (Internal)		In	100,000,000
5/11/2022 13:57	UST	TFL	Jump	105883450696 (Internal)		In	100,000,000
5/11/2022 13:59	UST	TFL	Jump	105883715641 (Internal)		In	100,000,000
5/11/2022 14:03	UST	TFL	Jump	105884269985 (Internal)		In	100,000,000
5/11/2022 14:05	UST	TFL	Jump	105884490586 (Internal)		In	70,000,000
5/11/2022 14:27	UST	TFL	Jump	71A7ACC320F0B0AC0525E7EBFB8F26358A5C488B81640D2CD14323E66B6A5C8	terra14tlthgtg6ep6xnqptyg8dp3gcq4jxvgqmskwkd	In	885
5/11/2022 14:36	UST	TFL	Jump	07A12C93FFADF2855AEA7A919155FB1F328FF176B7E17DC0045EA5CF9C118B9F	terra14tlthgtg6ep6xnqptyg8dp3gcq4jxvgqmskwkd	In	745,687,699
Total							1,515,689,462

Source: Binance Exchange API and Terra Finder

²² See Exhibit 3.

23. Separately, on May 10th, LFG transferred 28,206²³ BTC to TFL (163mp4eKBixViv7VPwG3aKvcNDkh3UmsSP) in an on-chain transfer. Below are the on-chain details of that transfer.

Timestamp (UTC)	Asset Type	Controlling Entity	Wallet Address	Direction (In/Out)	Amount
5/10/2022 1:20	BTC	LFG	bc1q9d4ywgfnd8h43da5tpxcn6ajv590cg6d3tg6axemvljvt2k76zs50tv4q	Out	28,206
5/10/2022 1:20	BTC	TFL	163mp4eKBixViv7VPwG3aKvcNDkh3UmsSP	In	28,206

Source: [BitInfoCharts.com](https://bitinfocharts.com)

24. Throughout the May 8 to May 10 period, TFL continued to purchase UST using its cryptocurrency exchange accounts as well as through its curve bot accounts.²⁴

From May 8th Through May 11th: TFL Purchased a Total of 23,053,022 LUNA on a Total Basis / 7,780,065 on a Net Basis through its cryptocurrency exchange accounts.

25. To defend the UST Price Peg, LFG, TFL, and Jump were initially purchasing UST and LUNA.

26. The LUNA token is used to help peg UST to the U.S. dollar. If the price of UST exceeds a dollar, \$1 of LUNA can be burned and redeemed for 1 UST and if the price of UST falls below the peg, one can swap 1 UST for \$1 worth of LUNA. During the depeg, UST was trading at such a low price that UST holders were attempting to arbitrage by swapping 1 UST for \$1 worth of LUNA. As UST was burned, more LUNA was minted by the protocol in response. Since the price of LUNA was also declining, all of the UST holders attempting to swap UST for LUNA created a significant sudden increase in LUNA's supply. This increase, along with other market factors, caused LUNA's price to further decline.

27. During the May 8th through May 11th period, TFL purchased a total of 23,053,022 LUNA on a Total Basis, with a contemporaneous value of \$1,001,864,982 U.S. dollars. Under the Net Basis, TFL purchased a total of 7,780,065 LUNA, with a contemporaneous value of \$268,444,270 U.S. dollars, by using TFL's own assets, not LFG assets.²⁵ Below is the breakdown of total LUNA purchases by day showing both the Total Basis and Net Basis:

Date	Luna Purchased (Total)	USD Equivalent (Total)	Luna Purchased (Net)	USD Equivalent (Net)
May 8th	5,658,070	\$364,633,261	(48,824)	(\$3,179,988)
May 9th	6,449,293	\$331,296,117	2,212,338	\$118,280,264
May 10th	9,667,482	\$294,499,752	4,338,374	\$141,908,142
May 11th	1,278,177	\$11,435,852	1,278,177	\$11,435,852
Total	23,053,022	\$1,001,864,982	7,780,065	\$268,444,270

Source: [Binance Exchange API](https://binance.com), [Bitfinex Exchange API](https://bitfinex.com), [KuCoin Exchange API](https://kucoin.com). USD Equivalent based on hourly pricing from cryptocompare.com

2. The LFG May 16, 2022, Tweets provided an accurate accounting of LFG's assets balances on May 7 and May 16, 2022.

LFG Tweets

²³ This number is rounded from actual BTC transferred of 28,205.54

²⁴ See Exhibit 5.

²⁵ See Exhibit 4.

28. On May 16th, 2022, LFG released statements through its Twitter account documenting how its Bitcoin reserves were disbursed to defend the UST peg.

LFG Beginning + Ending Balance

29. LFG's series of tweets begins with its Saturday, May 7th, 2022, reserve consisting of the following:

Holding Name	Beginning Balance
BTC	80,394
BNB	39,914
USDT	26,281,617
USDC	23,555,590
AVAX	1,973,554
UST*	697,344
LUNA**	1,691,261

30. Over the following days, TFL deployed the reserve in defense of peg in the following manner:

BTC

- 80,394 BTC Beginning Reserve Balance
- 22,189 BTC May 9 03:45 UTC LFG transfer to Jump
- 30,000 BTC May 9 18:42 UTC LFG transfer to Jump
- 28,206 BTC²⁶ May 10 01:20 UTC LFG transfer to TFL (Binance)
- 313 BTC May 16 TFL transfer back to LFG

BNB

- 39,914 No change

USDT + USDC

- Sold 26,281,671 USDT
- Sold 23,555,590 USDC
- 50,200,071 UST

AVAX

- 1,973,554 No change

UST

- 697,344 UST Beginning Balance
- 50,200,071 UST Converted from USDT + USDC
- 1,796,182,310 UST Amount of UST TFL sent to LFG²⁷

²⁶ This number is rounded from actual BTC transferred of 28,205.54

²⁷ The total purchases of UST on behalf of LFG totaled an estimated 2,601,740,975. TFL transferred 1,796,182,310 UST to

- LUNA
- 1,847,079,725 UST Ending Balance
 - 1,691,261 LUNA Beginning Balance
 - 220,694,577 LUNA Converted by TFL using estimated 805,558,665 UST and sent to LFG
 - 327,164 LUNA staked and sent to LFG
 - 222,713,002 LUNA Ending Balance

3. The measures recounted in the LFG May 16 Tweets were accurate.

LFG Tweets²⁸

31. JSH has reviewed and confirmed the accuracy of the beginning and ending balances of the May 7 and May 16 balances, respectively.
32. However, in our review of the mechanics reported in Tweets #6 and #7, we found that the amount of UST reported as having been purchased by LFG (1,164,018,521 UST) was an estimate. This exception is examined further below.

