

Before the  
**FEDERAL COMMUNICATIONS COMMISSION**  
Washington, DC 20554

In the Matter of )  
)  
**WorldVu Satellites Limited** ) IBFS File No. SAT-LOI-20170301-00031  
)  
Petition for Declaratory Ruling )  
Granting Access to the U.S. Market )  
for the OneWeb V-Band System )

**CONSOLIDATED RESPONSE OF WORLDVU SATELLITES LIMITED**

WORLDVU SATELLITES LIMITED

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**CONSOLIDATED RESPONSE OF WORLDVU SATELLITES LIMITED**

WorldVu Satellites Limited d/b/a OneWeb (“OneWeb”), pursuant to Section 25.154(c) of the Commission’s rules, hereby responds (“Response”) to the various pleadings filed in connection with OneWeb’s above-captioned petition for U.S. market access in the V-band (“V-band Petition”).<sup>1</sup>

**I. INTRODUCTION AND SUMMARY**

As described in the V-band Petition, the OneWeb V-band system will be an integral part of Commission-led efforts to close the digital divide. OneWeb has reviewed the comments filed with respect to the V-band Petition. In particular, OneWeb notes that:

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<sup>1</sup> See Comments of SES S.A. and O3b Limited, IBFS File No. SAT-LOI-20170301-00031 (filed July 17, 2017) (“SES/O3b Comments”); Letter from Jennifer A. Manner, Senior Vice President, Regulatory Affairs and Brennan Price, Senior Principal Engineer, Regulatory Affairs, Hughes Network Systems, LLC to Marlene H. Dortch, Secretary, FCC, *Re: Applications and U.S. Market Access Petitions for Q/V-band NGSO Systems*, IBFS File No. SAT-LOI-20170301-00031, *et al.* (July 17, 2017) (“Hughes Comments”); Comments of Space Exploration Holdings, LLC, IBFS File No. SAT-LOI-20170301-00031 (filed July 17, 2017) (“SEH Comments”); Consolidated Comments of Telesat Canada, IBFS File No. SAT-LOI-20170301-00031 (filed July 17, 2017) (“Telesat Comments”); Consolidated Comments of ViaSat, Inc., IBFS File No. SAT-LOI-20170301-00031 (filed July 17, 2017) (“ViaSat Comments”).

- Several commenters highlight the need for GSO and NGSO systems alike to work together to share V-band spectrum; OneWeb agrees and will coordinate in good faith with other operators to ensure an interference-free environment;
- OneWeb has provided all required information regarding its V-band operations as required by Part 25 of the Commission’s rules;
- Consistent with the Commission’s rules, OneWeb’s orbital debris mitigation plans will remain subject to the direct and effective oversight of the U.K. Space Agency, as was the case with OneWeb’s now-authorized Ku/Ka-band constellation; and
- Space Exploration Holdings’ statement that deployment of a small number of U.S. gateway stations raises interference concerns is unsupported and inaccurate.

No commenter suggested that the V-band Petition did not comply with the Commission’s Part 25 rules or other requirements for U.S. market access. Accordingly, OneWeb reiterates its position that grant of the V-band Petition is in the public interest.

## **II. ONEWEB INTENDS TO COORDINATE WITH BOTH GSO AND NGSO OPERATORS USING V-BAND SPECTRUM**

Several commenters ask the Commission to ensure NGSO systems like OneWeb’s are able to share spectrum with GSO systems operating in the V-band.<sup>2</sup> OneWeb agrees that both NGSO and GSO operators must cooperate in order to ensure interference-free use of V-band spectrum. Under the current regulatory regime, there are no EPFD limits applicable to NGSO operations in the V-band. Article 22.2 of the ITU’s Radio Regulations appropriately requires NGSO systems to protect GSO systems from unacceptable interference,<sup>3</sup> which has historically occurred via direct bilateral coordination between NGSO and GSO operators when no other regime (such as EPFD limits) was in place. Therefore, OneWeb will coordinate in good faith

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<sup>2</sup> See Hughes Comments at 2; SES/O3b Comments at 3-4; ViaSat Comments at 5-6.

