Project Athena - Mission To Implement Mars ISRU Habitat - Mission Design: Orbits & Propulsion, Earth Communications, Internal Habitat, Architect Point-of-Contact. J. R. Dunham\textsuperscript{1,} 1 Cranfield University, (jrolvdunham@gmail.com).

Project Athena is a group design project (GDP) to create a mission that lands and additively manufactures a Mars habitat designed by London-based architect, Hassell Studios. This GDP report summarizes the mass budgeting and life support selection of the habitat, as well as the Earth communications system selection. Additionally, it describes the mission concept, timeline, and propulsion trade-off for the necessary Mars Transfer Vehicles (MTVs), followed by the calculation of MTV propellant and overall MTV mass. A mass budget of the habitat using the architect’s Revit computer model is compiled and life-support, propulsion, and communications literature is reviewed. Using Tsiolkovsky’s Equation, an adaptable engineering tool is developed in Excel, calibrated to the NASA DRA 5.0, that calculates the propellant masses and LEO masses for all the MTVs needed for the selected mission concept and timeline. Validation of initial timeline delta-V assumptions is carried out via time-of-flight porkchop plots using a MATLAB script. For Earth Communications, an 8.40 GHz (X-band) areostationary satellite in Mars orbit is assumed accessible for our mission. The output of the habitat work package is an 86.9 T mass estimate for the total internal habitat, with 8.1 T of additional life support supplies and 9.8 T of consumables, and assumes a physicochemical life support system. The output of the mission work package includes determination of the detailed mission dates between 2028-2040 with the corresponding delta-Vs and confirmation that (2) MTVs will be used. Additionally the Mission work package entails deciding that the first MTV arrival of the rover payload will be via propulsive capture while the second trip of this MTV will deposit the habitat payload via aerocapture, and calculating the necessary propellant appropriate to all of these mission decisions. The least massive MTVs found under the mission constraints are: During the first trip of the first MTV, a total mass to LEO is 774.2 T; on its second trip, a mass to LEO is 409.4 T; and for the second MTV, a total mass to LEO of 837.7 T.

Concept model of the habitats, by Hassell Studios with LightField London. This structure is underneath the regolith shield (not shown). Each larger habitat module is connected to two smaller Life Support System (LSS) modules.

Interplanetary Mission Baseline. CREDIT IMAGE: Jack Batty, Cranfield University fellow team member.