Project Data Management Plan (PDMP)
New Horizons Data Management and Archiving Plan (DMAP) for the Second Kuiper Extended Mission (KEM2)

May 2023

SwRI® Project 05310

Document No. 05310-DMAP-01
Rev 3 Chg 0

Contract NASW-02008

New Horizons Data Management and Archiving Plan

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Document No. 05310-DMAP-01, Rev 3

Contract NASW-02008

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REVISION NOTICE

Initial Issue: February 2016
Rev 1 Chg 0: May 2018: Update for KEM1
Rev 2 Chg 0: January 2022: Update for KEM1 extended to 2022 and KEM2 (FYs 2023–2025)
Rev 3 Chg 0: May 2023: Updates for KEM2 and removed KEM1 section

1. Introduction

This document defines the process of archiving data from the New Horizons mission with NASA's Planetary Data System (PDS), Space Physics Data Facility (SPDF), and the Mikulski Archive for Space Telescopes (MAST), including the design, generation, validation, and transfer of the data archive to those archives. The archive includes formatted raw, calibrated, and derived science data and navigation and housekeeping data necessary for the interpretation of the science data, as well as documentation. Section 3 of this document gives an overview of the New Horizons mission including the Ground Data System by means of which the data stream is converted into science data products. Section 4 specifies the roles of and assigns responsibilities to each of the participants in the archiving process and provides an overview of the steps necessary to produce the New Horizons data archive. Section 5 outlines the PDS-compliant KEM2 data archive. Section 6 provides the schedule for data archiving, Section 7 specifies the data release policy for the New Horizons mission, and Section 8 specifies the waivers New Horizons has been previously granted.

For reference, a list of examples of the New Horizons science data products expected from each instrument, a glossary of acronyms used in this document, and the New Horizons data level definitions are given in the appendices.

This Data Management and Archiving Plan applies to the New Horizons (NH) Second KB Extended Mission (KEM2) that spans FY23-24.

2. Applicable Documents

New Horizons Mission Science Definition (MSD) 7399-9000, October 27, 2003.
New Horizons Mission Operations Center to Science Operations Center Interface Control Document, November, 2004.
New Horizons Navigation to SOC ICD. 05310-SOCNAV-01, September, 2005.
New Horizons SOC to Instrument Pipeline ICD, 05310-SOCINST-01, September, 2017.
PDS3 Planetary Data System Proposer's Archive Guide (PAG), JPL D-26359, ver. 1.0, June 15, 2003.
PDS3 PDS Data Preparation Workbook (DPW), JPL D-7669, Part 1, ver. 3.1, February 17, 1995.
PDS3 PDS Standards Reference (SR), JPL D-7669, Part 2, version 3.8, February 27, 2009.
PDS4 Planetary Data System Standards Reference, JPL D-7669, Part 2, ver. 1.16.0, April 21, 2021.
NASA SMD Policy Document SPD-41, version 1.0, June 30, 2021.
PDS4 Planetary Data System Mission Proposer's Archiving Guide (MPAG), ver. 5.0.0, April 20, 2019.

3. Overview of the New Horizons Mission

3.1 Mission Background

New Horizons is the first mission in NASA's New Frontiers program of the Office of Space Science. New Horizons was selected in response to NASA AO 01-OSS-01. New Horizons is a PI-led mission.

The New Horizons spacecraft was launched on January 19, 2006 and executed a Jupiter gravity assist in early 2007. Jupiter encounter science data were downlinked over the following months. The flyby exploration of the Pluto/Charon system was the primary target of the prime mission. The NH Pluto/Charon flyby closest approach occurred on July 14, 2015.

Downlink of Pluto/Charon encounter data to Earth completed in late October of 2016. Shortly after the Pluto/Charon encounter, New Horizons was retargeted to its January 1, 2019 flyby with Arrokoth, a Kuiper Belt Object (KBO) as the primary objective of the KEM1 mission. The objectives of the KEM2 mission expanded to include studies in heliophysics and astrophysics, and continued planetary science observations for Kuiper belt objects and the gas giants Uranus and Neptune.