<sup>3</sup> Int’l Telecomm. Union [ITU], Radio Regulations, Vol. 1, Ch. VI, Article 22.2 (RR22-1) (2016).

with the operators of future V-band GSO systems to the extent the rules developed by the Commission require coordination, or will abide by any limits (such as EPFD limits) developed for NGSO operators in the V-band by the Commission or the ITU.<sup>4</sup>

Some commenters suggest the Commission initiate a rulemaking proceeding to adopt EPFD limits on NGSO operations in the V-band and, in the meantime, condition grant of NGSO V-band applications on compliance with interim EPFD limits (potentially based on Article 22 of the ITU's Radio Regulations).<sup>5</sup> The Commission's rules have generally tracked the ITU's adoption of rules based on extensive technical studies and input from affected administrations. Adopting interim EPFD limits before the ITU has adopted NGSO-GSO sharing rules would be premature and could unnecessarily stymie the nascent, innovative uses of V-band spectrum proposed by OneWeb and other NGSO FSS constellations. Furthermore, there is currently no sound technical basis for establishing interim EPFD limits. Undertaking the studies necessary to calculate such interim limits in parallel with the ITU-R preparatory work would be duplicative and an inefficient use of Commission resources, especially since there are unlikely to be a substantial number of GSO V-band networks in operation within the next three years.

Instead, OneWeb supports the ongoing work occurring through relevant ITU-related forums. A number of proposals based on different methods of protecting GSO operations have been put forward thus far, and these proposals should be fully evaluated instead of simply

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<sup>4</sup> Ongoing technical studies in relation to WRC-19 Agenda Item 1.6 contemplate EPFD limits or other measures to ensure that both NGSO and GSO systems are able to operate in the V-band. OneWeb believes that the continued development of these detailed technical studies will lead to the adoption of the most efficient sharing mechanisms in the V-band, and would urge the Commission not to adopt any rules before the ITU studies are completed.

<sup>5</sup> Hughes Comments at 2; SES/O3b Comments at 4; ViaSat Comments at 6.

adopting interim EPFD limits based on the EPFD values applicable to other frequency bands, which are likely to be ill-suited for the V-band.

OneWeb intends to comply with any coordination or sharing rules put in place for NGSO operators in the V-band. In this regard, OneWeb agrees with Telesat that the 10-degree default trigger angle in the Commission's rules is unworkable.<sup>6</sup> As OneWeb demonstrated in the current NGSO rulemaking proceeding, the 10-degree separation angle is not equally applicable to all NGSO FSS frequency bands and all types of earth stations.<sup>7</sup> A more flexible rule, such as one based on the ITU's  $\Delta T/T$  metric, is more appropriate to calculate the necessary separation angle for NGSO satellites seeking to operate simultaneously without resorting to band-splitting.<sup>8</sup>

### **III. NO FURTHER INFORMATION IS REQUIRED FROM ONEWEB IN ORDER FOR THE COMMISSION TO GRANT THE V-BAND PETITION**

#### **A. The Description of the OneWeb V-band System is Thorough and Consistent With Commission Rules**

Space Exploration Holdings evidently overlooks much of the detailed information OneWeb has provided in its Petition, asserting that OneWeb's plans for its proposed V-band system should be "clarified."<sup>9</sup> In lieu of identifying specific information required by the

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<sup>6</sup> See 47 C.F.R. § 25.261(b).

<sup>7</sup> Telesat Comments at 3; Comments of OneWeb, *In re Updates to Part 2 and Part 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, IB Docket No. 16-408, at 14 (filed Feb. 27, 2017).

