

2 March 2026

Dr. Louise M. Prockter, Director  
Planetary Science Division  
Science Mission Directorate  
NASA Headquarters  
300 E Street, SW  
Washington, DC 20546

Dear Dr. Prockter:

I am pleased to submit the report of the 2026 Planetary Mission Senior Review (PMSR). On January 21 and February 11, 2026, representatives of the Mars 2020 mission presented their first Extended Mission (EM1) proposal and Responses to Questions to a review panel comprised of Subject Matter Experts.

Attached please find the 2026 PMSR Final Report, including the Panel Evaluation and Project Data Management Plan (PDMP) Evaluation of the extended mission proposal, as well as a list of panelists.

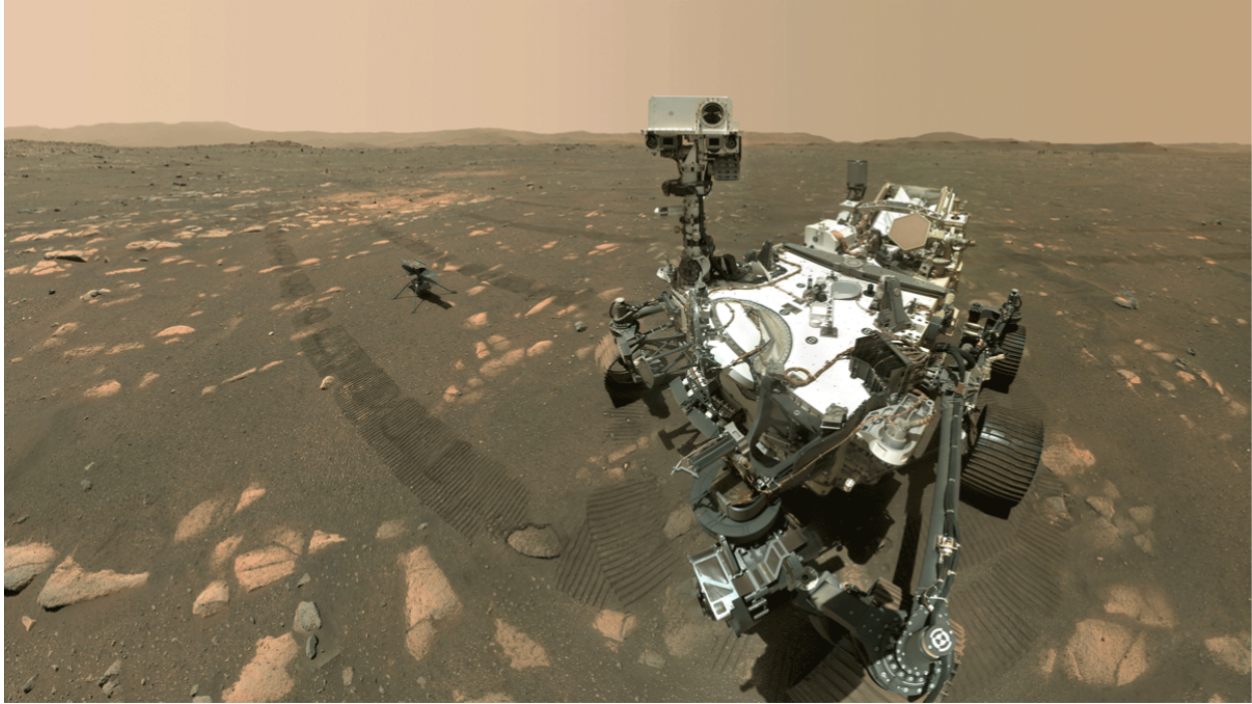
I look forward to presenting the findings of the PMSR to you on Monday, 9 March 2026, and answer any questions you might have.

Sincerely,



Melissa D. Lane, PhD  
PMSR Review Chair

cc: Linday Hays  
Tiffany M. Morgan  
Mitchell D. Schulte  
George Tahu  
Charles Webb  
Henry B. Throop  
John Mustard



Credit: NASA/JPL-Caltech/MSSS

# **2026 Planetary Mission Senior Review**

## **Final Report**

**2 March 2026**

**Review Chair**

**Melissa D. Lane, Fibernetics**

## Table of Contents

1. INTRODUCTION	1
2. REVIEW PROCESS	1
2a. Panel Composition and Evaluation Criteria	1
2b. First Mission Presentation, Panel Discussions, & Questions to the Mission	2
2c. Second Mission Presentation and Panel Discussions	3
3. MISSION SUMMARY	4
3a. Prime Mission Accomplishments and Instrument Status	4
3b. Extended Mission Description	6
3c. Panel Summary and Evaluation Scores	8
4. GENERAL COMMENTS ON THE REVIEW AND LESSONS LEARNED	11
5. CONCLUSION	12
PANEL EVALUATION	13
PROJECT DATA MANAGEMENT PLAN (PDMP) EVALUATION	25
PANEL MEMBERS	28

# **Report of the 2026 NASA Planetary Mission Senior Review**

## **1. Introduction**

The 2026 NASA Planetary Mission Senior Review (PMSR) was conducted in a series of virtual meetings from 21 January to 12 February 2026. Only one proposal was submitted and reviewed for a mission extension, which was for the Mars 2020 Perseverance Rover (M2020). This project will have completed its prime mission (PM) by the end of Fiscal Year (FY) 2026, and proposed a two-year Extended Mission (EM) for FY27-FY28.

## **2. Review Process**

The M2020 project submitted the proposal for its first mission extension (EM1) on 16 January 2026, following guidelines specified by NASA HQ in a Call for Proposals (CfP) released on 9 September 2025. Three two-year budget profiles, including “High”, “Guideline”, and “Low” were provided by NASA HQ to the project prior to proposal submission. For each of these budgets, the mission proposed distinct EM traverses; as per the CfP, the team was encouraged not to use merely scaled up/down versions of the same traverse for the different budget profiles. The CfP stipulated that the proposal, prepared in the form of an electronic presentation (e.g., PowerPoint), should include sections on current mission status, accomplishments during the current mission phase, prioritized scientific objectives for the proposed mission extension, programmatic objectives for the proposed mission extension if appropriate, an extended mission operational plan, a summary of the health of the spacecraft (i.e., rover) and payload instruments and identified mission risks, foreign partner contributions for the extended mission, a management plan, a Professional Development Plan (PDP), and a Project Data Management Plan (PDMP).

### **2a. Panel Composition and Evaluation Criteria**

A panel of subject-matter experts (SMEs) having appropriate scientific and technical expertise was constituted to evaluate the proposal; this panel was led by a Group Chief. The panel also had two non-voting participants including an Executive Secretary who

recorded discussion notes and drafts of panel questions and evaluations, and the PMSR Review Chair. All panelists were vetted for financial and personal conflicts of interest with the mission team and implementing organizations.