LFG Tweet #6



33. At the time that these Tweets were released, markets for both BTC and UST were highly volatile, and prices were fluctuating rapidly. Because actual trade data was not easily assessable at the time of the Tweets (it required weeks to process and tabulate), portions of the data included in the tweet had to be estimated based on easily accessible data. Thus, LFG estimated the number of UST that they would be able to purchase using 33,206 BTC as follows:
 - The 33,206 BTC that LFG transferred to TFL multiplied by an average BTC price of \$29,663 which equaled \$984,989,578 U.S. dollars. This was done to obtain the dollar value that could be used to purchase UST.
 - Then, the amount of \$984,989,578 U.S. dollars was divided by the average UST price of \$0.846197513 resulting in the 1,164,018,521 UST used in the tweet. This was done to find out how many UST could be obtained with the dollar value that LFG had.
34. This estimate didn't affect our analysis and confirmation that the beginning and ending balances were correct, because calculations using the actual trades reveal the reported balances to be accurate.
 - TFL transferred 1,796,182,310 UST to LFG. The resulting amount of 1,796,182,310 UST

LFG (which included 1,515,689,462 UST purchased by Jump), while the remaining 805,558,665 UST were swapped into 220,694,577 LUNA to prevent a potential governance attack. Swapped LUNA were eventually transferred to LFG as well.

²⁸ See Exhibit 6.

+ LFG’s original balance of 697,344 UST + the 50,200,071 UST that LFG converted from USDT + USDC equals the ending balance of 1,847,079,725 UST.

LFG Tweet #7



35. Tweet #7 was reported using estimated amount of UST that included in Tweet #6. The following shows that when the estimate of 1,164,018,521 UST is used, the remaining amount is 883,525,674 UST to be converted to LUNA. When this tweet was written, it utilized these estimates for the amount of UST that were purchased for the same reasons discussed above.
36. To arrive at a more accurate estimate of UST swapped into LUNA to protect network governance against potential attacks, we computed the amount of LUNA which were staked and into which UST were swapped by TFL trading addresses. The transfers of LUNA from 10 TFL trading bots on May 12, 2022, to five addresses which delegated the obtained tokens to protocol staking, total 220,694,577 LUNA.²⁹ This number is slightly smaller than 221,021,746 LUNA that Tweet #7 indicated as staked and obtained via UST swaps.³⁰
37. Using data on 5,286 UST/LUNA swap transactions executed by 10 TFL trading bots between May 9 and May 11, 2022, we identified the set of swaps which, in aggregate, minted 220,694,577 LUNA. Through this analysis, it was apparent that there was no specific set of swap transactions that could produce an exact match for the above LUNA amount. This is expected since trading bots burn/mint UST and mint/burn LUNA almost continuously for a variety of reasons, including staking LUNA to prevent a governance attack. For this reason, Tweet #7 could not precisely identify an exact number of UST swapped into LUNA for staking and governance purposes but could only include an estimate.
38. Depending on the assumed start and end time of swaps, and with the discrepancy being less than 1,000 LUNA, we estimated the amount of UST swapped into LUNA for staking and governance purposes to be between 785,501,572 UST and 825,615,759 UST, with a mid-point of this range at 805,558,665 UST.

²⁹ The 10 trading addresses *terra14tlthgtg6ep6xnqptyg8dp3gcq4jxvqgmskwkd*, *terra1mer7nd843n5g3v37xtd3hude6t5rf4cq3mnae*, *Terra14ny376fe7hys2zqxwc87p2achp9tju5q6jul4*, *terra12qmfxcy8kahwt44tn4aq4t6kdmtyer38xnrh7m*, *terra1t8szgkIntcwxxyfyflucuaq895gpjr8wn6tsqxye*, *terra1nexqdq252acp09m9eler7jhg9kd3rqfzkek9r0*, *terra1g5dmf4qpmdrw77d3ty6djrgujt8r2n3lgyknj*, *terra1lewnh53gt0hzgjeirtwdz8q7dennz09s6ds4k2*, *terra1v49w0m38fe87edhqdv30w96wq0pz6u6548q9gj*, *terra17p4mqd7yl9m0r7cfv0nf9s9zae3d3gm4tmyg2a* obtained the LUNA tokens by way of burning UST and then transferring them to the delegator addresses *terra13u3p30c2tn9m8dmru6mfyhmq5379qm43vr717*, *terra10zzfuednzhkmwn4tqks2mukstr02r5jklpmh2f*, *terra1anllr0tt8r2my88kp6kmdwdnewnja5246djj99*, *terra13vpm23s7rw5gqp9ckhqngjesxcuzatytknqpfj*, and *terra1zz2nf34fjkjykg0kplkrr29ycxarmct6kafvj*.

³⁰ Also, we identified that a small amount of staked LUNA (327,164) did not involve UST/LUNA swaps.

39. The variations in both Tweets #6 and #7 are immaterial for the following reasons:

- The May 7 beginning balance and the May 16 ending balances are in fact accurate.
- *TFL purchased a total of 1,901,559,334 UST on a Total Basis / 1,464,738,304 UST on a Net Basis during May 8 to May 10 to defend the UST price peg.*

VI. Acquisition of Historical Trading and Account Data

40. TFL provided JSH with authentication keys required to access certain accounts via their secure, internet-based Application Programming Interfaces (“APIs”) for the following exchanges: Binance, KuCoin, and Bitfinex. Each API provided a unique structuring of the historical data for each account. JSH developed custom Python scripts to systematically access and acquire a valid copy of all historical trading data dating back to December 31st, 2021.

41. The APIs allow the retrieval of trade, withdrawal, and deposit data for transactions that occurred between a window specified by start and end times. JSH divided the time range between December 31st, 2021, through September 15th, 2022, into 3-hour intervals. Each interval was queried in turn for the corresponding trades. If the number of trades returned was equal to the stated maximum, the interval was further divided into 30-minute sub intervals and the process repeated on each, recursively. The minimum time interval required was 10 milliseconds.

42. Using this approach, it is possible that, because the end time for one interval is the start time for the next, duplicative transactions were pulled for two different intervals. We used each trade’s unique ID to remove duplicative transactions.