<sup>8</sup> *Id.* Some commenters in the NGSO rulemaking proceeding have misunderstood OneWeb's proposal as requiring the calculation of  $\Delta T/T$  values to be used as a coordination threshold, so that coordination between NGSO operators would be required only if the 6% value is exceeded. To clarify, OneWeb proposes that all NGSO FSS systems that plan to operate in the same frequency band be subject to frequency coordination, as currently required by the ITU Radio Regulations. OneWeb proposes to use the  $\Delta T/T$  metric after coordination has commenced, so that if the 6% value has been satisfied, coordination is deemed complete and there is no need to resort to band segmentation.

<sup>9</sup> SEH Comments at 2.

Commission’s rules, Space Exploration Holdings offers a blanket, unsupported assertion that “[t]here remains much the Commission does not know about OneWeb’s plans for the operation and deployment of its NGSO system” and requests the Commission to require OneWeb to provide additional information regarding its proposed V-band constellation.<sup>10</sup> Contrary to Space Exploration Holdings’ assertion, the components and anticipated operational characteristics of the OneWeb V-band system are clearly and accurately described in the V-band Petition.<sup>11</sup> Space Exploration Holding’s request is unsupported and misguided.

Nonetheless, OneWeb takes this opportunity to restate the expected deployment parameters for its proposed V-band constellation. As OneWeb described in the V-band Petition, the OneWeb V-band system will involve a “720-satellite LEO constellation as well as a larger 1,280-satellite MEO constellation.”<sup>12</sup> For the LEO constellation, the same satellite bus will support separate V-band and Ku/Ka-band payloads. Although OneWeb described its V-band System as a “second generation constellation,” this does *not* mean that no V-band-capable satellite will be launched until all of OneWeb’s recently-authorized 720-satellite Ku-/Ka-band constellation is launched and in orbit.<sup>13</sup> Rather, “second generation” is a reference to the evolving, iterative nature of OneWeb’s innovative NGSO FSS constellation, the “first

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<sup>10</sup> SEH Comments at 2, 3.

<sup>11</sup> See V-band Petition at 8-10; Attachment A, Technical Information to Supplement Schedule S at 1-12 (“Technical Annex”).

<sup>12</sup> V-band Petition at 8; Technical Annex at 1-2.

<sup>13</sup> See *WorldVu Satellites Limited*, Order and Declaratory Ruling, IBFS File No. SAT-LOI-20160428-00041, FCC 17-77 (rel. June 23, 2017) (“OneWeb Declaratory Ruling”).

generation” of which is currently under construction.<sup>14</sup> OneWeb may begin incorporating V-band payloads into its production satellites at any time after it has obtained the necessary regulatory approvals. Therefore, it is possible that the first OneWeb satellite containing a V-band payload could be launched in conjunction with some of the satellites in the 720-satellite Ku/Ka-band constellation recently authorized in the OneWeb Declaratory Ruling – for example, by changing the production line from one that has a Ku- and Ka-band–only payload to one that also adds V-band equipment. Despite Space Exploration Holdings’ evident apprehension over OneWeb’s deployment schedule, there will simply be no “rapid turn-over” of the OneWeb constellation.<sup>15</sup> Any turn-over will be a gradual process without operational impacts. OneWeb anticipates the deployment of the OneWeb V-band system will pose no unique or challenging coordination issues.<sup>16</sup>

The description of the OneWeb V-band system provided in the V-band Petition is complete, accurate, and sufficient for the Commission and any interested parties to evaluate whether granting market access for the OneWeb V-band system is in the public interest. The information provided herein reaffirms that Space Exploration Holdings’ apparent concern over an alleged lack of information describing the OneWeb V-band system is unfounded.

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<sup>14</sup> See, e.g., Press Release, *OneWeb Satellites Inaugurates Serial Production Line for the Assembly, Integration, and Test of OneWeb's First Satellites* (June 27, 2017), available at: <http://oneweb.world/press-releases/2017/oneweb-satellites-breaks-ground-on-the-worlds-first-state-of-the-art-high-volume-satellite-manufacturing-facility>.

<sup>15</sup> SEH Comments at 2.