As outlined in the CfP, the extended mission proposal was evaluated on the basis of 10 criteria, organized as six primary and four secondary criteria:

*Primary criteria*

- Intrinsic merit of the proposed scientific investigations
- Responsiveness to the goals of the most recent planetary science decadal strategy<sup>1</sup>, or, at a lower priority, previous decadal surveys
- Capability of the spacecraft and payload to achieve the proposed science
- Merit of any NASA programmatic objectives
- Scientific productivity of the mission team in the current mission phase
- Recent performance of the mission team in archiving data with the Planetary Data System (PDS)

*Secondary criteria*

- Value of any scientific data to be acquired but not analyzed by the mission science team
- Capabilities and experience of key project personnel
- Expected effectiveness of the project's professional development plan in training future spacecraft mission leaders
- Thoroughness and appropriateness of the PDMP

**2b. First Mission Presentation, Panel Discussions, and Questions to the Mission**

In advance of the full panel meetings, each SME submitted a written, pre-panel review of the proposal to the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). On 21 January 2026 all panelists met for a one-hour plenary session to go over the review process and schedule. Following this initial plenary, the M2020 project, represented by members of the proposing project team, presented their EM1 proposal for approximately 90 minutes. This presentation session

---

<sup>1</sup> *Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032*, The National Academies Press, 2023 (hereafter OWL).

of no more than 60 slides (as specified in the CfP) included an overview of the proposed EM1, an update on the primary mission and its scientific and programmatic accomplishments, and the progress of the rover since proposal submission, followed by more detailed presentation of the project's science and programmatic objectives for EM1 as addressed by three possible budget-driven operational plans (i.e., High, Guideline, and Low). The project's presentation was followed by a 30-minute break during which the review panel discussed the presentation and assembled a few clarifying questions. These questions were then addressed by the project in a 30-minute Q&A follow-on session. After the project was dismissed, the panel discussed the presentation and developed a list of 13 questions for the mission project to address in depth on 11 February 2026 during their second EM1 presentation to the panel.

## **2c. Second Mission Presentation and Panel Discussions**

The project's second presentation followed the format of a 55-slide response to the 13 written questions from the review panel that took approximately 105 minutes. The project was dismissed for 30 minutes for the panel to discuss any additional clarifications required by the project. These clarifications required only 15 minutes of additional response from the project, after which the project was dismissed and the review panel continued discussion and evaluation of the proposal.

An additional panel meeting (i.e., 10 hours of discussion over two days following the second presentation) allowed for final debate and evaluation of the project's proposal (slides and live presentations) using the evaluation criteria specified in the CfP, and allowed for drafting of comments that reflected the consensus of the panel into the proposal review document for further editing and finalization. The panel then voted on the overall merit of the proposed mission extension from Excellent (5) to Poor (1), allowing for half-grades, with separate votes being cast for each of the three mission budget profiles (i.e., corresponding traverses). Final panel votes were expressed as median adjectival scores. The panel finalized a written evaluation of the M2020 extended mission proposal, and a copy is included with this report.

The Planetary Science Division was represented at each of the panel meetings by Program Officer Henry Throop. The NASA HQ Mars 2020 Program Scientist, Mitch Schulte, was present for a portion of the presentation and discussions.

### **3. Mission Summary**

Mars 2020 is a mission operated by the Jet Propulsion Laboratory (JPL) that launched on 30 July 2020. It consisted of a rover named *Perseverance* and an on-board, but separate, robotic helicopter named *Ingenuity*. The rover landed on Mars on 18 February 2021 on the floor of Jezero crater.

#### **3a. Prime Mission Accomplishments and Instrument Status**

During the Mars 2020 PM many important technological and scientific advances were made. *Ingenuity* was the first helicopter to fly on another planet, and it covered a total distance of 11 miles over the course of 72 flights (128.8 total minutes in flight). These flights provided insight into the dust-lifting characteristics of the martian atmosphere. The rover hosts a suite of seven main instruments including the cameras Mastcam-Z and SuperCam, plus PIXL<sup>2</sup>, SHERLOC<sup>3</sup>, RIMFAX<sup>4</sup>, MEDA<sup>5</sup>, and MOXIE<sup>6</sup>. A microphone integrated into the SuperCam recorded the first martian soundscape. MOXIE successfully produced oxygen from the CO<sub>2</sub>-dominated atmosphere, demonstrating a critical technological capability for future human exploration.

The rover has, to date, traveled over 26 miles (>42 km) on Mars using this suite of rover instruments to study the rock strata and identify general age relationships both inside and outside the former lake-filled impact crater that hosted a once-active delta and river system (Figure 1).

---

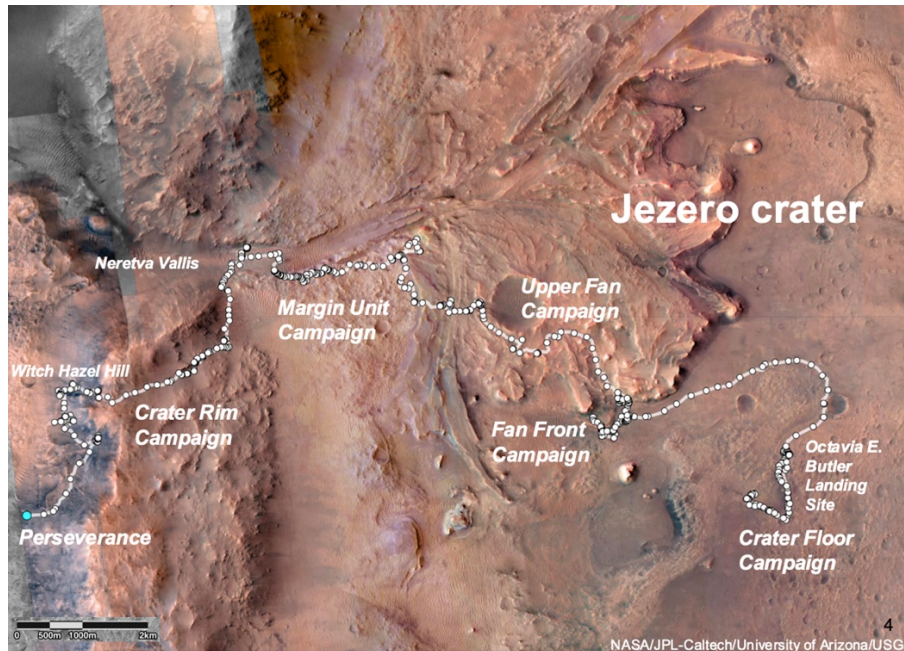
<sup>2</sup> PIXL (Planetary Instrument for X-ray Lithochemistry)

<sup>3</sup> SHERLOC (Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals)

<sup>4</sup> RIMFAX (Radar Imager for Mars' Subsurface Experiment)

<sup>5</sup> MEDA (Mars Environmental Dynamics Analyzer)

<sup>6</sup> MOXIE (Mars Oxygen In-situ-resource-utilization Experiment)



**Figure 1.** Traverse path of the *Perseverance* rover during the Prime Mission (figure modified from the Mars 2020 proposal).

Data from multiple rover instruments offered geologic evidence of abundant aqueous alteration as evidenced by serpentinization and production of carbonate, phyllosilicate, and kaolinite. Using data from the rover, the Mars 2020 mission team made a thrilling discovery of potential biosignatures through association of organic molecules with a distinct pattern of minerals (including iron phosphates) similar to those on Earth that can form via microbial activity. In addition, during the PM, the rover collected a suite of rock (27), regolith (2), and atmosphere (1) samples.