The scientific instruments aboard New Horizons are:

- Alice – an extreme and far ultraviolet spectrograph.
- Ralph – comprised of the Multispectral Visible Imaging Camera (MVIC) multispectral color imager and the Linear Etalon Imaging Spectral Array (LEISA) near-IR imaging spectrograph.
- REX – Radio Science EXperiment, radio science package that uses ultra-stable oscillators integrated into the New Horizons telemetry system to determine the atmospheric profile of Pluto and to measure bistatic radar reflections and to measure X-band (4 cm) brightness temperatures.
- LORRI – Long Range Reconnaissance Imager, high-resolution panchromatic imager.
- PEPSSI – Pluto Energetic Particle Spectrometer Science Investigation, medium-energy particle spectrometer.
- SWAP – Solar Wind Around Pluto, low-energy plasma and solar wind instrument.
- SDC – Student Dust Counter, dust detector that counts impacts by interplanetary dust as a function of impactor mass, throughout the mission.

3.2 Ground Data System

The New Horizons Ground Data System converts the raw spacecraft data stream to science data products. The Mission Operations Center (MOC), located at the Johns Hopkins Applied Physics Laboratory (APL), receives telemetry frames from DSN and processes them through Committee on Data Management, Archiving and Computing (CODMAC) Level 1 (New Horizons Levels 0, 0a, and 0b; see Appendix C for CODMAC and New Horizons data-level definitions). The MOC provides the CODMAC Level 1 data to the mission's SwRI-run Science Operations Center (SOC) in the form of Supplemented Telemetry Packets (STPs), which consist of standard Consultative Committee for Space Data Systems (CCSDS) telemetry packets with prepended blocks of supplementary data. Navigation data, including spacecraft and planetary ephemerides, and spacecraft pointing data, are relayed to the SOC in SPICE format. The New Horizons SOC has two principal locations, the Tombaugh Science Operations Center (TSOC) located at SwRI-Boulder and the Contingency Science Operations Center (CSOC) at APL.

The SOC supports the Science Team for processing and analysis of NH science data. It provides easy access to all the data required by the Science Team and the MOC. The SOC accepts and processes telemetry, command-history, and navigation data to produce decommutated raw data, creating the telemetry and calibration file archive. The SOC archives all the decommutated raw data with PDS.

The SOC processes the decommutated raw data using automated software and calibration files provided by the Instrument Teams to produce calibrated data products, which are archived by the SOC to PDS. Derived data products (e.g., maps and mosaics) are produced by the Science Theme Teams and archived by the SOC to PDS. Some derived data products are also archived at MAST (for astrophysics data) and SPDF (for heliophysics data). Deliveries to SPDF and MAST will be made directly from the New Horizons team and does not involve the PDS.

4. Archiving Functions

4.1 Overview

This section describes the structure and content of the New Horizons data archive, as well as the responsibilities of the different teams comprising the New Horizons project in producing the components of the data archive.

The New Horizons archive contains science data products from each of the instruments, spacecraft and instrument housekeeping telemetry, navigation and geometry data from the SPICE information system, algorithm definitions, and sufficient documentation of the data, instruments, and mission to enable future scientists to understand and use the archive.

Production of the New Horizons archive involves design of the archive structure and contents, generation of the archive components, component validation, and final bundling and delivery. The science data products form the core of the archive, and a preliminary list of data products expected from each of the instruments is given in Section 5.

4.2 Roles and Responsibilities

The responsibilities for data archive generation, validation, documentation, delivery, review, and storage and maintenance are distributed among a number of different organizations both within the New Horizons mission and outside of it. These organizations include the New Horizons SOC, Instrument Teams, and Science Theme Teams, public archives, and the National Space Science Data Coordinated Archive (NSSDCA). The following sections outline the specific responsibilities of these contributors.

4.2.1 Science Operations Center (SOC)

The SOC is responsible for producing and validating the decommutated raw science data files from CODMAC Level 1 science data packets provided by the MOC. The SOC will deliver to PDS and other archives the CODMAC Level 2 and higher data files and calibration files. It will also collect from the MOC, provide to the Science Theme Teams, and deliver to PDS the spacecraft ephemeris and spacecraft attitude records in SPICE format. Derived data products produced by the Science Team will be delivered to the SOC.

The SOC creates calibrated data products using automated data processing pipelines provided by the instrument teams.