<sup>16</sup> Similarly, Space Exploration Holdings asks OneWeb to “explain how it intends to deploy a total of 2,000 V-band LEO/MEO satellites within the six-year deployment window” without requesting a waiver of the Commission’s rules. *Id.* at 3. While this level of operational detail is not required by Section 25.164 of the Commission’s rules, OneWeb remains confident that it will procure sufficient launch capacity to satisfy the Commission’s applicable milestone rule, as it is currently doing for its Ku/Ka-band constellation. See 47 C.F.R. § 25.164(b).



**B. The Orbital Debris Mitigation Plan For the OneWeb V-band System Will Be Subject to the Direct and Effective Oversight of the United Kingdom**

Space Exploration Holdings' criticism of OneWeb's orbital debris mitigation plan for the OneWeb V-band system is unwarranted and demonstrates a misreading of the Commission's orbital debris rules.<sup>17</sup> Unlike Space Exploration Holdings, OneWeb is not a U.S. licensee. In the V-band Petition, OneWeb noted that the OneWeb V-band system "will be a UK-licensed satellite system" and OneWeb will be "pursuing a launch and space operations license from the United Kingdom."<sup>18</sup>

Consistent with Section 25.114(d)(14)(v), the Commission granted OneWeb's U.S. market access application subject to the requirement that it remain subject to direct and effective orbital debris regulation by the United Kingdom.<sup>19</sup> Moreover, the Commission's grant of U.S. market access to the OneWeb constellation "remain[s] effective only to the extent that launch and space operations continue to be authorized by the United Kingdom Space Agency under the United Kingdom Outer Space Act," which necessarily involves the approval of OneWeb's orbital debris mitigation plans.<sup>20</sup> Like that grant, OneWeb's application for a launch and space operations license for the OneWeb V-band system will also be subject to the direct and effective oversight of the UKSA. To the extent the Commission separately requests OneWeb to provide additional information regarding its orbital debris mitigation plans, OneWeb will of course

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<sup>17</sup> SEH Comments at 3-4.

<sup>18</sup> V-band Petition at 11.

<sup>19</sup> 47 C.F.R. § 25.114(d)(14)(v); OneWeb Declaratory Ruling, Condition 25(c) at 13 ("Satellite operations must be subject to direct and effective regulation by the United Kingdom concerning orbital debris mitigation.").

<sup>20</sup> *Id.*, Condition 24(f).

promptly respond to such an inquiry. OneWeb remains committed to maintaining its status as an industry leader on issues of debris mitigation and orbital safety.

#### **IV. ONEWEB’S PLANNED GATEWAY EARTH STATION DEPLOYMENTS DO NOT CREATE AN UNREASONABLE RISK OF IN-LINE INTERFERENCE EVENTS**

##### **A. The Number of Planned Gateways is Sufficient to Support OneWeb’s Broadband Services and Minimize Interference with Respect to Other Systems**

OneWeb has planned the number of its gateway earth station sites to provide the requisite level of service while ensuring sufficient gateway diversity to mitigate the possibility of interference to GSO networks and other NGSO networks.<sup>21</sup> However, Space Exploration Holdings suggests that OneWeb’s proposal to deploy approximately four V-band gateways in the U.S. will increase interference issues with other NGSO operators.<sup>22</sup> Space Exploration Holdings’ criticisms are incorrect and reflect a fundamental misunderstanding of OneWeb’s proposed V-band system.

*First*, Space Exploration Holdings suggests that satellite beams pointing toward OneWeb’s four proposed gateway earth station sites in the U.S. may not be able to “sufficiently mitigate their collective adjacent-channel interference to allow transmissions by other NGSO system operators during band-splitting events.”<sup>23</sup> By “band-splitting events,” OneWeb assumes

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<sup>21</sup> As noted in the V-band Petition, at this time OneWeb anticipates deploying approximately four U.S. gateway stations. *See* V-Band Petition at 9-10.

<sup>22</sup> SEH Comments at 5-8.