*Ingenuity* reached the end of its mission in January 2024. The rover-mounted MOXIE instrument completed its oxygen-production demonstration in 2023, and the MEDA instrument no longer has operational wind sensors, with the exception of one that continues to provide data, but total sensor failure is possible during EM1. However, the *Perseverance* rover continues to operate and navigate the surface of Mars, acquiring data with the remaining onboard instruments, including the mast instruments Mastcam-Z and SuperCam; the sampling-arm instruments SHERLOC, WATSON<sup>7</sup>, and PIXL; and the RIMFAX mounted in the body of the rover. These instruments remain generally

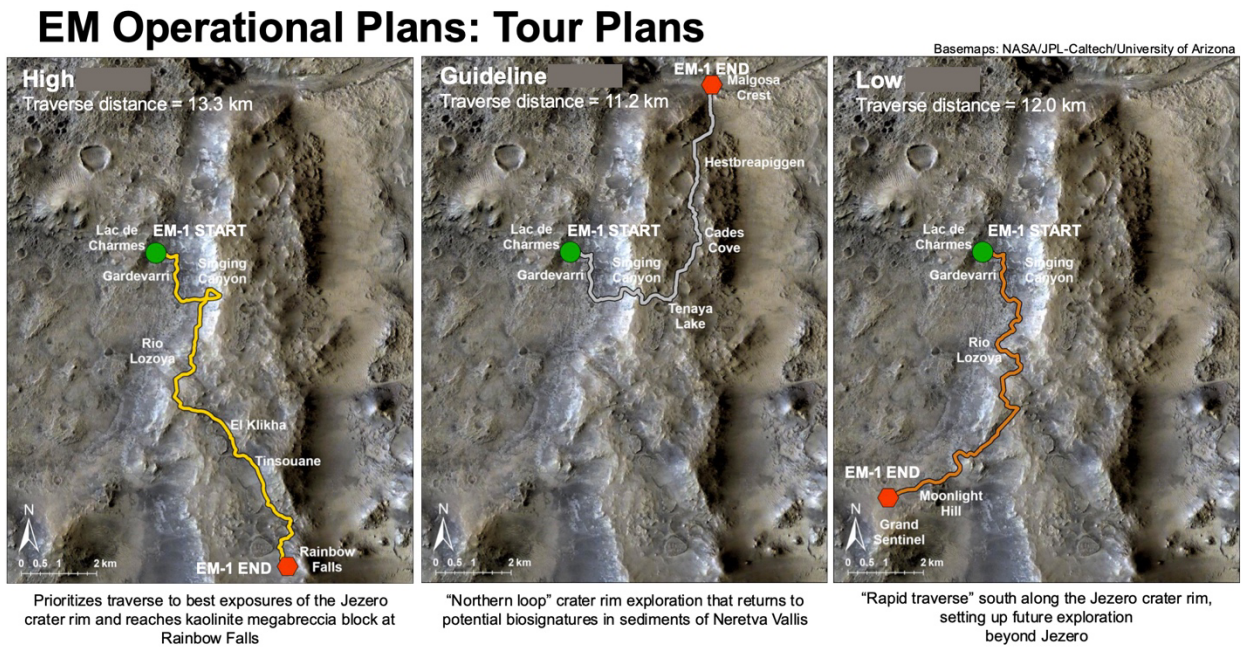
<sup>7</sup> WATSON (Wide Angle Topographic Sensor for Operations and eNginEering) is part of SHERLOC

healthy. The rover itself (hardware, software, and power generation) was evaluated to have no outstanding risks for the proposed EM1, described below.

### 3b. Extended Mission Description

The science themes to be studied during EM1 are to delve into the first half billion years on Mars (a timeframe that is lost on Earth) to understand the transition from rapid accretion, to a probable magma ocean, to planetary-scale geochemical differentiation and early crust formation and the appearance of an atmosphere and hydrosphere. This early era on Earth is likely when life originated, thus, the EM1 investigation will provide insight into the early geologic record and may provide insight into the possible development of life on early Mars.

The mission proposed three possible traverses in EM1, described as High (H), Guideline (G), and Low (L) based on the budget level, as shown on Figure 2.



**Figure 2.** *Perseverance* traverse plans for the proposed first extended mission (figure from the Mars 2020 proposal).

These traverse options are briefly described as follows:

- H: The planned H traverse would focus on the diverse geology of early Mars exposed on the Jezero rim. This option includes the longest traverse proposed (13.3 km) as well as the most time devoted to in-situ science (61 dedicated targeted science shifts; Figure 3). The rover would visit the best-exposed outcrops of pre- and post-Jezero bedrock. Good rock targets include a phyllosilicate-rich basement rock hosting diverse megabreccia blocks derived from the oldest and deepest crust exposed on Mars, overlain by an olivine/carbonate unit that is topped by a mafic cap rock (collectively known as the “mesa” stratigraphy); this stratigraphic sequence is best for studying age relationships that may be applied to a broader region around the Isidis basin. This traverse would investigate the history of aqueous activity and rock alteration (e.g., phyllosilicates at Singing Canyon and kaolinite at Rainbow Falls). This traverse would address the origin, early differentiation, impact history, aqueous alteration, habitability, and astrobiological potential of the early Mars crust.
- G: This traverse would cover 11.2 km (with 33 dedicated targeted science shifts; Figure 3) and would visit some of the same initial outcrops as the H option but then would turn north along the inner Jezero crater rim to study the mafic cap unit that may be similar to the mafic cap on the “mesa” stratigraphy in this region (but with poorer exposures and possibly less-clear age relationships than the H traverse) and a megabreccia unit (whose diversity is unclear due to the lack of CRISM<sup>8</sup> data), then study geomorphic ridges that may be of igneous, impact, or hydrothermal origin, and continue on to reach Neretva Vallis, where the rover has been previously during the PM, in order to further examine and sample the sedimentary rocks that host the potential biosignatures (green reduction spots) to acquire a deeper understanding of the context of these important rocks.
- L: This traverse would take the rover south along a somewhat similar initial traverse as H along the Jezero crater rim, but would turn southwestward to Nili Planum with the goal of reaching a structure called Grand Sentinel, which might be a volcanic edifice. This 12.0-km traverse would be dominated by autonomous

---

<sup>8</sup> CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) aboard the Mars Reconnaissance Orbiter (MRO)

navigation/driving due to a reduced staff (allowing only 12 dedicated targeted science shifts; Figure 3), consequently focusing on distance traveled to ancient rocks in and beyond the Jezero rim, with a reduction of science data-gathering stops along the way (and elimination of initial reports -- “field notes” – and sample dossiers).

**Figure 3.** Total tactical planning shifts for the proposed *Perseverance* EM1 traverse plans (figure from the Mars 2020 proposal).

### 3c. Panel Summary and Evaluation Scores

Each of the three proposed budget-profile missions (H, G, L) were voted on by the evaluation panel and the scores are shown below in Table 1.

**Table 1. Panel Evaluation of the Mars 2020 EM1 Proposal**

<b>Budget Profile</b>	<b>Panel Evaluation</b>
High	Excellent
Guideline	Excellent/Very Good
Low	Good

While the evaluation scores in Table 1 are based on the full Panel Evaluation that is presented in far more detail later within this report, a brief summary of the rationale behind the score for each proposed traverse is presented here.

H: This traverse, as described above, offers a wide range of diverse terrains for study from early-Mars basement rock to rocks that were deposited after the Jezero crater formation event. This traverse is thought to offer the best opportunity for studying the first half-billion years of the planet's formation and understanding the multiple olivine units with their lithologic associations. The traverse plan includes collection of four more lithologies in the sample tubes. The large number of science waypoints, the expected geologic diversity, and the potential for new discoveries drove the Excellent score for this traverse.

G: This traverse plan includes collection of three more lithologies in the sample tubes. The traverse also would visit diverse geologic units, including potential hydrothermal ridges, and megabreccias, although the waypoint for the key "mesa" unit has a poorer exposure than on the H traverse. A part of this traverse would retrace the path of the rover in the PM in order to revisit the Malgosa Crest sedimentary unit that hosts the green reduction spots (potential biosignatures). The continued study of these exciting, potential biosignatures drove a high score for this traverse; however, the score was tempered by the concern of the panel that revisiting the Malgosa Crest reduction spots would not offer significant advances with additional measurements nor allow for a clear determination of a biologic versus abiologic origin, resulting in a score of Excellent/Very Good.