The SOC coordinates the delivery of all data products to the PDS and MAST. As described below (Sections 4.2.2 and 4.2.3), the Instrument Teams and Science Theme Teams will deliver data products to the SOC, and the SOC will assemble the delivered data products and make the final archive volumes available for download by the respective archive groups. For the heliophysics data, the instrument teams deliver the data directly to the SPDF.

The SOC is responsible for clearing all liens generated by the review process on products delivered to the archives with assistance and guidance from the Instrument and Science Teams.

Within each delivery of data products to the PDS and MAST, the SOC will provide the location and archival version number of all SPICE kernels used to create and validate the data

The designated SOC contacts for New Horizons are as follows:

- Alan Stern for science issues
- Joel Parker for all data archiving issues

4.2.2 **Instrument Teams**

The New Horizons project includes Instrument Teams for the Ralph (MVIC and LEISA), Alice, REX, LORRI, PEPSSI, SWAP, and SDC instruments. Each Instrument Team is responsible for delivering to the SOC software source code for calibration and its associated documentation. Note that raw instrument telemetry is not included in the New Horizons archive. Also, pre-launch instrument data was not included in the archive, except for those data which the Instrument Teams designate as necessary for calibration of downlinked science data.

Each Instrument Team is responsible for providing the SOC with pipeline data calibration software suitable for calibrating instrument data in an automated environment. This software shall comply with interface specifications developed by the SOC in consultation with the Instrument Teams and shall be provided in one of the programming languages specified in the New Horizons SOC-to-Instrument Pipeline Interface Control Document (ICD) documents. The automated pipeline calibration software shall be used by the SOC in order to produce calibrated data products (see Section 4.2.1, above). Each Instrument Team is responsible for assisting the SOC in clearing all liens generated by the archive review process on products produced by his/her team's software.

4.2.3 **Science Theme Teams**

For KEM2, the Science Theme Teams are: Planetary Science (led by W. Grundy), Heliophysics (led by F. Bagenal), Astrophysics (led by T. Lauer), and Geology and Geophysics Imaging (led by J. Moore). Each Science Theme Team leader is responsible for delivering to the SOC a complete and validated archive of derived data products produced by the team, along with associated documentation. The Science Theme Teams deliver these data products to the SOC at least three months prior to the PDS archive date, consistent with the PDS delivery schedule outlined in Section 6. The SOC shall in turn deliver the complete data archive to PDS and other pertinent archives.

The leader of each Science Theme Team is responsible for assisting the SOC in clearing all liens generated by the archive review process on products produced by their team.

4.2.4 **PDS Small Bodies Node (SBN)**

PDS is the primary archive for NH providing peer-review and standards validation, .and all raw and calibrated data are archived there. PDS has designated the Small Bodies Node (SBN) as the lead node for interfacing with the New Horizons mission. Designation of a lead node greatly simplifies the PDS interface. The lead node will be supported by other PDS nodes, which may include the PPI node (particles and plasmas data), the radio science sub-node (radio science data), the imaging node (imaging data), the atmospheres node, and/or the NAIF node (SPICE data). Specific functions of PDS SBN are to:

a) Support the generation of the archive by advising the project/science teams on PDS archive standards, requirements and documentation needs. PDS will also support the data validation activity to ensure that the formal peer review process, a requirement for data ingestion into PDS, proceeds with a minimum of problems.
b) Conduct a formal peer review of the archive, as mandated by PDS prior to acceptance of archive data.
c) Advise New Horizons SOC, Instrument Teams, and Science Theme Teams in the resolution of liens that arise in the course of the peer review.
d) Provide the data archive volumes to NSSDCA.
e) Convert New Horizons Prime Mission and KEM1 PDS3 data archives to PDS4

The designated PDS SBN contacts for New Horizons are as follows:

- Lori Feaga for science and policy issues, with the oversight of James Bauer (SBN PI) and Ludmilla Kolokolova (SBN UMD Manager),
- Tilden Barnes and Ben Hirsch for technical issues, with the oversight of Anne Raugh (SBN lead engineer).