43. The results of the acquisition runs were each stored in compressed files. Python scripts were developed to normalize and merge the data sets. JSH used the bcp utility to ingest the compressed files into a Microsoft SQL Server database.

VII. Data Validation Between Acquisitions

44. **Time Zone.** JSH needed to normalize time to Coordinated Universal Time (“UTC”). Any data received from TFL was provided in Korea Standard Time (UTC+9). All times had 9 hours subtracted to equate to UTC time. The API collected time was acquired in Eastern Standard Time (UTC-5) and Eastern Daylight Time (UTC-4). Records before March 13, 2022, 2:00AM had 5 hours added to equate to UTC time. Records after March 13, 2022, had 4 hours added to equate to UTC time.

45. **Trade Pairs.** JSH retrieved a distinct list of traded coin pairs. For each coin pair, the total number of trades received from TFL was compared against the data pulled through the API. In addition to the number of trades, a total count of coin trades for each pair was summed and compared.

46. **Transaction Date.** JSH tallied and compared the total number of all trades for each day.

VIII. Conclusion

47. Based on our independent investigation, we conclude that:

(1) From May 8 to May 12, 2022, LFG and TFL used the following assets to defend the UST Price Peg.

- a. On May 8th, LFG directly sold 26,281,671 USDT and 23,555,590 USDC to buy 50,200,071 UST.³¹
- b. Between May 9th and May 10th, LFG transferred a total of 52,189 BTC from its reserves to Jump Trading for Jump to purchase UST.³²
- c. From May 8th through May 10th, on a Total Basis TFL purchased a total of 1,901,559,334 UST through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex) as well as through its TFL curve bots 1 and 2. These purchases had the contemporaneous market value of \$1,773,199,279 U.S. dollars. During this period, using a Net Basis, TFL purchased a net total of 1,464,738,304 UST through its cryptocurrency exchange accounts (Binance, KuCoin, and Bitfinex) as well as through its TFL curve bots 1 and 2. These purchases had the contemporaneous market value of \$1,375,600,151 U.S. dollars.
- d. Also, on May 10, TFL received a total of 33,206 BTC from LFG as a reimbursement for a portion of the assets TFL spent defending the peg. LFG transferred 28,206 BTC to TFL's Binance account and Jump transferred 5,000 BTC to the same account (313 BTC that had not been used was returned to LFG's wallet). The total amount of 33,206 BTC³³ had the contemporaneous market value of \$1,030,427,532 U.S. dollars.

Thus, based on the total UST purchased, TFL spent \$742,771,747 U.S. dollars more than it received from LFG to purchase UST in defense of the UST Price Peg. For the same period, using a total net amount of UST purchased, TFL spent \$345,172,619 U.S. dollars more than it received from LFG to purchase UST in defense of the UST Price Peg.

- e. Additionally, between May 8th and May 11th, using TFL's own funds, TFL purchased a total of 23,053,022 LUNA on a Total Basis, with a contemporaneous value of \$1,001,864,982 U.S. dollars. Under the Net Basis, TFL purchased a total of 7,780,065 LUNA, with a contemporaneous value of \$268,444,270 U.S. dollars.

In total, TFL spent **\$1,744,636,729 U.S. dollars on a total purchase basis** or **\$613,616,889 U.S. dollars on a net purchase basis** of its own in defense of the UST price peg.

(2) The LFG May 16 Tweets provided an accurate accounting of LFG's asset balances on May 7 and May 16.

³¹ See Exhibit 2.

³² See Exhibit 3.

³³ See Exhibit 3.

Holding Name	Beginning Balance	Ending Balance
BTC	80,394	313
BNB	39,914	39,914
USDT	26,281,671	0
USDC	23,555,590	0
AVAX	1,973,554	1,973,554
UST	697,344	1,847,079,725
LUNA	1,691,261	222,713,007

- a. LFG (through TFL and Jump’s purchases on LFG’s behalf) used approximately 80,000 BTC, 26,281,671 USDT, and 23,555,590 USDC in the LFG Reserve to purchase UST and to defend the peg.
- b. We confirmed that the first and last May 16 tweets, which reported the balances as of May 7 and May 16, respectively, are accurate.

(3) The measures recounted in the LFG May 16 Tweets included estimates that did not affect the calculation of the ending balances.

- a. Each of LFG’s May 16 Tweets about the details of the UST Price Peg defense operations are factually accurate, except for Tweet #6 and Tweet #7.
- b. Tweet #6 listed the amount of UST purchased by LFG as (1,164,018,521 UST).
- c. The reported number was an estimate of UST that had been calculated as follows:

The 33,206 BTC that LFG transferred to TFL multiplied by an average BTC price of \$29,663 which equaled \$984,989,578 U.S. dollars.

\$984,989,578 U.S. dollars was then divided by the average UST price of \$0.846197513 resulting in the 1,164,018,521 UST used in the tweet.

- d. This estimated amount did not affect our analysis and confirmation that the beginning and ending balances were correct.

48. Jump transferred 1,515,689,462 UST on behalf of LFG, to TFL. The addition of what TFL purchased + Jump’s transferred amount of UST equaled the estimated 2,601,740,975 UST. We then confirmed that TFL transferred 1,796,182,310 UST to LFG. The resulting amount of 1,796,182,310 UST + LFG’s original balance of 697,344 UST + the 50,200,071 UST that LFG converted from USDT + USDC equals the ending balance of 1,847,079,725 UST.

