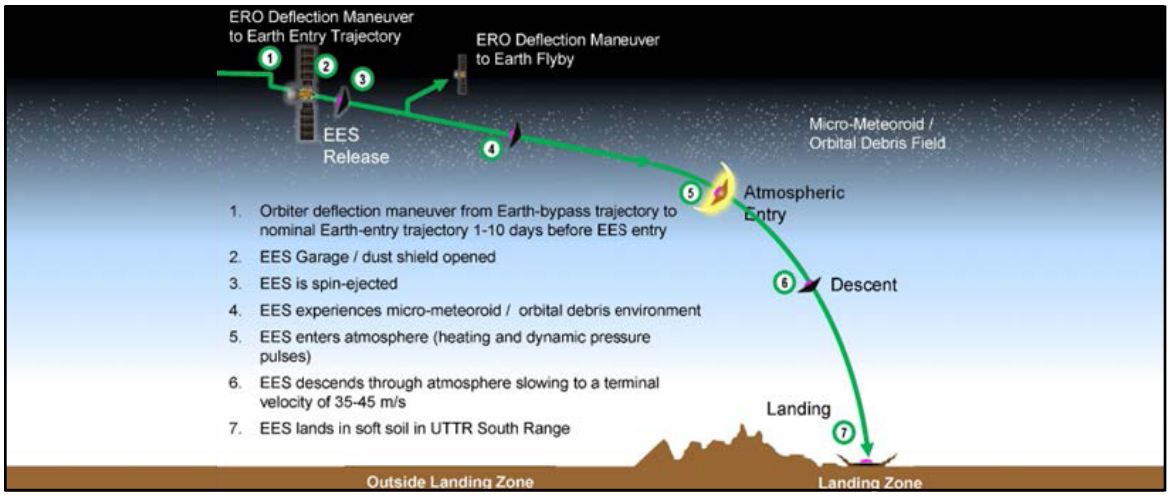
National Aeronautics and Space Administration

NASAfacts

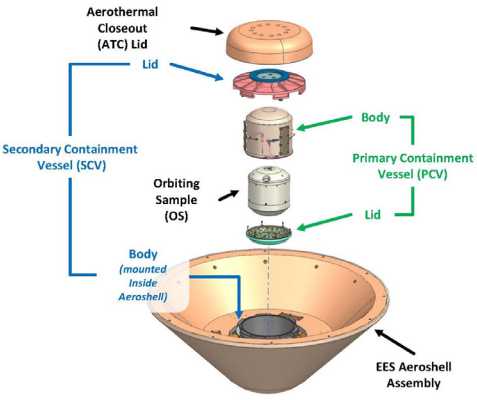
MARS SAMPLE RETURN EARTH ENTRY SYSTEM LANDING SITE RECOVERY OPERATIONS

Earth Entry System Landing

After departing orbit around Mars on an Earth-bound trajectory, the Earth Return Orbiter would release the Earth Entry System (EES) above the Earth's atmosphere. The cone-shaped EES, about the size of a tire on a semi-truck, would passively enter Earth's atmosphere on a predictable path shaped by gravity and atmospheric drag. During reentry, a sonic boom would be generated at a very high altitude. The figure below shows the release and entry process.



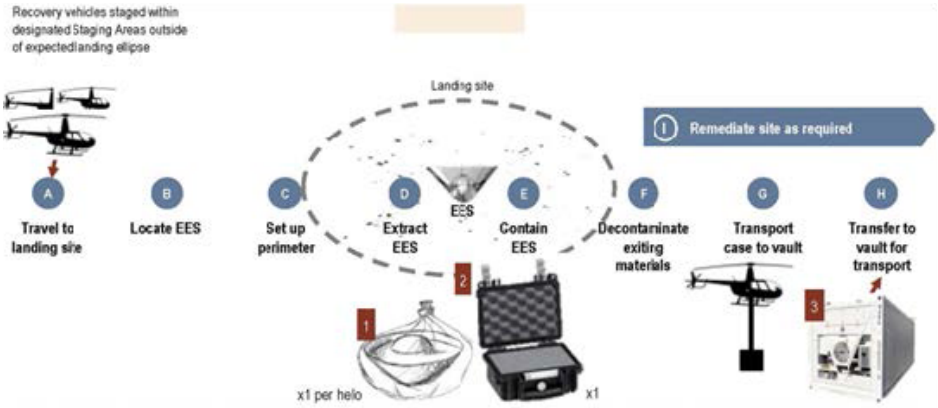
The EES has been designed from the bottom up to land without requiring the aid of a parachute. A series of ground-based impact tests involving drop towers and the dropping of full-scale tests from a helicopter have validated this approach. Data from these tests are informing detailed computational models of the landing as well as future drop tests. The EES includes two levels of containment designed to sustain the integrity of the sample container and sample tubes.