4.2.5 National Space Science Data Coordinated Archive (NSSDCA)

The NSSDCA will maintain a deep archive of KEM2 data for long-term preservation and for filling large delivery orders to the science community and other customers. PDS SBN will submit all KEM2 PDS-archived data products to NSSDCA for deep archive. NSSDCA is responsible for top-level data management of New Horizons data and for selected discipline-specific responsibilities defined by mutual agreement between the NSSDCA and the relevant SMD program division. New Horizons does not have any responsibility for direct interactions with the NSSDCA.

4.2.6 Heliophysics Data Archives

In KEM2, HSO-relevant data products collected over the period of FY23-24 will be archived at the Space Physics Data Facility (SPDF). The SPDF currently contains several New Horizons datasets from the Prime Mission and KEM1:

(1) New Horizons Ephemeris, Heliocentric Trajectories, Heliographic, Heliographic Inertial, and Solar Ecliptic Coordinates, HelioWeb, Daily Data

(2) New Horizons Solar Wind Around Pluto (SWAP) Count Rate Histogram Arrays

(3) New Horizons Solar Wind Around Pluto (SWAP) Pick-Up Ions Fit Results

(4) New Horizons Solar Wind Around Pluto (SWAP) Solar Wind Fit Results

(5) New Horizons Student Dust Counter (SDC) dust impact rate and spatial density data.

The data files are in CDF format and for Prime Mission and KEM1 were delivered from the SWAP team to the SPDF.

The KEM2 archive will contain PEPSSI and Alice data in addition to an archive for SWAP. The new products will continue to be derived data products, with the raw and calibrated data residing at the PDS. The SWAP team will assist the PEPSSI and Alice teams with archiving procedures with SPDF.

4.2.7 Astrophysics Data Archives

In KEM2, Astrophysics-relevant data products collected over the period of FY23-24 will be archived at the Mikulski Archive for Space Telescopes (MAST). The KEM2 archive will contain LORRI Cosmic Optical Background (COB), Alice Cosmic Ultraviolet Background (CUVB), and Alice Local Interstellar Medium (LISM) data.

MAST prefers having “science ready” products be delivered to the archive, so the Astrophysics team (through the SOC) will deliver derived data products to the MAST. These data products will be in the PDS format to align with what is delivered to the PDS/SBN.

4.3 Archive Generation

Responsibility for generating archive components is specified in Section 5. Science data products will be generated in PDS-compatible formats (e.g., FITS image and table files). Each data file (data table or image file) will be in a format approved by PDS and will be accompanied by a PDS "label," which is a detached header file describing the content and structure of the accompanying

data file. Metadata necessary to interpret the data (e.g., spacecraft ephemeris and attitude records, command histories, and spacecraft housekeeping files) will be provided as ancillary archive components. In addition, files documenting the archive components will be prepared by the parties generating the data. In general, all information necessary to interpret and use the data shall be included in the archive.

In place of the PDS3 “catalog files” used to provide high-level descriptions of the mission, the instruments, and the individual data sets submitted, the PDS4 system uses “context objects” that serve as hubs for associating various parts of the archive with the mission, instrument, etc., and labeled documents to provide the high-level, human reader-friendly descriptive information. Most context objects needed for the KEM2 archive already exist. SBN will create the mission context object and any additional context objects that might be needed, soliciting input from the SOC archive contact as needed for context object creation and for any updates that might be appropriate for existing context objects. New overview documents for the mission and data collections will be part of the archive submitted to PDS for review; updates to existing documents, if needed, can be submitted to PDS with the review submission as well.

4.4 Archive Validation

Data validation falls into two types, validation of the actual data (the data are scientifically plausible and useful), and validation of the compliance of the archive with PDS archiving requirements (the data products are correctly described and readable within the PDS system). The first type of validation will be carried out by the Instrument Teams and Science Theme Teams, and the second will be overseen by the PDS, in coordination with the SOC and the Science Team. The schedule of PDS deliveries will facilitate validation by ensuring that problems in the early deliveries are resolved by the time of the later deliveries and the final archive.

The formal validation of data content, adequacy of documentation, and adherence to PDS archiving standards is subject to external peer review. Each peer review will be scheduled and coordinated by the PDS. The peer review process may result in "liens", actions recommended by the reviewers or by PDS personnel to correct the archive. All liens must be resolved by the dataset providers: the SOC for decommutated raw data; the SOC with input from the Instrument Teams for calibrated data, calibration data, calibration algorithms, and relevant SPICE kernel updates; and the Science Theme Teams and the SOC for derived data products. Once the liens are cleared, PDS will do a final validation prior to bundling and delivery.

