National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

September 18, 2017

Reply to Attn of: 429

RECORD OF ENVIRONMENTAL CONSIDERATION

Landsat 9 (L9) National Environmental Policy Act Compliance

1.0 Introduction

The National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. § 4321, et seq.), requires Federal agencies to consider the project's environmental impacts in its decision making process. To comply with NEPA and associated regulations (the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA [40 C.F.R Parts 1500-1508] and NASA policy and procedures [14 C.F.R, Part 1216, Subpart 1216.3]), NASA prepared the "Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles," (November 2011). The 2011 NASA Routine Payload Environmental Assessment (NRPEA) assesses the environmental impacts of missions launched with spacecraft that are considered routine payloads from existing launch facilities at Cape Canaveral Air Force Station (CCAFS), Florida; Vandenberg Air Force Base (VAFB), California; the United States Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS) in the Republic of the Marshall Islands (RMI); NASA's Wallops Flight Facility (WFF), Virginia; and the Kodiak Launch Complex (KLC), Alaska.

Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles, launch sites, and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at VAFB, CCAFS, USAKA/RTS, WFF, KLC, and the Kennedy Space Center (KSC). The environmental impacts of launching routine payloads from these sites fall within the range of routine, ongoing, and previously documented impacts that have been determined to be insignificant. Spacecraft within the scope of this Environmental Assessment (EA) meet specific criteria ensuring that the spacecraft, its operation, and decommissioning, do not present any new or substantial environmental or safety concerns.

To determine the applicability of a routine payload classification for a mission, it is evaluated against the criteria defined in the EA using the Routine Payload Checklist (RPC).

2.0 Mission Description

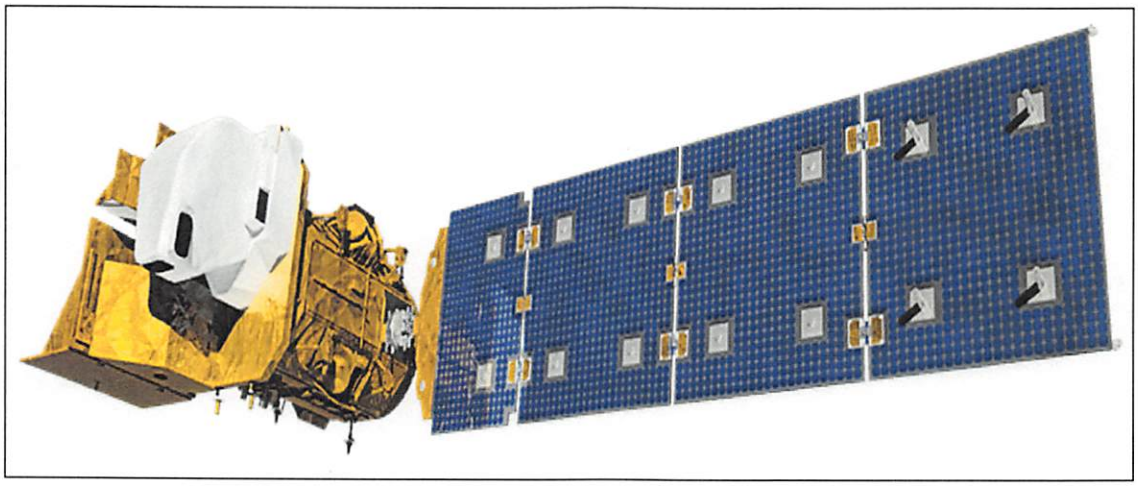
The Landsat satellites were the first designed for observing land surfaces. They provide the longest continuous record of the Earth's surface as seen from space. Landsat gave the world the first unabridged perspective of human-induced large-scale environmental changes, such as the rapid expansion of desert cities like Dubai and Las Vegas, the deforestation of the Amazon rainforest, and the disappearance of the Aral Sea. Landsat related research has led to the implementation of

many socially beneficial applications, such as improved water management techniques, crop insurance fraud reduction, natural disaster relief planning, continental-scale carbon estimates, and extensive cartographic advances.