EXHIBIT 1

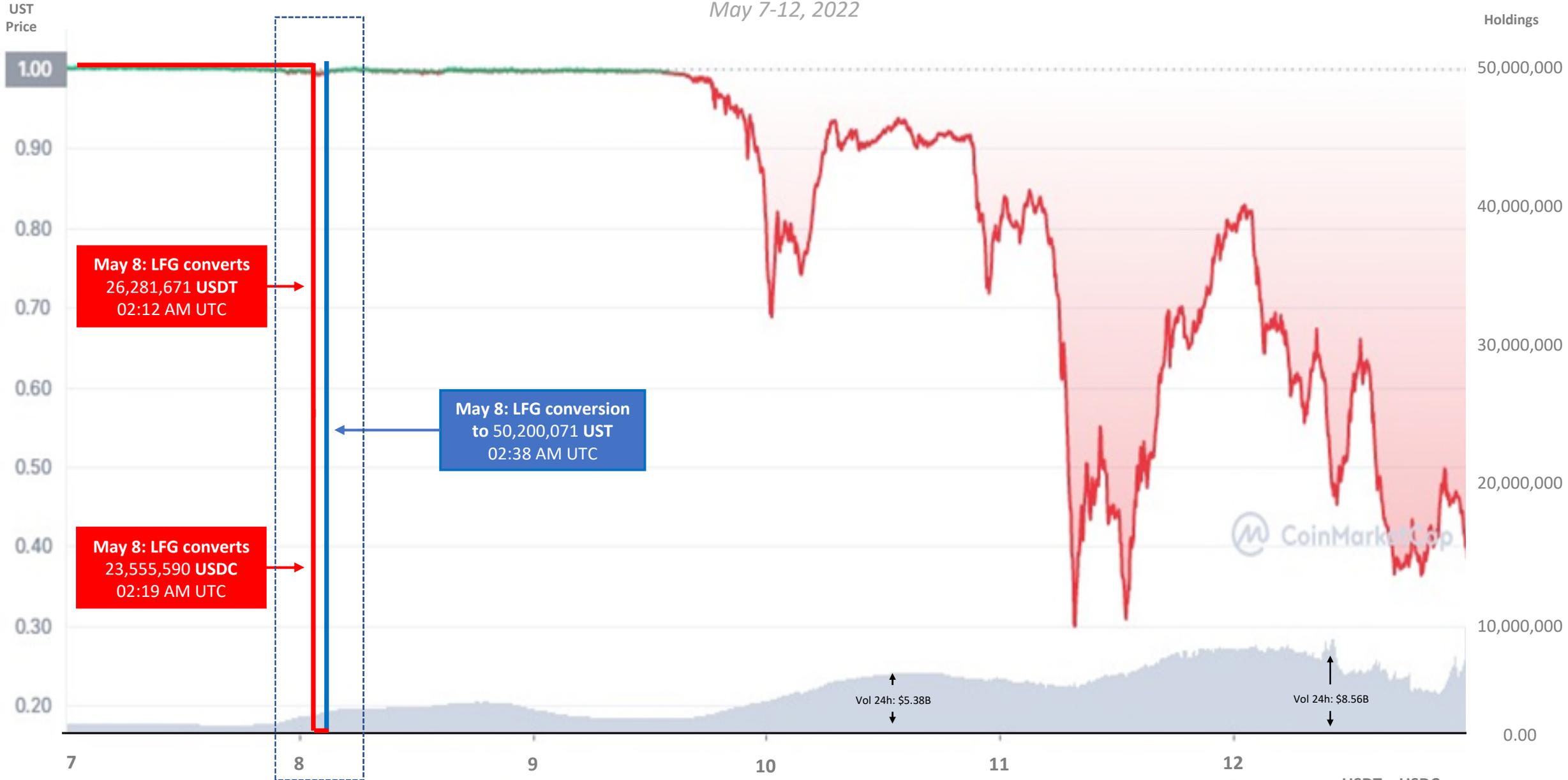
(Removed)

EXHIBIT 2

LFG Holdings (USDT+USDC) +UST Price

November 9, 2022

May 7-12, 2022



Price: A coin's price is calculated by taking the volume weighted average of all market pair prices reported for the cryptoasset.

Volume: The volume for each market pair is calculated by taking the 24h volume reported directly from the exchange in quote units and converting it to USD using CoinMarketCap's existing reference prices.