4.5 Final Bundling and Delivery

The New Horizons SOC shall be responsible for assembly, bundling, and delivery of all archive data to PDS. Responsibilities of the Instrument Teams and Science Theme Teams for delivering archive data to the SOC are delineated in previous sections of this document. The SOC will deliver archive data sets to PDS electronically or on appropriate temporary storage media as negotiated between the project and SBN.

The archive delivery schedule for New Horizons KEM2 is outlined in Table 2 in Section 6. All Prime Mission and KEM1 datasets have been delivered on schedule. The final KEM2 data archive will have its delivery in August 2024 during KEM2.

Calibrated scientific data are produced at the SOC using automated calibration pipelines provided to the SOC by the instrument teams. Raw, calibrated, and derived scientific data products are archived at the same time as reflected in the schedule in Section 6.

4.6 PDS3 to PDS4 Migration for Prime Mission and KEM1

The Small Bodies Node (SBN) will be handling the migration of the Prime Mission and KEM1 data archives from PDS3 Standard to PDS4 Standard. The SBN developed a workflow around the PDS *MILabel* tool for converting PDS3 data products to PDS4 products in their local environment, and will make their notes, scripts, and instrument-specific input to *MILabel* available to New Horizons, as well as providing label design templates and prototypes. SBN will coordinate further development of the NH PDS4 mission dictionary with New Horizons, as well as any further development of collections referenced across missions (documentation and calibration collections, primarily) and already converted to PDS4 as part of the migration effort. These items will assist the New Horizons project with creating PDS4 Standard bundles for KEM2 if needed.

It has been agreed between the New Horizons project and SBN that the K6 delivery of data to PDS will be in PDS3 format, and the SBN will migrate those data to PDS4 format as they did for the previous phases.

5. The New Horizons KEM2 Archive

5.1 Overview

The New Horizons KEM2 archive design will follow the patterns established in the primary and KEM1 mission data archives. A typical bundle will contain data from a specified mission phase time interval (i.e., K6, K7).

5.2 Archive Content

Each data collection holds the corresponding raw or calibrated data corresponding to mission phase for a given instrument. Details of what is in the raw datasets and the calibrations performed to generate the calibrated datasets can be found in the SOC-to-Instrument ICD. For the derived data products, an example list of these upper-level data products from the Pluto flyby generated by each of the New Horizons Science Theme Teams is given in Appendix A.

5.3 Archive Data Volume

Archive data bundle estimates for the New Horizons KEM2 are given in Table 1, broken down by instrument (or component). The values in this Table are based on estimates of planned observations for KEM2. The datasets incorporate the following:

Description	Size
Decommutated and Formatted Raw Data	2 x Raw
Data Quality Flags	
Calibrated Data	3-5 x Raw
Data Uncertainty	
Data Quality Flags	
Derived Data Products	5-25 Gbit
(Note: This is a ROM estimate).	

The data volume estimate for SPICE data is twice the size of the aggregate SPICE files for the mission, because both predicted and after-the-fact (reconstructed) spacecraft ephemeris and attitude kernels will be included in the archive. The total estimated data volume for KEM2 New Horizons mission, not including derived data, is 254 Gbit, where a gigabit (Gbit) shall be interpreted as 10^9 bits. This is equivalent to about 47 gigabytes (GB), where a gigabyte shall be interpreted as 10^9 bytes.

For KEM2, the derived data products are expected to add another 5-25 Gbit to the total archive size.

Table 1. Data Volume Estimates of KEM2 for Archive Components (Based on Science Activity Plans)

Archive Component	**Data Type Examples**	**Estimated KEM2 Archive Volume (Gbits[1])**
MVIC (Ralph)	Raw Images Instrument housekeeping Calibrations Calibrated Images Image Mosaics Support Data	4
LEISA (Ralph)	None	1
ALICE	Raw Spectra Instrument housekeeping Calibrated Spectra Atmospheric Profiles	5
REX	None	2
LORRI	Raw Images Instrument housekeeping Calibrations Calibrated Images Image Mosaics Support Data	25
SWAP	Raw Counts Solar Wind Parameters	81
PEPSSI	Raw Counts Particle Spectra Angular Distributions	132
SDC	Raw Counts Particle Size Distribution	3
Navigation	SPICE Kernels	1
Documentation	Catalog files, Mission History Files	0[2]
Total archive		**254**

[1] The term gigabit (Gbit) as used here shall be interpreted as 10^9 bits.