L: This traverse has the fewest science waypoints due to the emphasis on autonomous navigation of the rover, thus, this option is less scientifically ambitious and would not fully characterize the investigated geology, nor fully address key questions regarding the first half-billion years of Mars' crustal formation and differentiation, chemical evolution, or aqueous alteration. This traverse has a low potential for contributing information regarding habitability. Two lithology samples would be collected. The diminished amount and value of the science to be done on this traverse led to the Good score.

After lengthy discussions, the consensus of the evaluation panel was that the H option is strongly preferred because it is more likely to fully address the EM1 science objectives (and OWL Decadal Survey goals) by visiting and studying a wide variety of rock types with different ages, both pre- and post-Jezero formation, that could include a regional olivine-carbonate unit, phyllosilicate- and kaolinite-bearing pre-Jezero rocks, minimally altered Noachian igneous rock, impactites, and possibly sedimentary rock, and hydrothermal features. This traverse could lend insight into the first 0.5 billion years of Mars' formation, the potential magma ocean, the original crust and its evolution, and the presence of abundant water (possibly hydrothermal). Understanding and establishing the early crustal/mantle composition will help significantly to bound the geochemical models that are currently being used with somewhat arbitrary geochemical starting points for interpreting planetary differentiation on Mars. While the G traverse is exciting for astrobiology, returning the rover to a location where it previously has been, with no assurance for better data or more interesting possible biological evidence, was a much less supported option by the panel.

Reduced funding levels from that of the H budget option would decrease the operational cadence of the mission, limiting visited waypoints and causing a reduction of science. However, the panel found that if the H budget is unavailable, even with a reduced budget, the H traverse is preferred for scientific reasons. When the mission was asked about a G-budget-constrained option, their preference, as stated during the second presentation, would be for a scaled-down version of the H traverse, as well, which "offers the best opportunity for fundamentally new discoveries and is most responsive to the Decadal Survey." Had the CfP not required three distinct traverses, the submitted mission proposal would have presented this preferred scaled-down traverse for the G-budget option. In this scenario (H traverse on a G-level budget), the rover's preferred strategy would be to do a full exploration of the early south crater rim traverse (H) but conclude EM1 after reaching and studying the El Klikha region where there is an excellent exposure of the "mesa" stratigraphy that would help establish age relationships. In this scenario, the rover would not get to the farthest waypoints of Tinsouane or Rainbow Falls. The panel found that funding the extended mission below the Guideline budget would severely reduce the waypoint science and significantly

increase the potential for mission-ending command and operation errors due to much-reduced staffing (which historically has been a leading mode for loss of spacecraft) and loss of Subject Matter Experts (who are important for understanding mission anomalies that might occur).

#### **4. General Comments on the Review and Lessons Learned**

This PMSR ran smoothly for several reasons. The Program Officer who oversaw the review was effective at explaining procedures (with a focus on those that were different from previous PMSR strategies as directed by the CfP), the evaluation criteria, and how the review findings might be used by NASA. The Group Chief and Panelists were well chosen and experienced scientists who had the collective expertise to evaluate the M2020 EM1 proposal. Because several panel members had participated on previous PMSR evaluations and could assure similar scrutiny of the proposal and guide the discussions, the panel discussions were efficient and thorough and the voted-on panel evaluation scores were leveled comparably to past PMSR evaluations.

The presentation-based proposal format for PMSR26 differed substantially from the written proposal format use in previous PMSRs. The panel found several important items were lacking sufficient detail for the evaluation that could be requested for future submitted EM slide-type proposals. These missing items include: (1) detailed descriptions of the status and health of the rover and instruments (with respect to degradation and instrument performance) and their effect on the likelihood of the proposed data to be collected, (2) curriculum vitae for the mission's Key Personnel to better judge their expertise and chain of management. The Response to Panel Questions that were answered during the mission's second presentation allowed for the instrument and rover information gaps and concerns to be addressed.

The first and second live presentations by the mission and the interactions with the evaluation panel were productive, clarifying, and efficient. The virtual format of these presentations permitted the inclusion of expert panelists from a wide range of time zones.

Generally, the slide-deck format of the submitted EM1 proposal was well received by the evaluation panel (with noted limitations stated above), and the two live mission

presentations offered excellent insight into the proposed rover traverses and desired science goals. The timeline of the review was appropriate. Sufficient time was allotted for reviewing the proposal prior to the first presentation, generation of questions to the project team, mission presentations, panel discussions, preparing the evaluation, and writing the final report.

The PDMP was submitted by the project as a proposal appendix, and this plan was evaluated independently by external reviewers selected for their expertise in data management. The PDMP external review was summarized in written form by a panel of NASA personnel familiar with the Planetary Data Ecosystem, and was provided to the PMSR panel. This review was thorough and helpful, and was discussed by the evaluation panel. No issues rose to a level of concern that warranted itemization in this overview report.

## **5. Conclusion**

The Mars 2020 mission evaluated in this 2026 Planetary Mission Senior Review will conclude its prime mission at the end of FY26 and is seeking two years of additional funding to support their first extended mission over FY27 and FY28.

The *Perseverance* rover and the onboard instruments are generally healthy and the mission team has identified new and highly rated science objectives that appear to be achievable during the proposed two-year extended mission. EM1 would also support some programmatic objectives and would continue to collect samples for possible future return to Earth. The continuation of this mission, even at the highest budget profile, would be comparable to, but slightly less than, the rover's current FY26 operating budget.

Melissa D. Lane, Fibernetics LLC, PMSR Review Chair

2 March 2026

## **2026 NASA Planetary Mission Senior Review – Panel Evaluation**

**Title: Perseverance on the Rim of Jezero Crater: Exploring the Origin, Evolution, and Astrobiological Potential of the Early Mars Crust / 26-PMSR26-0001**

**PI: Kathryn Stack Morgan / Jet Propulsion Laboratory**

<b>Overall Score, High Budget Option:</b>	<b>Excellent</b>
<b>Overall Score, Guideline Budget Option:</b>	<b>Excellent / Very Good</b>
<b>Overall Score, Low Budget Option:</b>	<b>Good</b>

### **SUMMARY OF PROPOSAL**

The Mars 2020 Perseverance rover team has proposed a compelling set of scientific investigations for the two-year Extended Mission 1 (EM1). During EM1, Perseverance would explore the period of planetary evolution following accretion, a probable magma ocean, and planetary-scale geochemical differentiation to a first crust and atmosphere/hydrosphere. Most of the geologic record from this period on Earth is gone, but it is thought to be well represented on Mars. From the end point of its prime mission (PM), the Perseverance rover is poised to investigate the period of Mars' history when many geologic processes establish the planet's long-term evolution and its biological potential.

Three extended mission profiles are proposed:

- The High option investigates previously unexplored regions of Jezero's crater rim, and features several compelling waypoints of Noachian-aged rocks, megabreccia, olivine-rich outcrop in stratigraphy (with carbonate in some locations) and ends EM1 at a large kaolinite-rich megabreccia block to the southeast, in the Rainbow Falls region. This option delivers the best science return and maintains workforce development.
- The Guideline option would explore several waypoints in common with the High option before heading north and exploring unique outcrops on the way to the EM1 end point at the potential biosignatures ('green reduction spots') at Malgosa Ridge, which may present a different redox chemistry than the potential biosignatures ('leopard spots') analyzed at Cheyava Falls during the PM. This option presents a strong, balanced mission, though with less compelling outcrops relevant to Early Mars.
- Finally, the Low option would visit the first important exploration targets of the High and Guideline options, but would not examine them in as much detail, as influenced by reduced staffing (thus, fewer planning sessions) and an increased use of autonomous navigation of the rover. The traverse path to the endpoint toward the southwest has fewer defined waypoints, resulting in significantly reduced scientific and programmatic merit.