— USDT + USDC
— UST

LFG Holdings: USDT+USDC=UST Activity

November 9, 2022

May 8, 2022

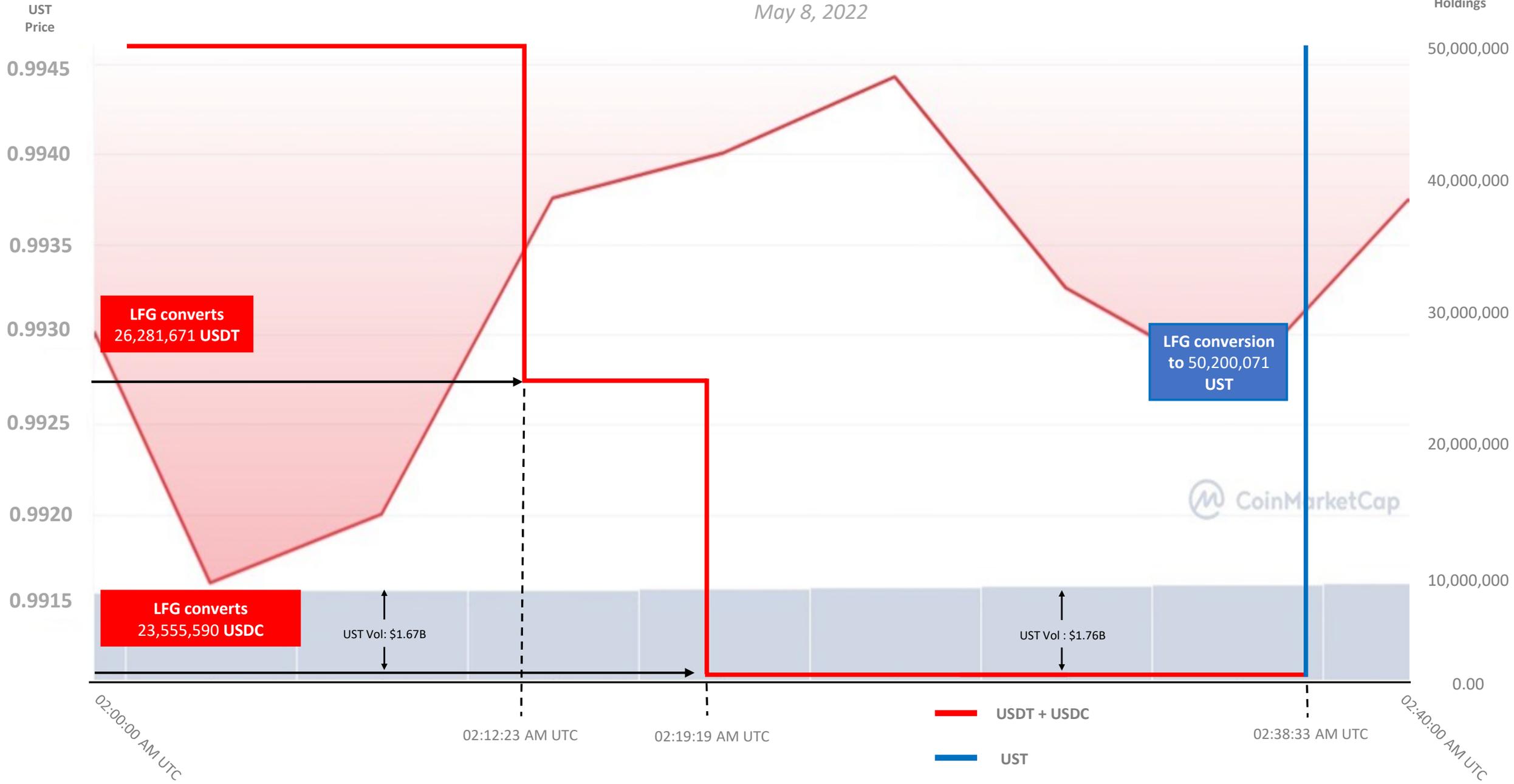
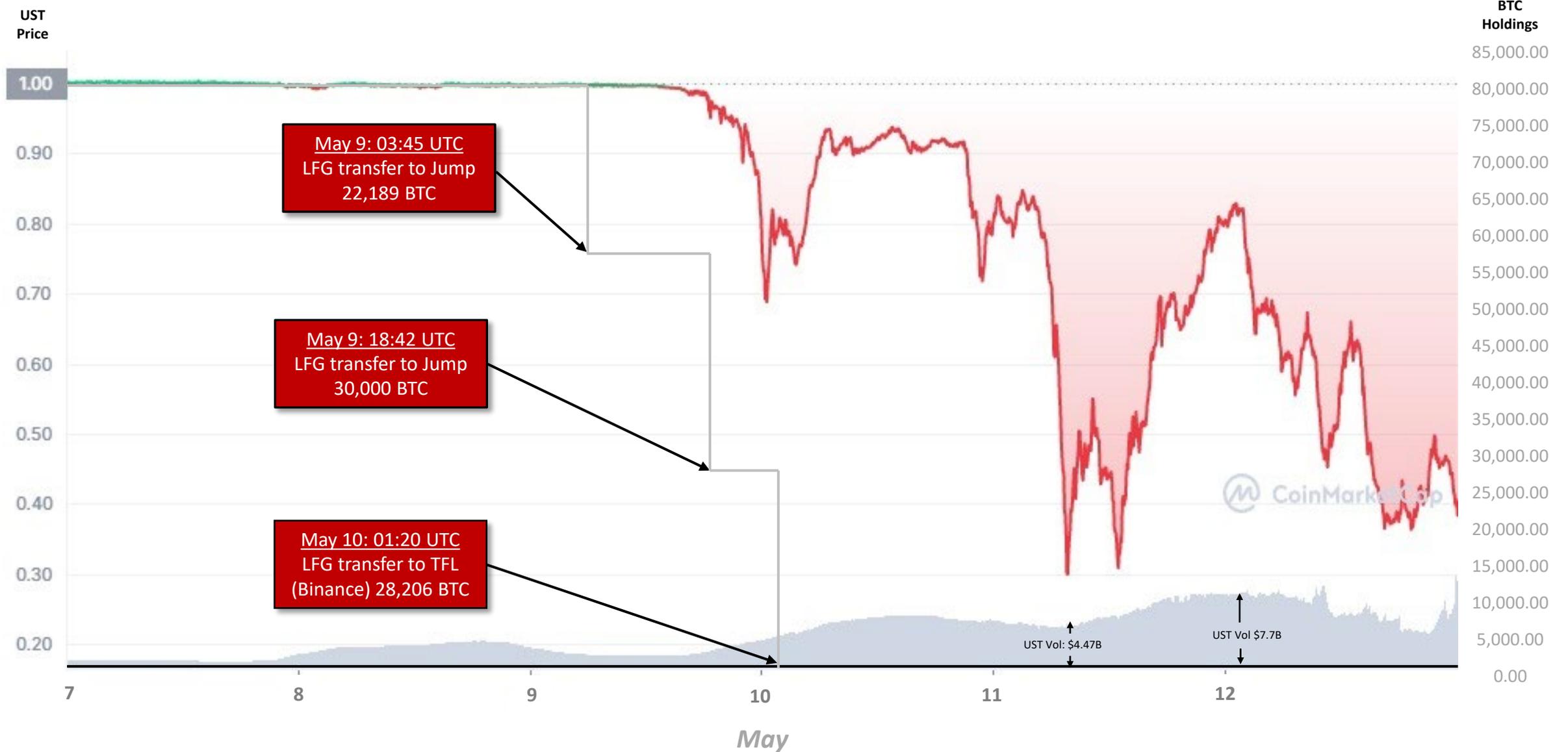