<sup>23</sup> SEH Comments at 6. OneWeb notes there is no need to address Space Exploration Holdings’ comments on the design of OneWeb’s Ku-band beams, which were thoroughly addressed in a previous comment cycle for OneWeb’s now-granted petition for U.S. market access and have no relevance to the Commission’s review of the V-band Petition. *See* SEH Comments at 5; *Opposition and Response of WorldVu Satellites Limited*, IBFS File No. SAT-LOI-20160428-00041, at 8-11 (filed Aug. 25, 2016).

Space Exploration Holdings is referring to an in-line interference event situation where the two NGSO operators cannot mitigate interference and thus would split the available frequencies between them. If such a case arises, only one of the potentially interfering OneWeb satellites (*i.e.*, the one with the in-line geometry) would reduce its transmissions to only half of the band; all other visible OneWeb satellites would be using the full frequency band. Space Exploration Holdings' victim receiving earth station would rely on its off-axis gain discrimination to protect itself from interference from all of these other visible satellites at all times, whether there is an in-line event or not. Space Exploration Holdings' reference to the in-line event situation therefore appears to be irrelevant.

The situation described above is a co-channel interference situation for three of the four gateways, rather than an adjacent-channel interference situation as Space Exploration Holdings asserts. An adjacent-channel interference situation would only result when a single OneWeb satellite operates in a portion of the frequency band during an in-line event (assuming other mitigation techniques are not employed). If that is the situation Space Exploration Holdings intended to raise, it has nothing to do with how many U.S. gateways are used by OneWeb and would also be irrelevant. OneWeb has proposed a very small number of gateway earth stations using very narrow beams and will be prepared to coordinate with other operators as their system designs mature.

*Second*, Space Exploration Holdings argues that deploying only four U.S. gateways will require OneWeb to operate its gateway beams at low minimum elevation angles to those gateways, enlarging the geographic area over which interference may occur.<sup>24</sup> While it is

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<sup>24</sup> SEH Comments at 6. Space Exploration Holdings' Comments refer to "very high steering angles" of 15 and 25 degrees. OneWeb assumes Space Exploration Holdings actually means

certainly true that the footprint of any satellite may cover a larger geographic area at low elevation angles than at high ones, this does not mean operation at lower minimum elevation angles creates a significantly larger *beam footprint* (as beam size could be kept constant) or creates an inefficient sharing regime with respect to other NGSO systems. If other NGSO operators have designed their systems with higher minimum elevation angles (as Space Exploration Holdings seems to suggest would be preferable), there would be no in-line interference events in situations where OneWeb's potentially interfering signal arrives at a low elevation angle.

If other NGSO operators are planning to use minimum elevation angles similar to OneWeb's, both operators have clearly contemplated the risk of in-line events based on the wide geographic spread at their gateway earth stations and are prepared to coordinate their operations with other NGSO systems or accept band segmentation during in-line events, if necessary.<sup>25</sup> In fact, given the relatively small number of gateway earth stations that each NGSO operator will likely deploy in the U.S., coordination should be simple, provided operators like Space Exploration Holdings are willing to share information about their proposed gateway locations in the course of bilateral coordination discussions. OneWeb stands ready to coordinate with other NGSO operators in the V-band based on the Commission's avoidance of in-line interference mechanism and any sharing rules the Commission may adopt in this band.

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"minimum elevation angles," as the values it cites from OneWeb's Petition are minimum elevation angles.

<sup>25</sup> See 47 C.F.R. § 25.261(c). As OneWeb acknowledged in its Petition, the V-band is currently subject to the band segmentation procedures set forth in 47 C.F.R. § 25.157(e). OneWeb sought a waiver of this rule and asked that it instead be permitted to share spectrum and coordinate with other NGSO operators. See OneWeb Petition at 28-30.

*Third*, OneWeb’s proposal for gateway earth station siting also has decisive benefits insofar as it minimizes the likelihood of interference with terrestrial services. The Commission has explored sharing between FSS users of the V-band and future 5G systems, and determined that reducing the number of FSS earth station sites in the U.S. is an important measure that can mitigate the impact of FSS systems on 5G systems.<sup>26</sup> OneWeb has determined that approximately four U.S. gateway sites would meet its deployment needs, minimize the impact on future 5G services, and enable it to avoid in-line events with the GSO arc and coordinate with other NGSO operators.