The rover is healthy, the team is proven and productive, and the data archiving is within expectations.

The extended mission profiles proposed are scientifically compelling, strongly aligned with the Decadal Survey, and executable under three clear budget profiles.

The High (H) option is the most compelling of the three with more targets that are well aligned with understanding the first 0.5 billion years of Mars (e.g., Noachian-aged rocks, megabreccia, olivine-rich outcrop in stratigraphy with carbonate in some locations and kaolinite megabreccia). The Guideline (G) option is less compelling due to fewer planning cycles, waypoints with less context from orbital data, and the rover arrives at a key destination, the green reduction spots, only at the end of EM1. The

Low (L) option has significantly lower scientific merit due to the reduced science operations and less compelling waypoints.

## **PRIMARY EVALUATION CRITERIA (1-6)**

### **1. Intrinsic merit of the proposed science investigations to be undertaken during the EM**

*The letters H, G and L indicate how any strength or weakness is related to the High, Guideline, or Low budget profiles, respectively. Multiple letters indicate the strength or weakness applies to more than one of the funding levels.*

#### **SCIENCE MERIT: MAJOR STRENGTHS**

**Major (H/G/L):** The EM science for all three options proposed is of exceptional merit. These options target fundamental questions about early Mars crustal formation, differentiation, impact history, habitability, and astrobiological potential. Investigations would include analyses of ancient rocks in, on, and near the Jezero crater rim.

The team has identified the first 0.5 billion years of Mars history as an unknown and compelling era for understanding the early geological evolution and chemistry of the planet and its biological potential. There are currently no existing or planned missions to Mars that will investigate this period of Martian history.

**Major (H/G/L):** The first waypoints that are common to all three proposed traverses are well chosen to address long-standing questions about martian crust through the study of pre-Noachian and Noachian bedrock.

**Major (H/G/L):** The Gardevarri waypoint specifically would target olivine-bearing outcrops to address basic questions of igneous, pyroclastic, or sedimentary origin and to resolve fundamental stratigraphic relationships. Carbonate associations with the olivine-bearing materials there would address high priority questions regarding the origin of this key association in this region.

**Major (H):** The H EM investigation would target key science questions relevant to early Mars exploration on the Jezero rim, ending at the Rainbow Falls kaolinite megabreccia block. The specific targets along the traverse path are well oriented to outstanding questions of Mars and solar system science, AND it would investigate the significant outcrops of intact mesas that have an olivine-rich base in contact with the ancient phyllosilicate-rich basement, and with a mafic cap. The origin and evolution of the alteration leading to the phyllosilicate-rich basement is a long standing question for Mars. The common stratigraphy of olivine-rich rocks, resting on phyllosilicate-rich basement and capped by a mafic unit is an enigmatic, regional unit. The variable alteration to carbonate is fundamental for understanding Mars' environmental history. This detailed in situ investigation would be the first of this stratigraphy making it a very important target for EM1.

**Major (H):** The El Klikha target offers a series of exceptionally well exposed and preserved mesas with light-toned, fractured, olivine-bearing rock in contact with underlying crater rim bedrock (including megabreccia), below a mafic caprock. This target is an important geologic connection to the regional olivine-bearing unit and would facilitate putting the Seitah-Maaz formation with a similar geologic stratigraphy observed in Jezero in context.

**Major (H/G):** The Singing Canyon waypoint would offer exposures of Noachian basement, including phyllosilicate-bearing layers, a range of megablocks and the regional olivine-bearing unit in stratigraphic context. The investigation plan would implement the instrument suite to address questions of Noachian basement composition and key stratigraphic characteristics for the olivine-bearing unit.

**Major (G):** The return to Neretva Vallis targets would offer a strong balanced plan with potential investigations of megabreccia, ridges of potential hydrothermal origin, altered igneous units, potentially phyllosilicate- and kaolinite-bearing rocks, and importantly, would visit sedimentary outcrops of potential biosignatures in Neretva Vallis (i.e., green reduction spots) identified during the PM.

**Major (G)** With the termination of Mars Sample Return (MSR), the return to Neretva Vallis is a unique opportunity to sample a potential biosignature. The site of reduction spots in Malgosa Ridge, potentially formed by microbial reduction, is complementary to the site at Cheyava Falls that was investigated during the PM. Studies at this site can potentially expand the context and the depth of knowledge about reduction spots on Mars and their biological significance.

## SCIENCE MERIT: MINOR STRENGTHS

**Minor (H/G/L):** The investigations would use the capability of the rover's analytical chemistry suite of instruments to assess diversity of igneous textures of the mafic igneous outcrops at the waypoints. Data collected here could allow the distinction among hypotheses for the origin and emplacement of mafic igneous units.

**Minor (H/G/L):** Along the EM traverses, the team would acquire atmospheric and environmental observations under a no-interference protocol for the G and L options. The H option includes opportunistic support for atmosphere and environment investigations. These measurements are of high value to understanding the atmosphere from the surface for fundamental science investigations.

**Minor (H/G/L):** All mission options anticipate obtaining additional rock samples for potential future return to Earth (H: 4 samples; G: 3 samples; L: 2 samples).

**Minor (H/G):** The H and G proposals explicitly provide support for a Participating Scientist Program that would bring a broader segment of the community into the Perseverance team.

## SCIENCE MERIT: MAJOR WEAKNESSES

**Major (G):** Given the measurements and analyses made during the PM, the proposed return to the Malgosa Crest does not present a highly compelling investigation in that some geochemical analyses have already been performed of the reduction spots during the PM. While spatially-resolved characterization of these features will provide additional information, potential advances in understanding of the origin of the target reduction spots are speculative. Demonstrating a definitive biotic origin of the structures at Malgosa Crest would normally require the use of numerous laboratory instruments (hence the justification for an MSR mission).

**Major (L):** The scientific value of the second half of the L mission option is low given the reduction in staffing for the science and operations team. After characterization of the initial campaign stops on the crater rim (at sites Gardevarri, Singing Canyon, and Rio Lozoya), the L option includes only one science question: whether or not a geomorphic feature (Grand Sentinel) is a volcanic edifice.

**Major (L)** The L option does not significantly address the described key scientific questions related to the first 0.5 billion years of Mars' planetary evolution, nor questions relevant to the early environmental evolution of Mars. Even at the early campaign stops, the proposed investigation is less ambitious than the G and H investigations. For example the L does not characterize clay mineral-bearing layers. There is also no investment in creating abrasion patches with proximity science nor RIMFAX observations that are included in the H option. Thus, it has low potential for significant new constraints on habitability questions.

## **SCIENCE MERIT: MINOR WEAKNESSES**

**Minor (G):** The waypoints in the G mission that focus on investigations of crustal composition are less compelling than those for the H mission. The existing orbital imaging data (*e.g.*, CRISM, HiRISE and CTX, onboard the Mars Reconnaissance Orbiter, MRO) of the proposed campaign stops are limited, and would not provide as much spatial context; where orbital data are available, they do not demonstrate the presence of clay minerals (although they may be present).

**Minor (H):** Key scientific questions regarding habitability (*e.g.*, timing and duration) are harder to evaluate in crustal rocks and megabreccias, the focus of the H option. Chances of potential biosignature identification are possibly lower than for the G mission due to seemingly more restricted habitability conditions and lower preservation potential of potential biosignatures.

**Minor (G):** This traverse scenario would visit fewer previously unstudied areas of the Jezero rim relative to the H option and, therefore, offer fewer high quality or priority targets that can be identified pre-EM. The G option visits only one of the top three most compelling sites as identified by the Perseverance rover team.