[2] Values of 0 for ancillary data are intended to indicate that the data volume is expected to be negligible compared to the scientific data.

5.4 Archive Design

The datasets to be archived by the New Horizons project are organized on a number of different levels. For KEM2, phases include Post Encounter (called K6–K7 by PDS), as defined in Table 2.

At the highest level, the primary data products will be organized by mission phase and instrument, with a second-level division for processing level. Within the delivered submission, data files and directories will be ordered by MET. Documentation, calibration files for each instrument, and data products derived from observations by more than one instrument will be delivered in an appropriate organization as agreed upon by the New Horizons and SBN when the details of these smaller product collections are known.

6. Schedule for Archive Generation, Validation, and Delivery

The principal archive elements, namely the science data products defined in Section 5 will be generated during the course of the mission, as will many ancillary products such as SPICE files. The timeline for archive delivery to PDS is included in Table 2, and must take into account both the time required for downlink and that required for processing and validation.

Following data delivery to PDS, the data will be peer reviewed by PDS. Liens that are identified by the peer review process will be rectified by New Horizons. Final acceptance of the data by PDS will occur after liens have been cleared. The early deliveries of data to PDS, most particularly the Jupiter and Pluto flyby data, helped to identify potential problems early in the mission, thus reducing liens on the data that could have required significant resources to correct in the final archive.

Table 2**.** Schedule Key Mission Events and PDS Data Deliveries for KEM2

Event	**Nominal Date**
Kuiper Belt Cruise Science Phases	5/2022 – 4/2024
KP10 Cruise	5/2022 – 4/2023
KP11 Cruise	5/2023 – 4/2024
KEM2 PDS Deliveries	8/2023 – 8/2024
PDS Data Delivery (K6). • Instrument data from Arrokoth Encounter and KP4 through KP10 Cruise on ground by 4/30/2023 Decommutated Raw and Calibrated Data	8/2023
PDS Data Delivery (K7). • Instrument data from Arrokoth Encounter and KP4 through KP11 Cruise on ground by 4/30/2024 Decommutated Raw and Calibrated Data Derived Data K7 will be a cumulative update to K6 THIS IS THE FINAL PDS DELIVERY FOR KEM2. Note: At this point, all KEM2 data archiving will be delivered to the PDS.	8/2024

7. New Horizons Data Release Policy

All science data from the New Horizons mission are available to the public. Selected uncalibrated and other data, particularly image data, will be publicly released by the New Horizons project over the internet in close to real time if a flyby target is found. Calibrated and peer-reviewed datasets for each mission phase are archived with the PDS. The full New Horizons Project Data Policy is given in Appendix D.

Fully reduced, calibrated, and corrected data products will be produced under the direction of the SOC, Instrument Teams, and Science Theme Teams for delivery to PDS per the schedule given in Section 6. The PI and Science Theme Team Leads are responsible for coordinating New Horizons scientific investigations and ensuring that science data products are delivered in a timely fashion.

Unless otherwise directed by NASA, all SMD-funded publications produced by New Horizons team members will be deposited in NASA's PubSpace repository. During KEM2, all New Horizons funded as-accepted peer-reviewed publications written after the start of KEM2 will be deposited no later than 12-months after their publication date, in order to meet the requirements of SMD Science Information Policy Document SPD-41a.

8. New Horizons KEM2 Waivers

The New Horizons project was granted waivers for two items described in the SMD Science Information Policy Document SPD-41a.

Waiver (1): The New Horizons project was granted a waiver from the new requirements described in SPD-41a of archiving all past and current software. This would be time intensive and cost intensive activities that were not conducted in any prior mission phases (because they were not required) and are not currently budgeted for in the New Horizons KEM2 budget.