Earth Entry System Containment and Recovery

Landing site recovery operations would include several steps that begin with retrieval of the EES and end with successful preparation of the EES and its contained samples for transportation to an off-site SRF.

Prior to EES landing, one or more recovery teams would be staged at a strategic location away from the proposed landing site, with the objective to contain and recover the EES promptly. The staging area would include communications equipment and vehicles (land and/or air) and equipment for use in transport to and from the landing site, as well as a mobile containment system (or "vault"). The exact location of the staging area has not been determined; however, the most likely location for a staging area would be the Department of the Air Force "Det 1" location adjacent to the Michael Army Airfield runway. located on Dugway Proving Ground. It is anticipated that the vault containing the EES would be transported off the UTTR to a sample receiving facility (SRF) location as soon as reasonably possible barring specific weather and other day of landing operational constraints.



Three-element encapsulation solution	Element	Rationale
	(1) Bag	Can carry multiple examples with limited space constraint, redundant containment with case.
	(2) Travel case	Provides shock, vibration, option for passive thermal control. Hard surface easier to sterilize than soft goods.
	(3) Vault	Required for highway transport. Can provide increased environmental capabilities. Too heavy to transport to landing site.

Because the potential for extraterrestrial life within the Mars samples is unknown, the EES would be handled under the highest level of containment standards. Simulations and ground-based testing have shown the EES landing would be expected to create a depression in the soil about the same size as the EES, with a diameter of approximately 4 feet and a depth of about 1.6 feet, with soil being ejected from the crater to a distance of approximately 49 feet (15 meters). Once the EES has landed, the recovery team would transit to the landing site and contain the EES. Because the EES should be treated as though potentially hazardous until demonstrated otherwise, the EES would be handled in a manner consistent with Biosafety Level 4 (BSL-4) protocols and the recovery team would be wearing appropriate personnel protective equipment. BSL-4 reflects the highest level of containment, handling, and transportation regulatory standards. After arrival of the recovery team, the landing site would be cordoned off. The EES would be recovered, enclosed within a protective bag similar in function to a biohazard containment bag, and then inserted into a 2-meter by 2-meter (6.56-foot by 6.56-foot) sealed travel case. The exterior of the EES travel case may be decontaminated and then transported to the vault for shipment to an SRF.

After removal of the EES, the entire landing site may be decontaminated as a precautionary measure. It is assumed that any decontamination process would involve standardized decontamination and/or sterilization methods, in alignment with current accepted practices by hazardous materials response teams. The standard decontamination of biohazards in soil typically involves the use of chemicals (such as chlorine dioxide or aldehyde). Potential impacts associated with decontamination methods would depend on the method utilized and landing location. The Programmatic Environmental Impact Statement (EIS) analyzed the potential impacts of the decontamination methods noted above (see MSR Hazardous Materials/Waste Impacts Factsheet). Should the proposed methods change, or supplemental data becomes available that affects the Programmatic EIS conclusions, then this may be addressed in follow-on National Environmental Policy Act documents associated with the Tier II elements of the MSR Campaign.

Representative Example - Mobile Containment System ("Vault")

Upon arrival at the vault's location, the EES would be transferred into the vault. The mobile containment system, or "vault," would house the EES for transport to an SRF. The vault would provide an environmentally isolated, bio-contained, safe, and secure enclosure for the samples after landing and prior to and during their transport to the SRF. An example of a vault-type system for EES containment and transport includes a BSL-4 equivalent "trailer" or other similar high containment transport.