## ***2. Responsiveness of the proposal to goals described in the Decadal Survey “Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032”***

### **RESPONSIVENESS TO DECADAL: MAJOR STRENGTHS**

**Major (H/G/L):** The Extended Mission proposal is exceptionally well-aligned with the Origins, Worlds and Life (OWL) Decadal Survey. The proposal directly addresses numerous Strategic Research and Science Questions (Q3-Q6, Q10-Q11) concerning early Solar System formation, crustal differentiation, impact processes, habitability, and the search for life.

### **RESPONSIVENESS TO DECADAL: MINOR STRENGTHS**

**Minor (H/G/L):** All three extended mission options include sample collection, which is consistent with eventual retrieval of samples for analysis on Earth. Analysis of these samples is stated as the top mission priority for the Decadal Survey.

**Minor (H/G/L):** All EM options include measurements that constitute ‘precursor missions’ for future human exploration, In Situ Resource Utilization, and planetary protection. With the H option, these are done opportunistically, and with the G and L options they are taken on a non-interference basis. Key measurements include the Mars Environmental Dynamics Analyzer (MEDA) instrument’s daily, long-

term reports on temperature, humidity, pressure, and dust, essential for designing habitats and forecasting weather.

**Minor Strength (G):** The return to Neretva Vallis and the potential biosignatures in the sedimentary rocks is strongly connected to OWL Question 11 (Search for Life Elsewhere).

## **RESPONSIVENESS TO DECADAL: MAJOR WEAKNESSES**

None noted.

## **RESPONSIVENESS TO DECADAL: MINOR WEAKNESSES**

None noted.

### ***3. Capability of the spacecraft to achieve proposed science***

#### **CAPABILITY OF SPACECRAFT: MAJOR STRENGTHS**

**Major (H/G/L):** The instrument payload is well-equipped for all three proposed mission profiles. The instrument suite is particularly well-suited to characterize major element rock chemistry, including outstanding spatially-resolved elemental measurements along with organic and mineralogical characterization. The rover can also make thorough remote observations with its remote sensing instruments and camera suite. The rover's ground-penetrating radar provides subsurface geological context for understanding the bedding directions of formations encountered.

**Major (H/G/L):** The rover and instruments remain in good health with ample design life margin to accomplish the mission as proposed. The team has proactively begun extended-life testing on critical components (e.g., mobility actuators) to increase confidence as they are approaching or have exceeded their initial design lifetimes. Additional confidence is gained from the heritage of these devices that remain performing well on the older Curiosity rover of the Mars Science Laboratory (MSL). The proposal described a plan to target a capability of driving 100 km, exceeding the total proposed distance through the end of EM1 of 60 km, but life qualification testing has predicted that the mobility actuators could exceed 150 km. Mobility brake testing is underway at about 33% of expected life with no issues reported. A minor anomaly in the Vehicle System Test Bed (VSTB) associated with the corer's 'percuss' mechanism is being investigated, but does not appear to affect the rover; it is also not required for the scientific observations proposed in EM1. The Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) continues to perform as predicted and has sufficient capability to support operations through the end of EM1. The mission instrument suite is in good condition with only minor anomalies reported. The Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC) dust cover is no longer operational, but its status does not degrade data collection. The Planetary Instrument for X-ray Lithochemistry (PIXL) X-ray tube is past its planned lifetime, but based on usage rate appears to be sufficient to support operations through the end of EM1.

**Major (H/G/L):** As has been demonstrated by the rover accomplishments during the PM, including the total distance covered, the extensive measurements made, and the successful coring of 32 samples, the spacecraft is very capable and, with few to no losses of functionality, is in an excellent position to continue operations.

## **CAPABILITY OF SPACECRAFT: MINOR STRENGTHS**

**Minor (H/G/L):** The risk posture described in the EM1 proposal is appropriately balanced between maximizing the use of resources while maintaining sufficient margin and conservative planning approaches. Specific examples include:

- The process of margin allocation for planning sols is robust and appropriately conservative. It is based on experience of the mission through various phases of the PM, and it is tuned to the proposed activities in EM1.
- The team is collaborating with other missions to keep the Mission System Test Bed (MSTB) available for anomaly responses. Note that the proposal states that the MSTB would be discontinued for the L and G options, but the team reported during their second presentation that they have collaborative cost-sharing arrangements with other missions to maintain it. Keeping the MSTB significantly reduces risk that a rover anomaly would stall EM1 progress.

## **CAPABILITY OF SPACECRAFT: MAJOR WEAKNESSES**

**Major (G):** The reduced operations cadence in the G option to 2.5 shifts per week may increase the risk of command errors.

**Major (L):** The reduced operations cadence in the L option to 2 shifts per week, and the loss of personnel, significantly increases the risk of command errors and may result in reduced mission performance in acquisition and archiving of data as well as rover operations.

## **CAPABILITY OF SPACECRAFT: MINOR WEAKNESSES**

None noted.

### ***4. Merit of any programmatic objectives***

#### **PROGRAMMATIC OBJECTIVES: MAJOR STRENGTHS**

**Major (H/G/L):** The characterization of the sampling sites and acquisition of samples that will be added to the sample cache would increase the scientific value of the samples, if they are eventually retrieved for analysis on Earth.

#### **PROGRAMMATIC OBJECTIVES: MINOR STRENGTHS**

**Minor (H/G/L):** The characterization of Mars' surface dust size and composition adds comprehensive programmatic value in preparation for human exploration.

**Minor (H/G/L):** The search for, and characterization of, potential biosignatures will inform guidelines for planetary protection in preparation for human exploration.

**Minor (H/G/L):** Improved atmospheric characterization with the MEDA will inform the potential spread of contaminants in preparation for human exploration.

#### **PROGRAMMATIC OBJECTIVES: MAJOR WEAKNESSES**

None noted.

## **PROGRAMMATIC OBJECTIVES: MINOR WEAKNESSES**

None noted.

### ***5. Scientific productivity of the mission team in the current phase***

#### **TEAM SCIENTIFIC PRODUCTIVITY: MAJOR STRENGTHS**

**Major (H/G/L):** The Mars 2020 team productivity has been impressive, with 10 major discoveries highlighted in the proposal, including evidence of potential biosignatures, habitable ancient environments, diverse igneous processes, serpentinization, and creation of the first Martian soundscape recording. The team has published extensively in high-impact journals (e.g., *Science*, *Nature*) and discipline-specific journals (*Icarus*, *JGR Planets*, etc.) with over 190 peer-reviewed publications.

**Major (H/G/L):** The team has built a strong foundation for positive future science outcomes. Sampling campaigns have been executed with discipline, resulting in a diverse, well-documented cache of 33 samples in the primary mission. The Ingenuity helicopter completed 72 flights, revolutionizing aerial reconnaissance and increasing context for rover observations. The high quality of data archived from the mission to date will be useful for substantial future studies.

#### **TEAM SCIENTIFIC PRODUCTIVITY: MINOR STRENGTHS**

None noted.

#### **TEAM SCIENTIFIC PRODUCTIVITY: MAJOR WEAKNESSES**

None noted.

#### **TEAM SCIENTIFIC PRODUCTIVITY: MINOR WEAKNESSES**

None noted.

### ***6. Performance of the mission team in archiving data to the PDS in the current phase***

#### **PDS ARCHIVING: MAJOR STRENGTHS**

**Major (H/G/L):** Most of the data archiving is systematic, timely, and comprehensive. The team has delivered regular PDS releases every 4 months (120 sols), with data public within 3-7 months of acquisition.