Waiver (2): The New Horizons project was granted a waiver to archive the mission data once per year, rather than once every 6 months. SPD-41a states “There shall be no period of exclusive access to Mission data. A period after the data have been obtained may be allowed for activities such as calibration and validation of the data. This period shall be as short as practical and shall not exceed six months.” NH interprets “obtained” as the ground receipt of the data at the DSN. NH will downlink data as able, but with the relatively low data rates from New Horizons and the fact that NH is planning to hibernate and periodically conduct observations one or a few times per year at most, a yearly PDS cadence is considerably more practical and cost effective.

Appendix A
EXAMPLE NEW HORIZONS DERIVED PDS SCIENCE DATA

The following are examples of derived (i.e., CODMAC Level 5) data products that were produced for archiving by the PDS for the Pluto mission phase. Note that any derived data products the project chooses to deliver, including some or all of the examples listed below, or others, are in addition to the CODMAC Level 2-4 data (and supporting SPICE/ancillary data) described elsewhere in this document. For KEM1, the derived science data products were of a similar type to the prime mission though there were some differences – for instance, the atmospheres products were not produced, but full body and stereo shape models of Arrokoth were produced. For KEM2, it is assumed no flyby target will be found, thus there will be fewer products, but NH still anticipates delivering a few higher-level products based on Arrokoth data (e.g., updated shape models).

ATMOSPHERES

- Wavelength-dependent solar and stellar atmospheric occultation profiles
- Lower atmospheric temperature and pressure profiles
- Atmospheric composition profiles for selected species
- Atmospheric haze/cloud profiles

GEOLOGY, GEOPHYSICS, AND IMAGING

- Global monochrome maps
- Shape models
- Regional stereo maps (digital elevation models)

PARTICLES AND PLASMA

- Solar wind density, velocity, and ion temperature along New Horizons trajectory
- Time series of dust particle counts along the mission trajectory
- Particle size distribution of dust along the mission trajectory

COMPOSITION

- MVIC
    - Global monochromatic maps
    - Global color maps
    - Registered color images
- LEISA
    - Calibrated spectral image cubes
    - Spectral maps
    - Composition maps

Appendix B
GLOSSARY OF TERMS AND ACRONYMS

TERMS

Catalog object	-	A PDS required file formally documenting the details of a mission, spacecraft, instrument, or data set.
Label	-	An attached or detached header which formally describes the structure and content of a data file.
Lien	-	An action recommended by reviewers or PDS personnel to correct the archive.
Template	-	Generic file format for instantiation as a catalog object
Volume	-	A single CD-ROM or other volume of a storage medium.

NAMES AND ACRONYMS

Alice	-	The New Horizons ultraviolet mapping spectrograph.
AID	-	PDS Archive Interface Document.
APL	-	Applied Physics Laboratory, Johns Hopkins University.
ATM	-	ATMospheric Studies Team.
C&DH	-	Command and Data Handling system for the New Horizons spacecraft.
CCSDS	-	Consultative Committee for Space Data Systems.
CODMAC	-	Committee on Data Management And Computation. CODMAC standard data level definitions are required for data products archived to the PDS.
COMP	-	COMPosition Science Theme Team
CSOC	-	Contingency Science Operations Center (at APL).
DPW	-	PDS Data Preparation Workbook.
DSN	-	Deep Space Network.
GGI	-	Geology and Geophysics Imaging team.
GSE	-	Ground Support Equipment.
JCA	-	Date of Jupiter closest approach.
JPL	-	Jet Propulsion Laboratory.
KB	-	Kuiper Belt.
KBO	-	Kuiper Belt Object.
KEM1	-	First KB Extended Mission
KEM2	-	Second KB Extended Mission
LEISA	-	Linear Etalon Imaging Spectral Array. This is the IR wavelength detector of the Ralph instrument.
LORRI	-	Long Range Reconnaissance Imager. The New Horizons long focal length imager.

