Question 1:

Dear Cheap Astronomy – How likely is a space waystation like Deep Space 9?

So, anything is possible, but what is likely is what is economically feasible. In other words, while you could have a deep space way station like Deep Space 9, there's has to be a need for it. So, for example here on Earth there's no deep Sahara desert or a deep Congo jungle bases, but there are deep Antarctica bases, indeed several of them.

It's not that no-one's interested in deserts or jungles, it's just that you can go to those places with a tent and a few supplies. But Antarctica is a different proposition, where you really need a building to survive even a short stay, due to the cold and the storms. The economic business case is that it's worth occupying unclaimed territory that might have untapped resources and even tourism potential – and if you get some science done along the way, then all the better.

Similarly with space there's an assumption that just being there will open up unexpected opportunities. And while you're there why not do some science, which is mostly focused on learning how to live in space and on investigating the opportunities that living in space could bring.

The idea of a waystation is a different proposition. So rather than having a base at the extreme edge of accessibility, a way station is positioned at a point that's on the way to somewhere else, largely to provide a temporary rest and refueling stop for weary travelers. But for that to work, it also has to receive supplies – so there has to be a rudimentary space economy where bulk supplies can be delivered by big purpose-built tankers and then those supplies are doled out to weary, but cashed-up, travelers.

But also consider that rather than just being refueling points, a space way station might be where you change spacecraft. So you launch from Earth on a purpose-built launcher which docks with an orbital station that has a purpose-built deep space spacecraft in dock. That deep space spacecraft then takes you to Mars, where you then dock with a Mars orbital station and hop aboard one of its docked Mars landers for the trip down to the surface. Although you probably wouldn't just hop aboard. There'd be various safety briefings, some kind of mandatory quarantine period might be required and you'd also want time to organise all the gear that you'd sent on ahead. The basic principle of spaceflight is that if you want to go fast you need to keep your mass low. Humans will want to go fast as possible on deep space journeys, to protect both their physical and their mental health, so it makes sense to put all your heavy gear on a slower robotic shuttle that might leave Earth a year before you do.

So, if for all these reasons you're not immediately hopping aboard your Mars lander after several months aboard a very utilitarian spacecraft built for speed rather than comfort, you might appreciate a bed for the night, along with a shower, a fresh-cooked meal and maybe even a drink at the bar. This is the business proposition for a Mars orbital waystation, after months of sitting in a tin can, this will seem like unspeakable luxury and having the additional bonus of a view of Mars outside the window will make it all priceless – although it will cost you, a lot.

Whether you need a crew with slim-fit uniforms and wide-ranging personality quirks is another question. More likely a remote waystation station would be run by a lighthouse keeper - a lone human problem-solver with a team of robot drones to do most of the work, where the 24 minute radio delay would make running such a robot crew from Earth impractical.

Of course, we don't have such multifunction, semi-autonomous robots today, but then we don't have a queue of cashed-up travelers planning their next trip to Mars either. Once again, all this may become technologically possible when it becomes economically possible.

Question 2:

Dear Cheap Astronomy – Are there still plans for a crewed asteroid mission?

Well not really. There's probably still lots of people still thinking about such a mission, but there's nothing that's in any respect scheduled, at least for NASA and as far as we now. The closest NASA got was a mission on paper plan of flying a crewed Orion capsule into lunar orbit and then leaving orbit on a new trajectory that looped out further into deep space for an asteroid encounter and then looped back to the Moon again – and then after a lunar orbit or two, the spacecraft would follow a return trajectory back to Earth.

The idea of a loop out into deep space from the Moon has merit insofar as there is some possibility of limping back to the Moon on the return loop in the event of some unexpected calamity or major malfunction – think Apollo 13.

But for that loop idea to work, you can neither land on nor orbit an asteroid, since once you fire your retro-rockets all the benefits of being on a looping trajectory are lost. So, the plan, called the asteroid retrieval mission, was not to stop at an asteroid but instead to rendezvous the crewed spacecraft with a robotic mission that had been sent out beforehand. That robotic mission would have either bagged an asteroid, literally encapsulating it in some kind of open ended bag attached to an ion drive spacecraft. The idea was that the bag that could be inflated into an open position, positioned around an asteroid around 8 metres in diameter and then you'd pull a draw string closed and so bag it and then fly it back towards Earth using gentle trajectory corrections. Remember it was orbiting the Sun anyway so you just have to tweak that orbit into the direction you want it to go for the rendezvous.

Trouble is, small bodies of 8 metres in diameter are unlikely to be spherical since they don't have enough intrinsic mass to generate the gravity required to form a sphere. And with something that small you won't really know its exact shape until you get quite close – and if it's not right it could take a while, not to mention luck, to find another similar sized body within reach of your fuel supply. And even if you do fortuitously find a roughly-spherical object that's around the right size, it's likely to be spinning relative to your spacecraft. So, either that spinning will shred the bag you try and enclose it in or if you try and clamp down on it, your spacecraft will take on that same spin. And if you do decide you are going to clamp down on it, then what's point of the stupid bag?

So instead, plan B was adopted – and it was actually called plan B –whereby a robotic lander with four outstretched legs would visit a large aggregate asteroid and land astride a small boulder, say four metres in diameter which was sitting on the asteroid's surface. Various clamps and screws would then secure the boulder and the lander would lift off with a piece of asteroid firmly in its grasp. Of course Plan B also had various risks where landing astride something requires close-to-pin-point landing accuracy – which can't be managed remotely given the radio delay with Earth. Also you need to be confident that boulder you pick really is just a boulder – not an iceberg with most its mass hidden beneath the asteroid's dusty surface. So, there's some risk you may need multiple pinpoint landings until you find a boulder that's just right.

Anyhow, whether it's plan A, B, C or D you follow to redirect a piece of asteroid, the idea is to get it onto a trajectory where the crewed Orion spacecraft can rendezvous with it without having to markedly veer off its looped trajectory back to the Moon. Then the two craft dock and an astronaut does an EVA and collects lots of samples from the asteroid piece, including surface dust and drill cores, which are collected into sealed containers. The astronaut then returns to the Orion capsule, the two craft undock and the Orion returns to Earth along with carefully-curated samples of an asteroid.

The asteroid redirect mission was an idea pending approval around 2013, but it never got up, a key criticism being that it wouldn't get us any closer to flying a crew to Mars. So, there you go, if you have an asteroid mission plan, getting it approved depends on you having a plan with minimum risk and which fits the major objectives of your employer – if you've got all that then ad asteroid.