**Major (H/G/L):** Over 19 million data products (86 TB) have been archived to date. Sample documentation is thorough, with Initial Reports publicly available and Sample Dossiers maintained in the Analyst's Notebook. The archive is PDS4 compliant and user accessible.

### **PDS ARCHIVING: MINOR STRENGTHS**

None noted.

### **PDS ARCHIVING: MAJOR WEAKNESSES**

None noted.

### **PDS ARCHIVING: MINOR WEAKNESSES**

**Minor (L):** Ongoing personnel loss from the mission may negatively impact the project's ability to maintain a steady cadence of PDS deliveries.

**Minor (H/G/L):** Some PDS deliveries have been delayed per the Report Card (specifically some engineering camera RDRs; RSS sample cache engineering data; rover targets bundle; rover science intent bundle). The PDS Geosciences node indicates that the mission plans to deliver backlogged data by release 17, which is scheduled for November 2026. Thus, the PM archiving issues are expected to be resolved by early in EM1.

### **PDS ARCHIVING: MINOR WEAKNESSES**

None noted.

## ***SECONDARY EVALUATION CRITERIA (7-10)***

### ***7. Intrinsic merit of any science data to be acquired and archived, but not analyzed***

#### **ADDITIONAL SCIENCE DATA: STRENGTHS**

**Major (H/G/L):** All data acquired will be archived in PDS with full PDS4 metadata, enabling future community analysis. Archived subsurface radar data from the Radar Imager for Mars' Subsurface Experiment (RIMFAX), atmospheric measurements (MEDA), and systematic imaging (Mastcam-Z, Navcam) would provide long-term value for understanding Martian geology, climate, and surface-atmosphere interactions.

**Major (L):** The acquisition of data during autonomous drives will document new terrains and landscapes and will be of high science value for future investigations.

#### **ADDITIONAL SCIENCE DATA: WEAKNESSES**

None noted.

## **8. Demonstrated capabilities and expertise of key personnel**

### **KEY PERSONNEL: STRENGTHS**

**Major (H/G/L):** The mission management team is strong and effective as evidenced by the success of the PM. To date, the mission has traveled farther than any previous landed mission while simultaneously collecting cache samples, performing substantial *in situ* science, and obtaining extensive remote observations. This level of success is only possible if the management team is guiding planning and operations effectively, focused both on sol-by-sol and year-long mission goals. Successful leadership requires outstanding communication and effective negotiation of competing interests among the project/deputy project scientists, instrument PIs, and operations teams for both science and engineering.

A good balance across the science interests is demonstrated by the diversity of topics covered in the publications, including many papers that are not focused on the primary goals of the mission. A good balance on the engineering side is demonstrated by the outstanding health of the rover and instruments; they are being heavily used and in a responsible manner. Continued effective management is expected based on the content of the proposal, which balances engineering and science opportunities and interests in the proposed activities.

The team's response to the Evaluation Panel's review questions demonstrated outstanding within-team communications and support for the success of each component of the mission. As a specific example, in responding to a question about different uses of planning sols, the Project Scientist clearly described tradeoffs between science-focused multi-sol plans that may be limited by plan complexity (the ability of the team to create a well justified and safe plan for the rover), versus autodriven-focused multi-sol plans, which require less personnel time and provide mostly untargeted science data. The value of each (and other operations options) was tightly coupled to the proposed EM1 mission activities within the budget constraints in a way that showed a depth of understanding that gives confidence for effective future operations.

**Major (H/G/L):** The depth of management and operations experience on the team is substantial. Many of the project and engineering leads worked on the MSL mission, worked on developing Mars 2020, and are now operating this mission. Many individuals have more than a decade of experience effectively operating rovers and scientific instruments on the surface of Mars. They have also mentored others as they grew into leadership roles, increasing the depth of expertise on the team. This depth of experience was demonstrated in the presentation of the proposal and response to questions; all aspects showed a deep understanding of this mission as well as how to manage its complexity to obtain exceptional results. The collective knowledge and experience of the team is unique because of the sustained exploration of the surface of Mars over the last few decades. And this collective past experience is exceptionally valuable for ensuring an effective and productive EM1 for Mars 2020.

**Major (H/G):** Operations staffing risk management plan is strong. Succession planning is strong, and the team showed a deep understanding of the tradeoffs among staffing, plan content, and plan complexity.

## **KEY PERSONNEL: WEAKNESSES**

**Major (L):** Numerous key positions would be partially or completely defunded in EM1 in the L option. Positions that would be eliminated include the Deputy and Acting Deputy Project Scientists, the Deputy Project Manager, and the Deputy Mission Manager. The loss of these positions makes the mission dependent on a single individual for leadership in each of these critical areas. Similarly, the loss of all seven Mission Leads significantly reduces engineering and operations expertise for critical systems required for rover operations. Finally, one engineer from each of Robotic Operations, Engineering Operations, Instrument Operations, and Science Operations would be eliminated, reducing the depth of expertise and shift scheduling flexibility. Overall, the loss of these positions would significantly increase risk for the mission.

### ***9. Expected effectiveness of the proposed PDP in training future mission leaders, and demonstrated progress toward the goals of the PDP in the current mission phase***

## **PROFESSIONAL DEVELOPMENT PLAN (PDP): STRENGTHS**

**Major (H/G/L):** The mission has an excellent record of mentoring and promoting early- and mid-career scientists and engineers. Numerous team members have advanced into leadership roles (Project Scientist, DPS, instrument Co-PIs, campaign leads).

**Major (H/G/L):** The proposal presents a plan for Professional Development. There are plans to add new early to mid-career campaign leads, giving early career scientists the opportunity to gain mission leadership skills and develop new mission goals. The proposal to continue the Participating Scientist Program is also valuable to the broader community.

**Major (H/G):** The proposal includes structured PDP elements for the High and Guideline options, including new campaign leads, a Participating Scientist Program, early-career liaisons, and leadership transitions.

## **PROFESSIONAL DEVELOPMENT PLAN (PDP): WEAKNESSES**

None noted.

### ***10. Thoroughness and appropriateness of the Project Data Management Plan***

## **PROJECT DATA MANAGEMENT PLAN (PDMP): STRENGTHS**

The PMSR review panel concurs with the findings of the PDMP external evaluation:

*“MAJOR STRENGTH: The proposal provided a detailed, well-structured accounting of the data that have been archived, including all science data and engineering products and team roles and responsibilities. This detailed description provided significant confidence in the continued delivery of*

*Mars 2020 Project mission data to the science community. This attention to detail was demonstrated by diagrams such as Figure 1 which illustrated the workflow for data delivery to the Planetary Data System (PDS), Table 4 which listed the Mars 2020 Project data products to be archived, and Table 5 which provided a data delivery and archival schedule from the start of the mission through the proposed extended mission. In addition, the data generation and archival roles and responsibilities were clearly described, a detailed description of all data products to be archived was supplied, and a detailed description of how the specific data documentation needs for this mission (e.g., cached samples) would be met was provided. Also, the data products (both of Experimental Data Records and Reduced Data Records) were validated through peer review. Scientists representing typical users confirmed the design and labeling of data products and validated the labeling using sample data. Finally, the PDS documentation contains the algorithms, models, and numerical simulations necessary for reproducibility of the higher order data products.*