Landsat satellites have continuously acquired multispectral images of the global land surface since the launch of Landsat 1 in 1972. The Landsat data archive constitutes the longest moderate-resolution record of global land surface as viewed from space. L9 is the latest satellite in the Landsat series. It will continue Landsat's irreplaceable record of the Earth's land surface upon its 2020 launch. To reduce the build time and risk of a gap in observations, L9 will largely replicate its predecessor Landsat 8.

Landsat is a joint program between NASA and the U.S. Geological Survey (USGS). The lead centers for the program are NASA's Goddard Space Flight Center (GSFC) and the USGS Center for Earth Resources Observation and Science (EROS) in Sioux Falls, South Dakota. L9 is composed of three mission segments: the space segment (spacecraft and instruments), the launch segment, and the ground segment. NASA is responsible for developing the space and launch segments, and USGS is responsible for developing the ground segment and operating the mission after on-orbit checkout.

L9 has two instruments, the Operational Land Imager 2 (OLI-2), and the Thermal Infrared Sensor 2 (TIRS-2). The OLI-2, built by Ball Aerospace in Boulder, CO, is a reflective-band multi-channel Earth-imaging instrument to detect and quantitatively characterize changes on the global land surface at a scale that can detect and differentiate natural and man-made causes of change. The TIRS-2, built in-house at GSFC, is a thermal infrared imaging instrument with two spectral bands that are complementary to the reflective bands sensed by OLI-2. The spacecraft handles power, propulsion, data storage/downlink, and housekeeping. Orbital ATK is responsible for the design and fabrication of the spacecraft.



Launch Services Program at KSC will competitively procure launch services. At this time, the launch vehicle has not been selected. The mission will launch from VAFB.

The primary components of the ground system are the Mission Operations Center (MOC), the Ground Network Element (GNE), and the Data Processing and Archive System (DPAS). The MOC will plan and schedule spacecraft activities, command and control the spacecraft, and

monitor the spacecraft and ground operating systems' health and status. The MOC will be located at NASA GSFC within existing facilities. The GNE will provide the hardware, software, and networks to communicate command and telemetry data with the MOC and mission data to DPAS. The GNE will utilize a variety of existing ground stations to communicate with the spacecraft for commanding and housekeeping data via the S-Band and to receive mission data from the spacecraft over the X-Band. The DPAS will ingest, process, distribute, and archive all L9 mission data. The DPAS will be located at the USGS EROS center in Sioux Falls, South Dakota within existing facilities.

3.0 NASA Routine Payload Determination

The components utilized for L9 are made of materials normally encountered in the space industry. The L9 mission will not utilize radioactive sources or lasers, will not carry any pathogenic organisms, and will not return samples to Earth. L9 plans to utilize a controlled reentry.

The 2011 NRPEA, using the RPC (see enclosed evaluation recommendation package), was used to evaluate the L9 mission. The evaluation indicates that the mission meets the criteria for a routine payload and falls within the scope of the reference EA. The launch vehicle selection is not yet complete. However, the candidate launch vehicle/launch site combinations all fall within the scope of the EA. The EA addresses site-specific impacts of these combinations. The L9 mission does not present any unique or unusual circumstances that could result in new or substantial environmental impacts. Based on the analyses set forth in the 2011 NRPEA, NASA has determined that the environmental impacts associated with the L9 mission will not individually or cumulatively have a significant impact on the quality of the human environment and that a routine payload classification for this mission is applicable. No additional NEPA action or documentation is required at this time. Once the launch vehicle/launch pad selection is made, the mission will be reviewed to ensure that the routine payload classification is still valid.

David F. Mitchell
Director of Flight Projects

8/31/17
Date

C J. Scolese
Christopher J. Scolese
Director

18 SEPTEMBER 2017
Date

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
Flight Project Environmental Checklist

Enclosure

NASA Goddard Space Flight Center
RECORD OF ENVIRONMENTAL CONSIDERATION (REC)

PROJECT NAME: LandSat 9

1. **Description of proposed action:** The Landsat 9 project is the successor to Landsat 8. The Landsat data archive is the longest continuous moderate-resolution record of the global land surface as viewed from space. The Landsat 9 mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and human-induced causes of change can be detected and differentiated.