EXHIBIT 3

LFG Holdings (BTC) + UST Price

November 9, 2022

May 7 -12, 2022



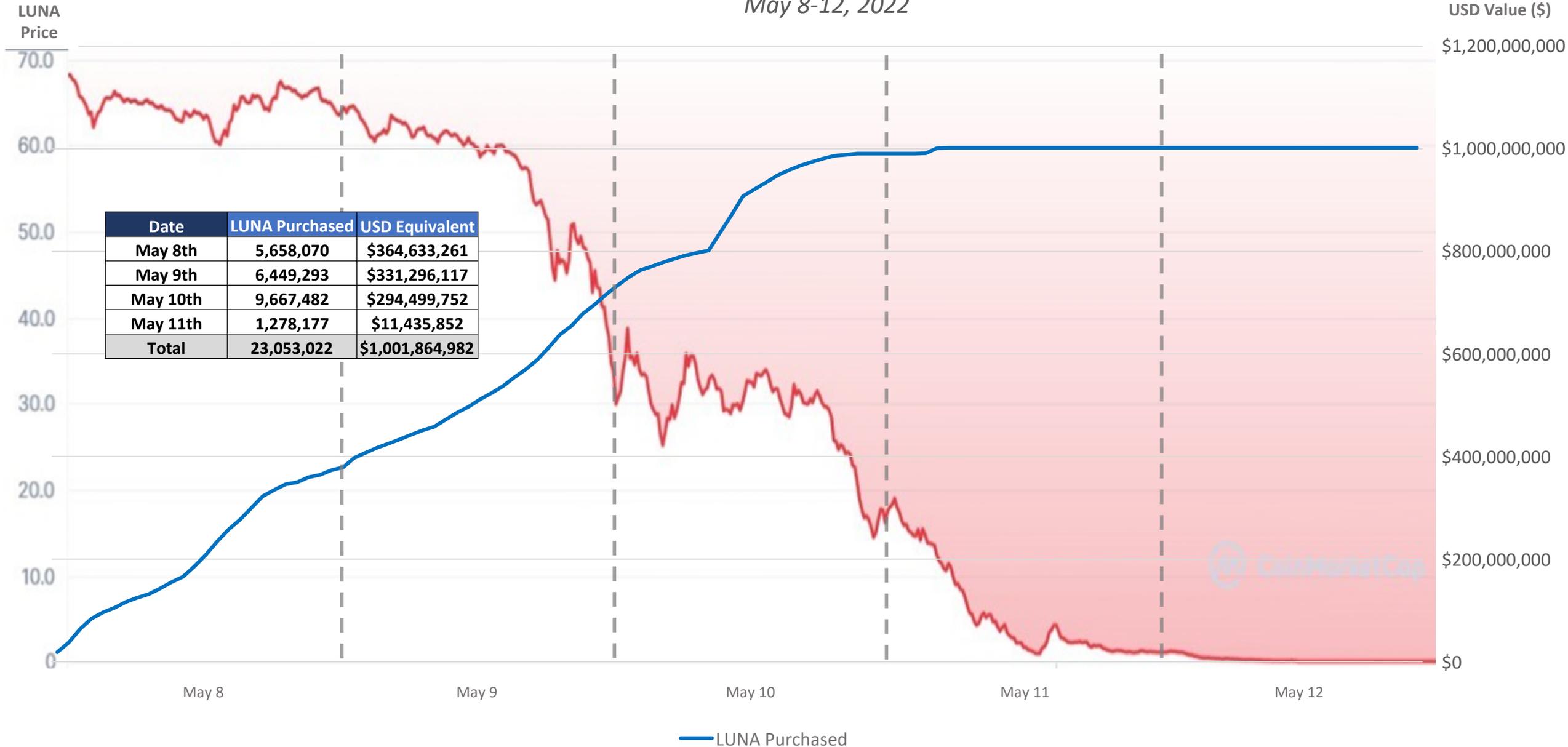
*There is a remaining balance of 313 BTC that was transferred by TFL to LFG on May 14 to LFG wallet ~lyr.