MOC	-	Mission Operations Center
MVIC	-	Multispectral Visible Imaging Camera. This is the visible wavelength detector of the Ralph instrument.
NAIF	-	Navigation and Ancillary Information Facility at JPL, leads the design and implementation of the SPICE system and is a node of PDS.
NASCOM	-	NASA Communications.
NEAR	-	Near Earth Asteroid Rendezvous.
NH Level	-	New Horizons Level. Indicates use of the mission legacy data level definitions.
NSSDCA	-	National Space Science Data Coordinated Archive.
P&P	-	Particles and Plasmas team.
PCA	-	Date of Pluto closest approach.
PDS	-	NASA's Planetary Data System archive.
PEPSSI	-	Pluto Energetic Particle Spectrometer Science Investigation. A medium energy particle spectrometer.
PPI	-	Planetary Plasma Interactions, a discipline node of the PDS.
Ralph	-	The instrument consisting of the MVIC and LEISA detectors along with their common electronics, housing, optical elements, radiator, thermal control system, and mounting flexure system.
REX	-	The Radio Science Experiment, a New Horizons experiment package.
SBN	-	Small Bodies Node. The PDS lead node for New Horizons.
SCM	-	Surface Composition Mapping team.
SDC	-	Venetia Burney Student Dust Counter. The interplanetary dust distribution mapping instrument.
SOC	-	Science Operations Center.
SPICE	-	Spacecraft, Planet, Instrument, C-matrix, Events. The information system of ancillary data products for navigation and geometry definition, managed by NAIF.
SR	-	The PDS Standards Reference.
SWAP	-	Solar Wind Around Pluto. The New Horizons solar wind and low-energy plasma instrument.
TSOC	-	Tombaugh Science Operations Center (primary SOC facility, hosted at SwRI).

Appendix C
NEW HORIZONS AND CODMAC DATA LEVEL DEFINITIONS[1]

NH	CODMAC	Description
0	1	The raw telemetry data as received at the ground receiving station or ground test GSE, organized by contacts or ground test.
0a		The telemetry data as produced by the C&DH system on the spacecraft and passed to the telemetry subsystem. NASCOM headers and trailers have been separated. NH Level 0a contains transfer frame packets organized by contacts or ground tests.
0b		The transfer frame packets plus radiometric tracking data, all organized by contacts or ground test.
1		NH Level 0b data that have been cleaned and merged, time ordered, and in packet format. Cleaned and merged means that duplicate data have been deleted, missing packets are padded out, and the data are organized by days. The actual format of these data is the same as NH Level 0b. This is the level that should be passed to the instrument GSE's for their processing.
1a		The NH Level 1 data that have been separated by instrument.
1b	2	Fully decommutated raw data. The NH Level 1a data that have been sorted by instrument data types and instrument modes. Data are in scientifically useful form, e.g., as images or individual spectra. These data are still uncalibrated.
2	3 (4)	Calibrated data. NH Level 1b with calibration and corrections applied to yield data in scientific units. Note: The data at this level will generally correspond to CODMAC Level 3. If a calibration algorithm involves irreversible transformations of the data, however, the data products will correspond to CODMAC Level 4.
3	5	Derived data products. The derived data products developed for specific scientific investigations.

[1]CODMAC data levels for PDS archives are defined in the Planetary Data System Standards Reference (JPL D-7669, Part 2), p. 6-6 (version of August 1, 2003).

Appendix D
NEW HORIZONS PROJECT DATA POLICY

This is a summary of the data analysis and release policies for the New Horizons Project. It is meant to cover the pre-flight, post-launch, and data analysis activities of the New Horizons Mission Science Team and associated scientists. The New Horizons Data Policy is based upon a set of three general principles, referred to below as ground rules that apply to planetary missions funded by NASA. To implement these principles, guidelines are adopted as given below. These guidelines are applicable to the period prior to the submission of mission data to the Planetary Data System, after which the data are freely and publicly available through PDS. These policies will also be informed by SMD Policy Document SPD-41a.

Ground Rules

- Fully reduced, calibrated and corrected data products will be published and forwarded to the Planetary Data System annually after they have been generated and validated.
- The Project strongly encourages shared data analyses, under the direction of the teams whose data are being used, among members of different instrument teams.
- The PI, the Project Science Team, Instrument Teams Leads, and Science Theme Team Leads are responsible for coordinating all scientific investigations involving the use of data from New Horizons.

Guidelines

- In the interest of a systematic and orderly data analysis, the PI must approve of all scientific investigations by non-team members involving the use of data from the mission instruments. This applies only to data not yet available through the PDS archive.
- Likewise, the PI must approve of all plans to release or to publish calibrated data not yet available through the PDS archive. In this context, 'to publish' includes not only journal articles but also abstracts and public scientific meeting presentations.