Date and/or Duration of project: Launch - December 2020

2. It has been determined that the above action:

☒ a. Is adequately covered in an existing EA or EIS.
Title: *Environmental Assessment for Launch of NASA Routine Payloads*
Date: November 2011

☐ b. Qualifies for Categorical Exclusion and has no extraordinary circumstances per 14 CFR 1216.304 (c) which would suggest a need for an Environmental Assessment.

Categorical Exclusion: _____

☐ c. Has no significant environmental impacts as indicated by the results of an environmental checklist and/or detailed environmental analysis.

☐ d. Is exempt from NEPA requirements under the provisions of: _____

☐ e. Will require the preparation of an Environmental Assessment.

☐ f. Will require the preparation of an Environmental Impact Statement.

☐ g. Is addressed under EO12114.
- ☐ Is exempt from EO12114 requirements under the provisions of: _____
- ☐ Action not included under EO12114: _____
- ☐ Qualifies for an EO12114 categorical exclusion: _____
- ☐ Is adequately covered in existing documentation: _____
- ☐ Requires an environmental summary document: _____
- ☐ Requires EO documentation IAW 2-4. (a) i, ii, iii: _____

☐ h. Is not federalized sufficiently to qualify as a major federal action.

Beth Montgomery NEPA Manager, Code 250 — 8/1/17 Date

Del Jenstrom Project Manager, Code 429 — 8/21/17 Date

NASA Routine Payload Evaluation and Determination Process and Checklist

After a proposed spacecraft mission is sufficiently well formulated (usually the Phase B design study), the Sponsoring Entity, in coordination with the local Environmental Management Office (EMO), will prepare an environmental evaluation. An environmental evaluation is a preliminary review that determines what aspects of the proposal are of potential environmental concern. The environmental evaluation also assists in determining the appropriate level of National Environmental Policy Act (NEPA) documentation (i.e., environmental assessment [EA], or environmental impact statement [IEIS]) for the proposal. The local EMO uses a comprehensive checklist to provide a level of rigor to this early evaluation of the proposal, helping to ensure that pertinent considerations are not overlooked. Local EMO review of the Routine Payload Checklist (RPC, below) forms the basis for evaluating the applicability of a NASA Routine Payload (NRP) spacecraft classification for a proposed mission.

The local EMO uses the completed RPC (and required attachments) to evaluate the proposed mission against the NRP EA criteria. If the EMO evaluation of the RPC indicates that a NRP categorization may be appropriate, the Sponsoring Entity documents this in an Evaluation Recommendation Package (ERP). The ERP is then processed for review and approval in accordance with established National Aeronautics and Space Administration (NASA) procedures and guidelines. If approved, the ERP would be attached to a Record of Environmental Consideration (REC).

The Sponsoring Entity can then proceed with the proposal while monitoring the project activities, for changes or circumstances during implementation that could affect classification of the proposed mission as a NRP spacecraft. If a NRP spacecraft categorization is determined to be inappropriate, the local EMO will initiate plans for preparation of additional NEPA documentation.

NASA Routine Payload Checklist

Project Name: Landsat 9		Date of Launch: Dec 15, 2020
Project Contact: Del Jenstrom	Phone Number: 301 296-6316	Mailstop: Code 429
Project Start Date: March 2015	Project Location: NASA/GSFC	

Project Description:
The Landsat 9 project is the successor to Landsat 8. The Landsat 9 mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and human-induced causes of change can be detected/differentiated.

A. Sample Return:	Yes	No
1. Would the candidate mission return a sample from an extraterrestrial body?	☐	☒
B. Radioactive Materials:	Yes	No
1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?	☐	☒
Provide a copy of the Radioactive Materials On Board Report as per NPR 8715.3 with the ERP submittal.	Attachment	
C. Launch and Launch Vehicles:	Yes	No
1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those indicated in Table C-1 on Page 2?	☐	☒
2. Would the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?	☐	☒

Comments:
The Landsat 9 LV SEB is active, award targeted for August / September 2017. However, the LV and launch site will be one of the LV/launch site combinations in Table C-1.

D. Facilities:	Yes	No
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?	☐	☒

Provide a brief description of the construction or modification required, including whether ground disturbance and/or excavation would occur.