EXHIBIT 4

LUNA Total Purchases by TFL

November 9, 2022

May 8-12, 2022



CalMarketCap

LUNA Net Purchases by TFL

November 9, 2022

May 8-12, 2022

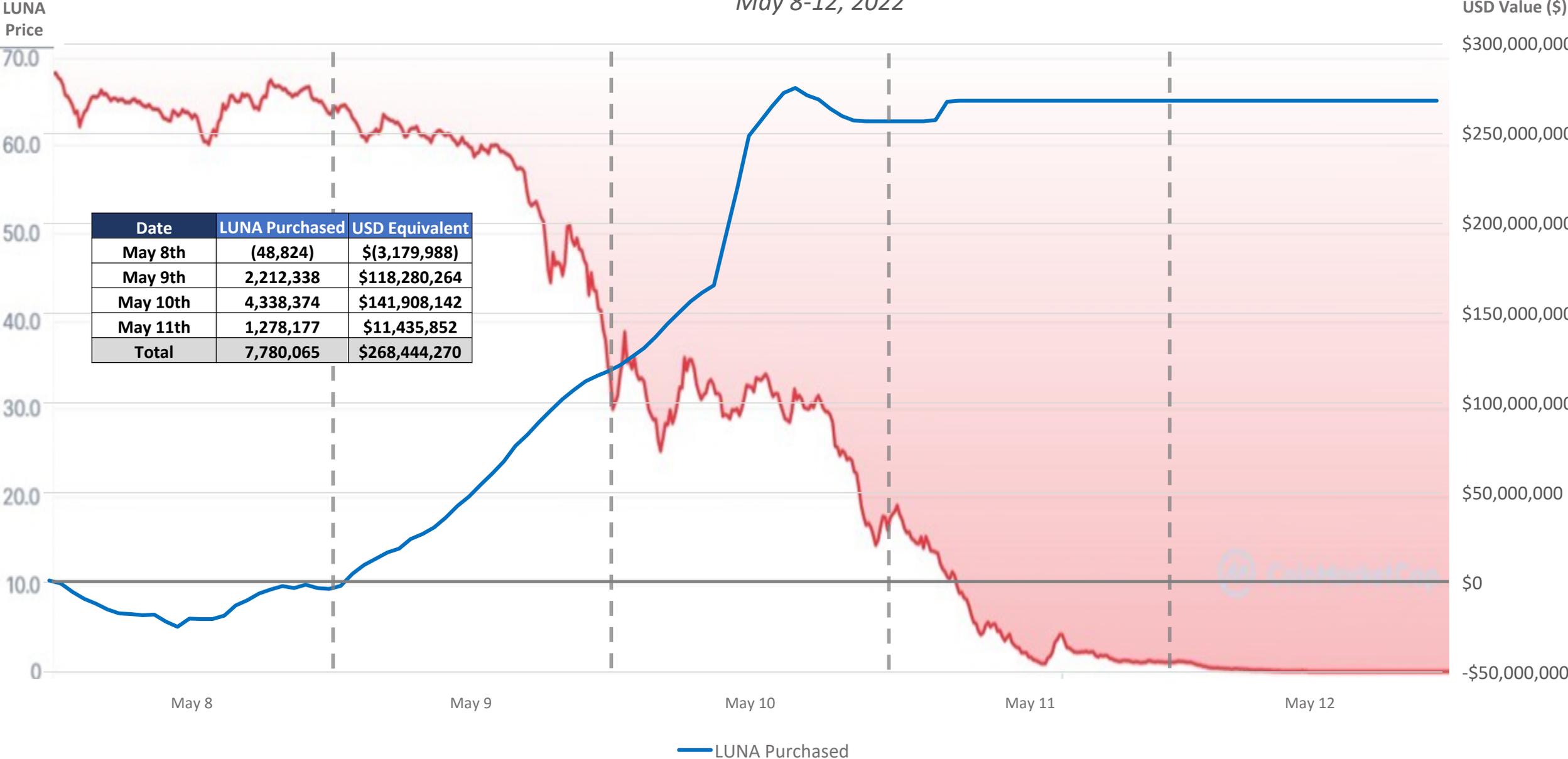


EXHIBIT 5

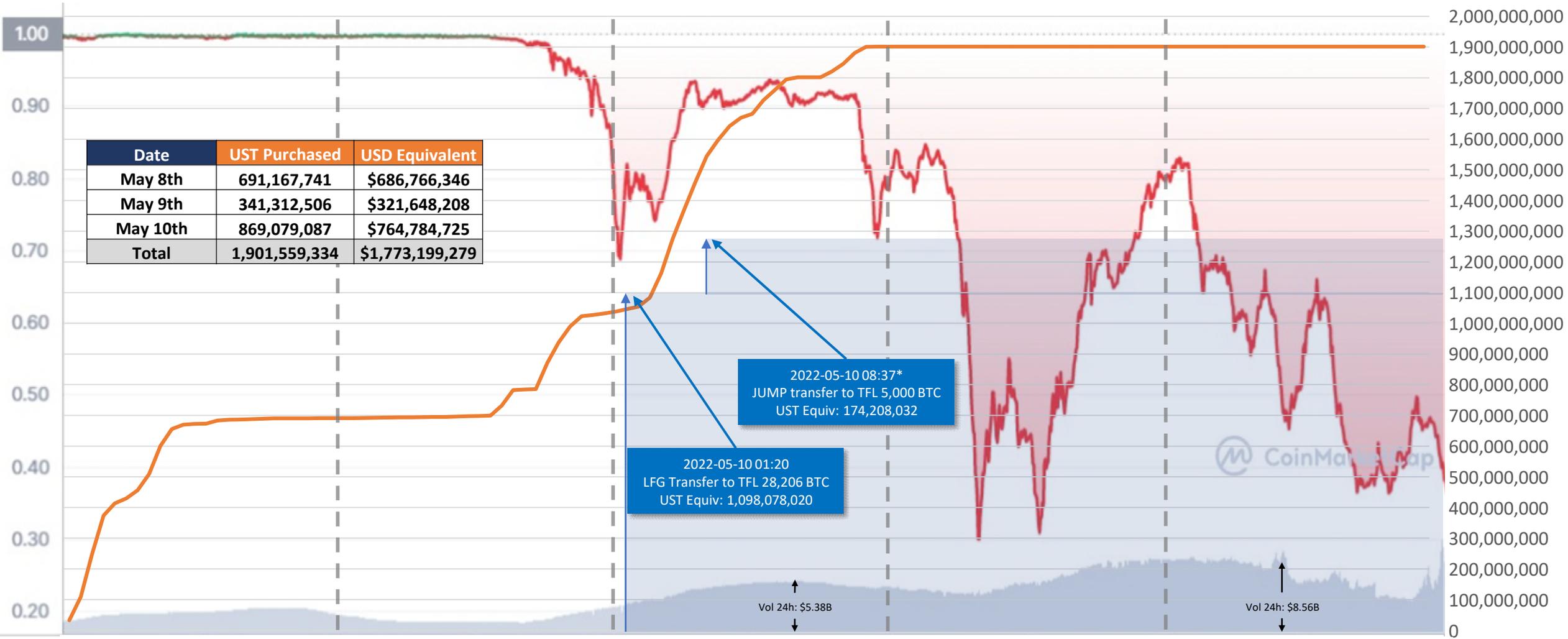
TFL Total Purchases of UST

November 9, 2022

May 8 -12, 2022

UST Price

Volume



Date	UST Purchased	USD Equivalent
May 8th	691,167,741	\$686,766,346
May 9th	341,312,506	\$321,648,208
May 10th	869,079,087	\$764,784,725
Total	1,901,559,334	\$1,773,199,279