*MAJOR STRENGTH: The Project Data Management Plan clearly demonstrated a commitment to maximizing data accessibility and usability by supporting critical services for the science community. This commitment was demonstrated through thoughtful consideration for how the science community would use these data and the effort and thought dedicated to making the data usable. For example, the Mars 2020 Project recognized that the instruments must operate in close coordination and that the general science community will require access to science data archives that are integrated across instruments by time, location, and observation target. In response, the mission team generates documentation that provides significant context for each observation and supports two complementary systems, the PDS Planetary Image Atlas and the Analyst's Notebook, to provide the desired data accessibility. The Notebook allows users to correlate data products from different instruments, documents decisions made about the rovers' actions, and provides access to documentation, software, and SPICE kernels. The Atlas allows users to download selected products and the Data Search allows the user to apply desired search criteria."*

## **PROJECT DATA MANAGEMENT PLAN (PDMP): WEAKNESSES**

The PMSR review panel concurs with the findings of the PDMP external evaluation:

*"MINOR WEAKNESS: The Mission Report Card notes several end-to-end validation tests, but these processes are not described in the Project Data Management Plan."*

## **ADDITIONAL NOTES TO THE MISSION**

Accessibility to the Perseverance data for scientists not involved directly with the mission is perceived as difficult, with a steep learning curve for individual instrument data. Furthermore, integration across instruments requires knowledge not readily available through the PDS and publications. The broader planetary science community would benefit dramatically from data usage workshops conducted by the Perseverance team. The workshops could introduce the external community to basic data collection, data analysis software use and reduction for individual instruments. NASA and the mission should consider the value of workshops on how to access, process, and analyze data, to maximize usage of Perseverance instruments and mission data. This strategy has been implemented with instruments on MRO (e.g., CRISM) that presented examples of data used in publications to walk through the workflow. Such workshops could be done in conjunction with professional meetings, or as webinars for maximum accessibility.



## PROJECT DATA MANAGEMENT PLAN EVALUATION

**Proposal Number:** 26-PMSR26-0001

**Proposal Title:** Perseverance on the Rim of Jezero Crater: Exploring the Origin, Evolution, and Astrobiological Potential of the Early Mars Crust

**PI:** Kathryn Stack Morgan

**Organization:** Jet Propulsion Laboratory

### **PROJECT DATA MANAGEMENT PLAN SUMMARY**

The proposal provided a detailed, well-structured accounting of the data that have been archived, including all science data and engineering products and team roles and responsibilities. This detailed description provided significant confidence in the continued delivery of Mars 2020 Project mission data to the science community. In addition, the Project Data Management Plan clearly demonstrated a commitment to maximizing data accessibility and usability by supporting critical services for the science community. However, some data products are not archived to the PDS in a timely manner and according to the PSD Mission Report Card.

### **PROJECT DATA MANAGEMENT PLAN MERIT**

#### **Major Strengths**

**The proposal provided a detailed, well-structured accounting of the data that have been archived, including all science data and engineering products and team roles and responsibilities. This detailed description provided significant confidence in the continued delivery of Mars 2020 Project mission data to the science community.** This attention to detail was demonstrated by diagrams such as Figure 1 which illustrated the workflow for data delivery to the Planetary Data System (PDS), Table 4 which listed the Mars 2020 Project data products to be archived, and Table 5 which provided a data delivery and archival schedule from the start of the mission through the proposed extended mission. In addition, the data generation and archival roles and responsibilities were clearly described, a detailed description of all data products to be archived was supplied, and a detailed description of how the specific data documentation needs for this mission (e.g., cached samples) would be met was provided. Also, the data products (both of Experimental Data Records and Reduced Data Records) were validated through peer review. Scientists representing typical users confirmed the design and labeling of data products and validated the labeling using sample data. Finally, the PDS documentation contains the algorithms, models, and numerical simulations necessary for reproducibility of the higher order data products.

**The Project Data Management Plan clearly demonstrated a commitment to maximizing data accessibility and usability by supporting critical services for the science community.** This commitment was demonstrated through thoughtful consideration for how the science community would use these data and the effort and thought dedicated to making the data usable. For example, the Mars 2020 Project recognized that the instruments must operate in close coordination and that the general science community will require access to science data archives that are integrated across instruments by time, location, and observation target. In response, the mission team generates documentation that provides significant context for each observation and supports two complementary systems, the PDS Planetary Image Atlas and the

Analyst's Notebook, to provide the desired data accessibility. The Notebook allows users to correlate data products from different instruments, documents decisions made about the rovers' actions, and provides access to documentation, software, and SPICE kernels. The Atlas allows users to download selected products and the Data Search allows the user to apply desired search criteria.

### **Minor Strengths**

The Mars 2020 Project has archived data to the PDS in accordance with their nominal delivery schedule and most data deliveries to the appropriate PDS nodes were complete, ensuring rapid community access and dissemination of future scientific data. The Mars 2020 Project has completed fourteen public data releases, adhering to the modified seven-month release schedule agreement between the Mars 2020 Project, PDS, and NASA Headquarters. The data deliveries to the PDS and the community occurred in 120-sol increments, in PDS4 format, and were generally on schedule according to the PDS Mission Report Card.

The Sample Dossier provides records and context for samples cached during the mission, which would be invaluable when the sample is retrieved in the future.

### **Major Weaknesses**

**Some data products are not archived to the PDS in a timely manner and according to the PSD Mission Report Card.** Specifically, only a portion of the Mars 2020 Sample Dossier Bundle has been delivered (the Initial Report pdfs, accessible here: [https://pds-geosciences.wustl.edu/missions/mars2020/returned\\_sample\\_science.htm](https://pds-geosciences.wustl.edu/missions/mars2020/returned_sample_science.htm)). The data bundle is intended to include relevant engineering data related to the acquisition of each drill sample. Also, the Engineering Camera RDRs delivery are delayed due to multiple Mastcam-Z RDR Ops bundles being paused/delayed for releases 2-8. Finally, the release of the Rover Target and Rover Science Intent bundles have also been delayed.

### **Minor Weaknesses**

The Mission Report Card notes several end-to-end validation tests, but these processes are not described in the Project Data Management Plan.

### **ADDITIONAL NOTES**

## **Mars 2020 Mission Staffing Concerns**

Staffing changes and insufficient Mars 2020 Project resources have been the main issue causing the delay in data archival noted in the major weakness above. Progress is being made on these delayed deliveries, but at a slower pace than required.

### **SPD-41a efforts**

In preparation for Senior Review, the Mars 2020 Project team updated this Data Management Plan to include sections to specifically address SPD-41a. This mission is not required to comply with SPD-41a, and we applaud efforts to assess how well-aligned the Mars 2020 Project is with current mission expectations. With respect to data management, the project conforms to SPD-41a with one exception. As detailed in section 2.4, the six-month requirement was relaxed, per agreement between the Mars 2020 Project, PDS, and NASA Headquarters to allow for data to be delivered to the PDS within seven months after its receipt on Earth. With regards to software, the project is not in compliance with SPD-41a, as mission support software for the project is not being developed or released as open-source software. At this point in the project, open sourcing the project's software would be cost prohibitive. The project instead plans to archive the documentation of algorithms and/or software used to produce reduced data records.

### **Conversion of legacy data to PDS4 format**

The Mars 2020 archives are compliant with the PSD4 standard and information model and are delivered to the PDS in PDS4 format.

## Panel Members

Panelist	Institution	Role
Melissa Lane	Fibernetics LLC	RC
John Mustard	Brown U	GC
W. James Adams	NASA HQ (ret.)	P
Charles Cockell	U Edinburgh, UK	P
Frederic Foucher	CNRS, France	P
Christopher House	Penn State U	P
Thomas Lapen	U Houston	P
Gordon Osinski	U Western Ontario	P
Marisa Palucis	Dartmouth College	P
Dawn Sumner	UC Davis	P
Candace Gray	Boston U	ES
RC = Review Chair (non-voting) GC = Group Chief P = Panelist ES = Executive Secretary (non-voting)		