E. Health and Safety:	Yes	No
1. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellant, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the EPC's in Table C-2 below?	☐	☒
2. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA Standard 8719.14?	☐	☒
3. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload Characteristics?	☐	☒
4. Would the candidate mission, under nominal conditions, release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?	☐	☒
5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?	☐	☒
6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operation (ANSI Z136.1-2007 and ANSI Z136.6-2005)?	☐	☒
7. Would the candidate spacecraft contain, by design (e.g., a scientific payload) pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety Level 1 (BSL 1)[1]?	☐	☒

Comments:

The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices including the use of mechanical pipetting devices, no eating, drinking, or smoking in the laboratory, and required hand-washing after working with agents or leaving a lab where agents are stored. Personal protective equipment such as gloves and eye protection is also recommended when working with biological agents.

NASA Routine Payload Checklist (continuation)

Project Name: Landsat 9		Date of Launch Dec 15, 2020
Project Contact: Del Jenstrom	Phone Number: 301 296-6316	Mailstop: Code 429
Project Start Date: March 2015	Project Location: NASA/GSFC	

Project Description:
The Landsat 9 project is the successor to Landsat 8. The Landsat 9 mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and human-induced causes of change can be detected/differentiated.

F. Other Environmental Issues:	Yes	No
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?	☐	☒
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?	☐	☒
3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?	☐	☒

Comments:

Table C-1. Launch Vehicles and Launch Sites

Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Athena I, IIc, III[a]	LC-46	CA Spaceport (SLC-8)	NA	Pad 0	LP-1[a]
Atlas V Family	LC-41	SLC-3	NA	NA	NA
Delta II Family	LC-17	SLC-2	NA	NA	NA
Delta IV Family	LC-37	SLC-6	NA	NA	NA
Falcon I/Ie	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-1
Minotaur I	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur IV[c]	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	NA	Pad 0	NA
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	NA
Taurus	LC-20 and/or LC-46	SLC-576E	NA	Pad 0	LP-1
Taurus II	NA	NA	NA	Pad 0	LP-3[b]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance.					

a
Athena III is currently under design.
b
LP-3 is currently under design.
c
While not explicitly listed in this table, the Minotaur IV includes all configurations of this launch vehicle, including the Minotaur IV+, which is a Minotaur IV with a Star 48V 4th stage.

Key: CA = California; CCAFS = Cape Canaveral Air Force Station; KSC = Kennedy Space Center; LC = Launch Complex; LP = Launch Pad; MARS = Mid-Atlantic Regional Spaceport; SLC = Space Launch Complex; SLF = Shuttle Landing Facility; USAKA/RTS = United States Army Kwajalein Atoll/Reagan Test Site; VAFB = Vandenberg Air Force Base; WFF = Wallops Flight Facility.

Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Structure	• Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion[a]	• Liquid propellant(s); 3,200 kg (7,055 lb) combined hydrazine, monomethyhydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (RF) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (NiH_2) battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe lasers (see Section 4.1.2.1)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered outside of the scope of this environmental assessment

a
Propellant limits are subject to range safety requirements.

Key: kg=kilograms; lb=pounds.

GSFC Flight Project Environmental Checklist

1. Project/Program	Date:
Landsat 9	May 11, 2017

2. Schedule

PDR/CDR:	Launch Date:
September 2017 / March 2018	December 15, 2020

3. Current Status

Project is in Phase B with Key Decision Point-C (KDP-C) APMC scheduled for December 2017.

4. Project Description

a. Purpose:
The Landsat 9 project is the successor to Landsat 8. The Landsat data archive is the longest continuous moderate-resolution record of the global land surface as viewed from space. The Landsat 9 mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and human-induced causes of change can be detected and differentiated.

b. Spacecraft:
Orbital ATK (OA)

c. Instruments:
Operational Land Imager-2 (OLI-2)
Thermal Infrared Sensor-2 (TIR-2)

d. Launch Vehicle:
TBD. To be competitively selected, SEB currently in progress. Launch vehicle selection targeted for August/September 2017.

e. Launch Site:
TBD. The launch site is a function of the launch vehicle selection.