2022-05-10 01:20
LFG Transfer to TFL 28,206 BTC
UST Equiv: 1,098,078,020

2022-05-10 08:37*
JUMP transfer to TFL 5,000 BTC
UST Equiv: 174,208,032

Vol 24h: \$5.38B

Vol 24h: \$8.56B



Circulating Supply 18.7 billion UST

May 9 18.6 billion UST

May 10 17.4 billion UST

May 11 13.3 billion UST

May 12 11.4 billion UST

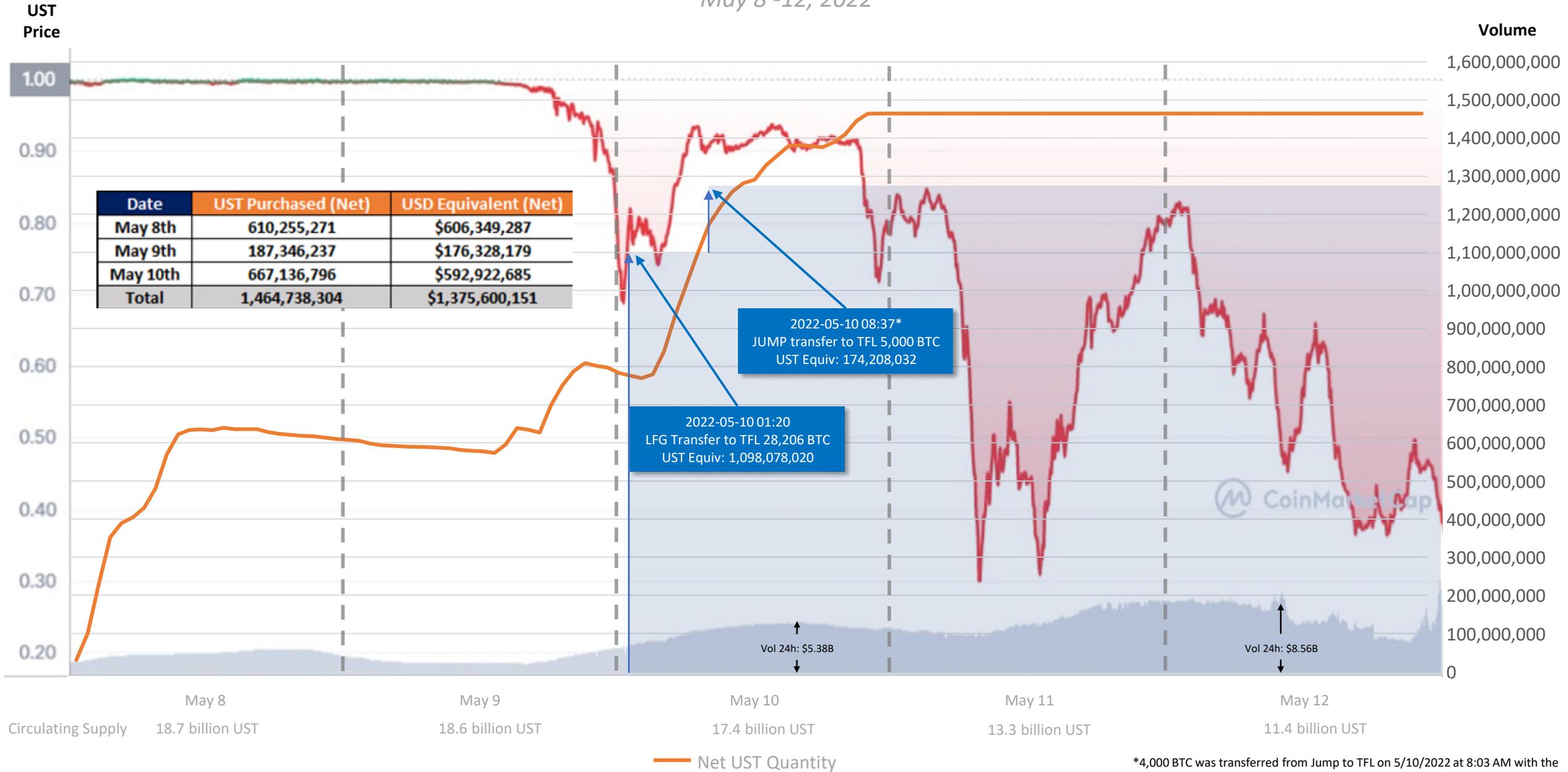
— Total UST Quantity

*4,000 BTC was transferred from Jump to TFL on 5/10/2022 at 8:03 AM with the final 1,000 BTC transferred at 8:37 AM for a total of 5,000 BTC.

TFL Net Purchases of UST

November 9, 2022

May 8 -12, 2022



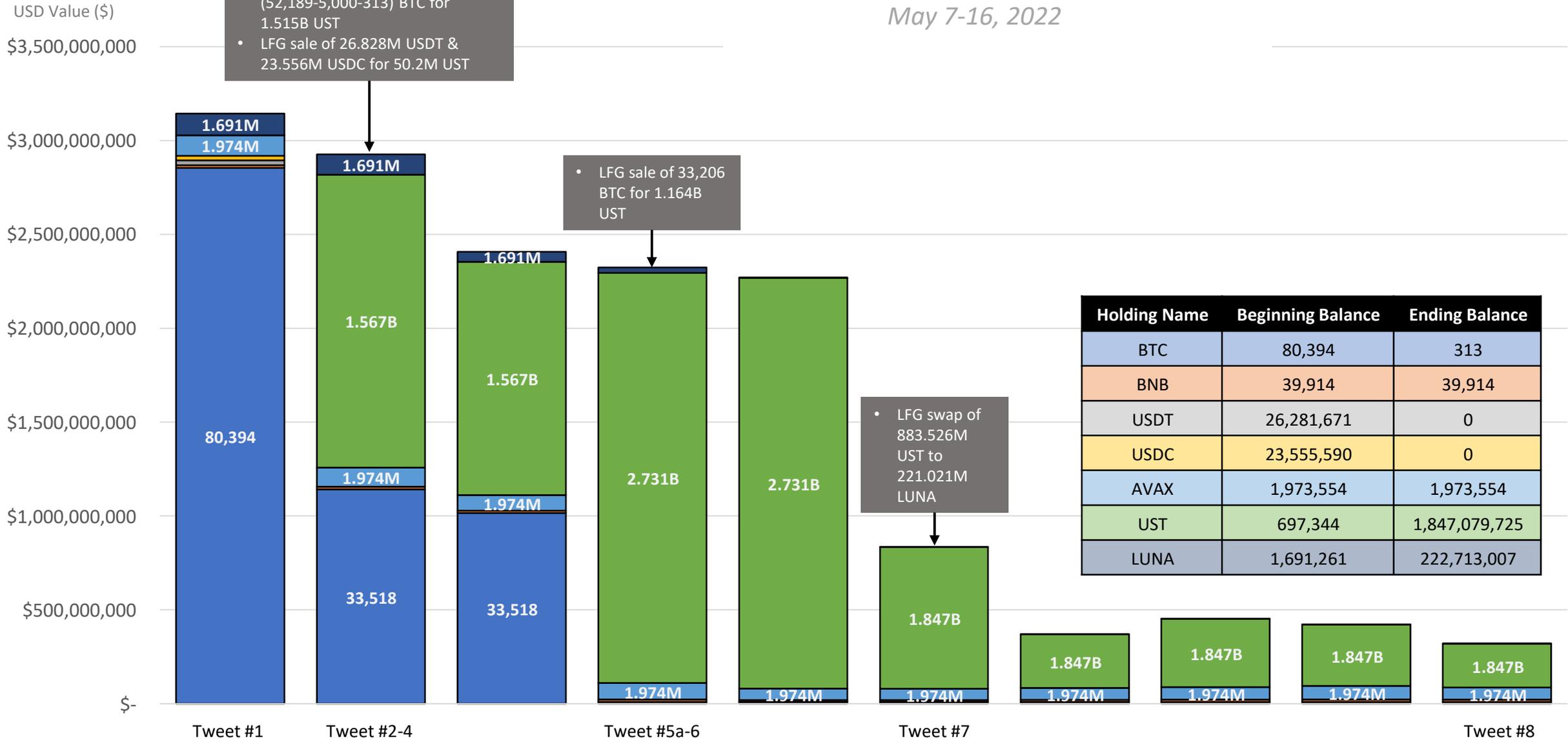
*4,000 BTC was transferred from Jump to TFL on 5/10/2022 at 8:03 AM with the final 1,000 BTC transferred at 8:37 AM for a total of 5,000 BTC.

EXHIBIT 6

LFG Balances—Tweets (by Tweet)

May 7-16, 2022

November 9, 2022



	Tweet #1	Tweet #2-4	Tweet #5a-6	Tweet #7	Tweet #8					
BTC Price	\$35,501.95	\$34,059.26	\$30,296.95	\$31,022.91	\$28,936.36	\$29,047.75	\$29,283.10	\$30,101.27	\$31,305.11	\$29,862.92
UST Price	\$0.9969	\$0.9964	\$0.7934	\$0.7999	\$0.8011	\$0.4086	\$0.1540	\$0.1964	\$0.1767	\$0.1264
LUNA Price	\$68.25	\$64.08	\$32.00	\$17.52	\$1.07	\$0.00017	\$0.000102	\$0.000459	\$0.000215	\$0.000196