**B. Information-Sharing to Minimize In-Line Events Will Take Place Via Bilateral Coordination**

Space Exploration Holdings suggests that OneWeb should provide real-time pointing data for its beams in order to minimize in-line interference events.<sup>27</sup> While providing this data is possible in conjunction with the sharing of satellite ephemeris data in near real-time for feeder-link beams,<sup>28</sup> such data sharing is not possible for any NGSO operator that plans to use steerable beams to service ubiquitously-deployed user terminals or a large number of earth stations at undefined locations.

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<sup>26</sup> See *In re Use of the Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report & Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8049-51 ¶¶ 90-93 (2016) (noting that accommodating earth stations in the V-band requires drawing an “exclusion zone” to limit interfering signals from nearby terrestrial operators, and limiting the number of earth stations permitted per economic area in order to accommodate future 5G deployment).

<sup>27</sup> SEH Comments at 9.

<sup>28</sup> NGSO FSS operators in certain frequency bands are required to exchange ephemeris data to avoid in-line interference events, and this can potentially be supplemented to include satellite beam pointing data for gateway beams. See 47 C.F.R. § 25.271(e); *In the Matter of Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, 31 FCC Rcd 13651, 13661 at ¶ 24 (2016).

Space Exploration Holdings should recognize that OneWeb's network will operate with extremely precise and constantly changing beam pointing for its user beams. Beam pointing for user beams cannot be pre-planned, so orbital location data, if sent to other operators, would be received long after that particular location and frequency have been utilized. OneWeb cautions that any such complex system to exchange user-beam pointing information in real time would necessarily dictate the design of satellites and may cause the satellites to be heavier, less efficient, and more expensive, defeating the opportunity for the best satellite technologies to evolve and for low-cost broadband to be made available to rural and remote areas.

OneWeb would expect the exchange of any operational gateway or feeder-link beam pointing information to be discussed between NGSO operators during bilateral coordination in order to minimize mutual interference. Bilateral coordination has long been a very successful method for exchange of information between operators. During such bilateral coordination discussions, NGSO operators typically discuss the most efficient ways to coordinate their operations to mutually minimize interference, which can easily be applied to feeder-link earth station or gateway operations.

The size of the footprint of OneWeb's MEO satellites has nothing to do with the need for NGSO operators to engage in coordination discussions and information exchange, as this is required of all NGSO operators who may operate co-frequency. The actual beam size, particularly at high frequencies such as the V-band, will always be significantly smaller than the visibility footprint, whether it originates from a LEO or MEO satellite. Space Exploration Holdings' request that the FCC condition grant of OneWeb's Petition on providing this data is therefore inappropriate and would remove the necessary incentive for operators to fully cooperate to adopt interference mitigation measures during bilateral coordination.

## **V. CONCLUSION**

The OneWeb V-band system will bring transformative broadband services and applications to unserved and underserved populations and meaningfully contribute towards bridging the digital divide. The OneWeb V-band system is a natural evolution of its Ku/Ka-band system, for which authority has already been granted. As demonstrated in the V-band Petition and the instant Response, the OneWeb V-band system complies with all applicable Commission rules and is designed to operate without causing harmful interference or compromising orbital safety. Therefore, OneWeb respectfully submits that grant of the V-band Petition is in the public interest. OneWeb looks forward to building upon its leading role in the ongoing evolution of innovative, NGSO satellite-based connectivity.

Respectfully submitted,

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July 27, 2017



**CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING  
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I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this Response, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this Response, and that it is complete and accurate to the best of my knowledge and belief.

Dated: July 27, 2017

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**CERTIFICATE OF SERVICE**

I, Ashley Yeager, hereby certify that on this 27th day of July 2017, a copy of the foregoing Response is being sent via first class, U.S. Mail, postage paid, to the following:

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