f. NASAs Involvement/Responsibility: (include other NASA Centers)
NASA/GSFC is responsible for project management; systems engineering; oversight of spacecraft bus and OLI-2 contracts; TIRS-2 in-house instrument; science and cal/val; coordination with USGS partner developing ground system and performing mission operations; coordination with NASA/KSC procuring the Launch Service.

g. Participants/Locations:
GSFC Greenbelt, MD 20771
KSC Florida 32899
USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD 57030

h. End-of-Mission Plan: Planned Re-entry (controlled/uncontrolled?)
Controlled re-entry

5. Is there anything controversial or unique about the mission, spacecraft or instruments? If yes, Explain. Yes ☐ No ☒

6. Is the mission compliant with NASA requirements for limiting orbital debris (NPR 8715.6, and NASA Standard 8719.14? Explain non-compliances. Yes ☒ No ☐

7. During any phase, does the mission/project include or involve: Check yes for all that apply. If uncertain, check the corresponding box. For all that apply, provide an explanation	Yes	No	Uncertain
A. Fuels	☒	☐	☐
B. Ionizing Radiation Devices/Sources	☐	☒	☐
C. Explosives	☐	☒	☒
D. Hazardous Materials/Substances/Chemicals	☒	☐	☐
E. Lasers (Class, Earth Pointing)	☐	☒	☐
F. Disease Producing Pathogenic Microorganisms/Biological Agents	☐	☒	☐
G. Discharges/Venting of any Substances into Air, Water, or Soil	☐	☒	☐
H. Hazardous Waste Generation	☐	☒	☐
I. High Noise Levels	☐	☒	☐
J. Sample Return to Earth	☐	☒	☐
K. Radio Frequency Communications	☒	☐	☐
L. Construction/Modification/Demolition of a Facility/Lab (onsite - offsite)	☐	☒	☐
M. Land Disturbance, Tree Clearing, Removal of Vegetation	☐	☒	☐
N. Impact on Threatened or Endangered Species	☐	☒	☐
O. Impact/Destruction of Sensitive Wildlife Habitat	☐	☒	☐
P. Impact on Cultural Resources	☐	☒	☐
Q. Impact on Local Social or Economic Conditions (Increase in Traffic, Employment, etc.)	☐	☒	☐
R. Impact on Minority or Low Income Populations	☐	☒	☐
S. New or Foreign Launch Vehicle	☐	☒	☐
T. Other Issues of Potential Environmental Impact	☐	☒	☐
U. Environmental Permits	☐	☒	☐

Additional Information:
A. Spacecraft will use Hydrazine fuel for station keeping, etc.
D. Spacecraft Fuel is a hazardous material.
K. RF communications will be used for data, telemetry and command transmissions between ground stations and the L9 observatory.

8. What Safety Hazards are associated with the mission?

Spacecraft fueling and launch.

9. Summary of Subsystem Components

Propulsion (Include fuel type, amount, tank size, materials, dimensions	Blow down Hydrazine system, with 8 22N Thrusters Fuel: Hydrazine, Amount: 383kg, Tank Size (read as capacity): 453.6 kg Material: Tank Shell 6Al-4V Titanium and AF-E-332 diaphragm, Dimensions: 40.85" dia., 41.7" Length
Communications	Fixed full-earth coverage X-band antennas. S-band omni antennas.
Structural Materials	Aluminum longeron frame with honeycomb panels. Composite instrument deck, composite / AL honeycomb solar array panels
Power	3638 W EOL single wing deployable solar array with multi-junction GaAs solar cells 268Ahr (Nameplate) Li-ion Battery
Science Instruments	Operational Land Imager-2 (OLI-2) (Optical) Thermal Infrared Sensor-2 (TIR-2) (Thermal Infrared)
Hazardous components (radioactive materials, lasers, chemicals, etc.)	Propulsion fuel (Hydrazine)
Other (include dimensions and weight of s/c)	Observatory Stowed Dimensions: 4.5 m length, and 2.75m x 2.5m laterally NTE Observatory Wet Mass: 3550 kg

GSFC Flight Project Environmental Checklist

Project Manager Printed Name:	Signature Field		
Del Jenstrom			
Project Name:	**Date:**	**Phone Number:**	**Org Code:**
Landsat 9	May 11, 2017	301 286-6316	429

Comments: