



Western Australian Speleological Group (Inc)

Report on a karst investigation of the site of the proposed Arrowsmith Hydrogen Project

Prepared for Infinite Green Energy
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Acknowledgments

This report is based on information and knowledge collected by WASG over several decades of visitation to the area, plus two visits since the property has been under the management of IGE. WASG members who attended the site for the purposes of this report did so under WASG's insurance policy and volunteered their time and travel expenses freely, as did other present and past WASG members. Thanks to the following individuals who assisted in this report: Ian Collette, Bert De Waele, Luana Dwyer, Ann-Marie Meredith, Marcos Silverio, Rob Susac, Andrew Thomas, Greg Thomas and Brett Wiltshire.

Scope

Approximately one year after first contact and discussions between WASG and IGE, and following the EPA referral process, WASG was permitted to access the IGE property to investigate the potential impacts of the development proposal on the cave system. This occurred over four days, being 10–11 September and 1–2 October 2022. Allowing for travel time from Perth, two of the four onsite days were half-days.

Introduction

The IGE property contains 57 karst features which have been recorded in the Western Australian Karst Index. It is a highly significant karst system including the longest known cave on privately owned land in the south-west of Western Australia. Karst areas known to contain limestone caves in the south-west of WA are limited to a narrow strip of Aeolian limestone following the coast between Cape Leeuwin to the south and the IGE property to the north. Only parts of this strip support caves and thus any areas that do support caves are significant due to their scarcity. North of the IGE property, no areas containing significant caves are found for hundreds of kilometres, and these are in different climatic/geological zones. As the IGE property contains practically the northernmost limestone caves in the south-west of WA, it is particularly important that speleologists should have ongoing access to the caves for reference purposes.

It is clear that public sentiment does not tolerate the destruction of caves such as those at Juukan Gorge in the Pilbara. While legislative requirements for protection of geological formations generally are much less specific than the protections afforded for cultural reasons, the scientific and aesthetic values of caves must surely merit protection.

An important point to consider in the context of the Arrowsmith proposal is that road and/or firebreak development by bulldozer drivers has been recorded as accidentally covering known cave entrances in the past (e.g. at Yanchep National Park). Caves have also been discovered in this

process (e.g. WI-187 Bulldozer Cave, opened by the grading of the powerline track to Lake Cave in the Boranup forest).

Ecoscape (2021) has concluded via sound monitors that at least 5, possibly 6 species of bats inhabit the caves on the property. During the current work, WASG revisited a cave chamber recorded as containing bats during the last visit (5 years ago), and bats were seen again this visit. Although enduring, the number and frequency of bat sightings by cavers is quite small and ongoing monitoring seems appropriate for an area undergoing significant and irreversible development. It is also timely to note that other significant karst areas (i.e. the Nullarbor) are also in the pipeline for similar green energy development and information recorded by this early trial may provide valuable information for protection of irreplaceable karst formations and biota being impacted by similar future developments.

During the 4-day work period, WASG members conducted both above-ground and underground exploration work. Above-ground surveys in karst areas in this region require pushing through dense scrub with visibility in the range of 1–5m in any direction. Typical cave entrances in this region are solution pipes, which are easily overlooked and could be missed even when walking right past them. Surface investigations focused on areas identified via satellite imagery as containing karst or known from WASG records to contain caves, plus locations provided by IGE as sites to be cleared for wind turbine construction.

Significant time was dedicated to underground surveys to check the previously recorded layout of caves and to extend the known extent of humanly accessible underground passages. It should be noted that cave survey is a labour-intensive process and years of work go into mapping any significant cave system. WASG underground surveys found far more passages than time permitted us to survey and as such any maps should be considered far from complete.

Investigation results by area

Area: Limestone ridge in northern part of the property

Description

Freshly cleared firebreak track over limestone ridge in northern part of property. Satellite imagery shows a ridge running approximately north–south with multiple patches of limestone. This area is between the two highways with the house on the neighbouring property to the west visible. This area includes no known karst features.

Surface exploration during the 2022 visits looking for karst features targeted locations chosen from satellite imagery. The ridge contains a generally solid and undulating layer of caprock covered in dense scrub. The main discovery was a buried solution pipe located by one member but it was not considered likely to lead to a humanly accessible void. It was the general consensus of members present that in the prevailing conditions (dense scrub) further time spent searching here was unlikely to result in any significant discovery.

Issues noted

Areas around this are marked for clearing for the main hydrogen plant which would be intensive clearing. The current landscape is dense scrub covering limestone caprock so is impossible to completely assess.

Conclusion

The current plan for the main IGE development to be in the northern extremity of the property seems reasonable. The current landscape makes it impossible to visually check and exclude the possibility of caves but based on current knowledge, the risk to cave values in this area is considered low.

Recommendation

It is expected that any significant construction would be preceded by a detailed survey and include reporting procedures for anything found.



Figure 1. The start of the search on the northern ridge line, showing the dense scrub encountered. © Marcos Silverio

Area: E-23 River Cave***Description***

River Cave has over 500m of mapped passage and is therefore a highly significant cave in the south-west of WA. It has multiple fairly small and inconspicuous inflow and solution-pipe-type entrances that are quite close to cleared farmland. The cave passage follows a shallow path under the caprock and passes below two firebreak tracks plus a new track to the west of the entrance constructed by IGE within the past year.

Issues noted

Versions of IGE plans prior to the later engagement with WASG show a large evaporation pond being built in the cleared farmland area that forms the catchment for River Cave in times of flood. Current discussions indicate this plan is no longer current.

Current plans still show a road/track/powerline passing over the path of River Cave. WASG spent a large proportion of our time on the property measuring roof thicknesses and locating surface connections. The data is of interest for those interested in speleology but the simple conclusion for development purposes is that ideally nothing should pass over the cave for the sake of preservation. The cave roof thickens further away from the entrance and an existing firebreak track already passes over the cave a few metres from a surface connection.

The survey data (Figure 2) lower line is the underground line survey using any convenient point of the passage (floor, wall or roof). The upper line is the ground level recorded later following the same surveyed path on the surface. It should be noted that with cave surveying techniques every point is only as accurate as those that precede it and as such there is a cumulative uncertainty in the data. Also, due to natural hollows and projections in the cave roof, roof thickness measurement is a general approximation. In the daylight hole closest to the firebreak track, the cave ceiling thickness was recorded to be approximately 5.5m.

It is also of note that the firebreak track actually diverts around an area of the cave where a collapse/insoluble barrier has caused the cave passage to sharply divert. The firebreak track diverts around this but also then unfortunately follows directly above the cave passage for about 30m before crossing to the other side. (Some of this is visible in Figure 7, noting that the satellite imagery does not show recently created tracks.)

There is no visible clue on the surface that the cave exists beneath the tracks, and it is therefore important that this area be marked to show that heavy vehicle access is not permitted.

Conclusion

WASG concerns about the evaporation pond have been noted and the IGE plan changed. The plan for passing of powerlines/road over River Cave remains without detail on how exactly this will be done.

Recommendations

- 1 Review of final plans to confirm that any works in the River Cave catchment area will not cause sediment to flow into the cave in times of flood.
- 2 Review of final plans to confirm that the current track over the cave will be restricted to small vehicles only.
- 3 Review of final plans to confirm that any plans for infrastructure passing over the cave (even overhead powerlines) consider the expected unknown voids, the risks of erosion into the multiple small cave entrances due to earthworks, and the preservation of the unique geological values of the cave.
- 4 Trenching should not be carried out over the course of River Cave or in the vicinity of any of the known cave and karst features.

E-23 River Cave profile view - looking due north. Survey is split to fit to page for visibility reasons : upper right (station 0) is the slot entrance (30m from inflow entrance), lower left of drawing (station 59) is the farthest point surveyed, the arrow shows where the survey is split for formatting reasons. The survey shows both the underground passage and the surface level at surveyed points above the cave following the underground cave path +/- 10m horizontally. The underground survey also shows splays indicating passage height in some locations. The horizontal bold gridline below the cave is consistent, the cave drops approx 3m over its passage, the lowest point being a section of phreatic dissolved rock passage. (stn 44-52)
The farthest surveyed area (stn 56) is an inclined fissure with a layered rock roof peeling off in sheets. Note the actual cave plan is longer than shown as the cave does not head exactly due west and another passage heading towards the surface is expected around station 41.

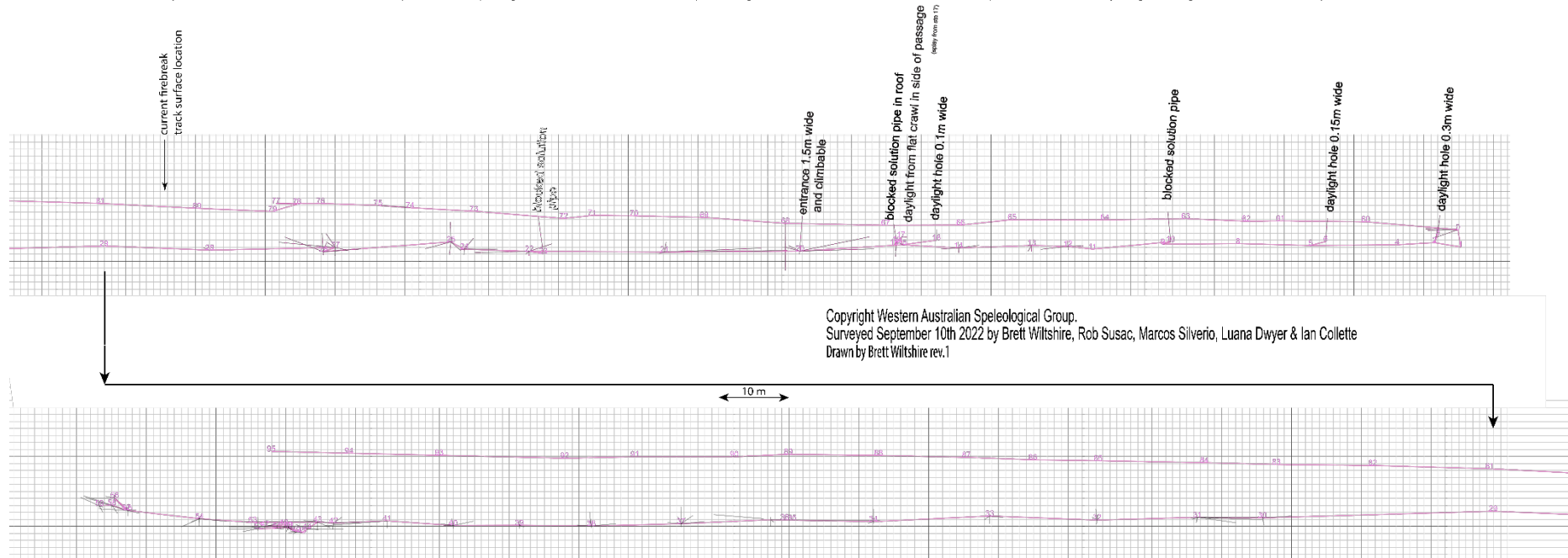


Figure 2. WASG 1 October 2022 survey of average roof thickness above River Cave. © Brett Wiltshire

Area: E-153 area***Description***

E-153 is a hole opened up by earthmoving equipment on a former drill site/gravel pit. The hole is 1m wide and 3m deep with soft limestone and soil edges. We did a brief search of the immediate surrounding area and found no other surface features. The landscape is sandy with thick vegetation and further voids are possible. See Figures 3 and 4 below.

Issues noted

The presence of a collapse suggests voids could be present in the area.

Recommendation

Warrants further investigation.



Figure 3. The hole at E-153. © Ian Collette



Figure 4. The hole at E-153. © Ian Collette

Area: WP17 and WP16 turbine locations

Description

Sloping hill with extensive fragmented caprock and thick vegetation.

Issues noted

No surface karst features found. No recommendation required.

Area: WP15 turbine location

Description

Patches of sand and karst features covered in low woodland.

Issues noted

Although there are no surface holes in the immediate area, this location is close to E-182, which is a large karst area 50m long and 20m wide with multiple holes 3–6m deep. This turbine location is the

one of greatest concern to WASG. It sits within the crescent-shaped area of known caves and therefore might be expected to contain voids.

Recommendation

WASG strongly urges relocation or elimination of turbine WP15. Additionally, no heavy vehicle road or trenching should occur between WP14 and the Sodar station.



Figure 5. Proposed turbine WP15 in relation to known karst features. © WASG

Area: Line marked on IGE map between Sodar station and solar array (possibly a road or overhead powerline with powerline service track)

Issue noted

Close to the edge of the cleared area, this line passes between the main entrance to River Cave and E-183, a large karst area 35m long and 25m with multiple, blind solution pipes 3–4m deep (Figure 6).

Recommendation

This line should be relocated further north, away from the known karst area, closer to the existing shed.



Figure 6. The karst area at E-183. Note the caver standing in a blind solution pipe. © Ian Collette

Area: WP11 and line heading north which crosses over River Cave

Issues noted

Multiple karst areas as described elsewhere. Figure 7 shows the line (track/firebreak) crossing the course of River Cave.

Recommendation

Cranes or heavy vehicles required for turbine construction should not be allowed to proceed along the tracks (old or new) north of WP11 as this area contains fragile voids. Any roads between known cave locations should be restricted to light vehicles only and no trenching of power cables should be permitted.

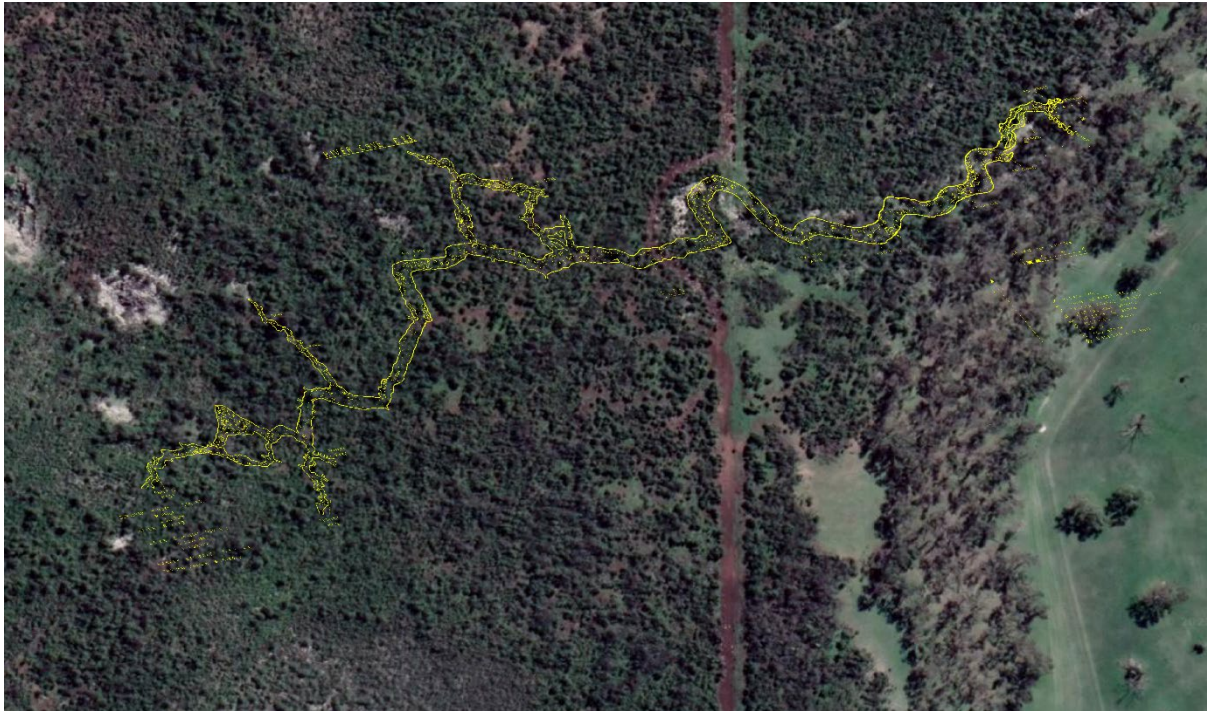


Figure 7. River Cave map overlaid onto aerial image. © WASG

Area: Areas between WP2 and WP3 and between WP9 and WP10

Description

Dense scrub vegetation with patches of sand and isolated limestone caprock.

Issues noted

During the 2022 site visits a brief time was spent searching these areas but as the vegetation was so thick, we were not able to assess the area particularly well. It was the general consensus of members present that in the prevailing conditions (dense scrub) further time spent searching here was unlikely to result in any significant discovery.

Area: E-22 Arramall Cave

Description

Arramall Cave is the longest known cave on private property in Western Australia. The cave passage splits and passes under Brand Highway in two locations and passes close to several known features on the neighbouring property (although no other entrances are known). There are also several other known caves and features near the entrance to Arramall, including E-48 Sponge Cave.

Recommendation

Current development plans show no development in this area and WASG recommends that this area is never developed.

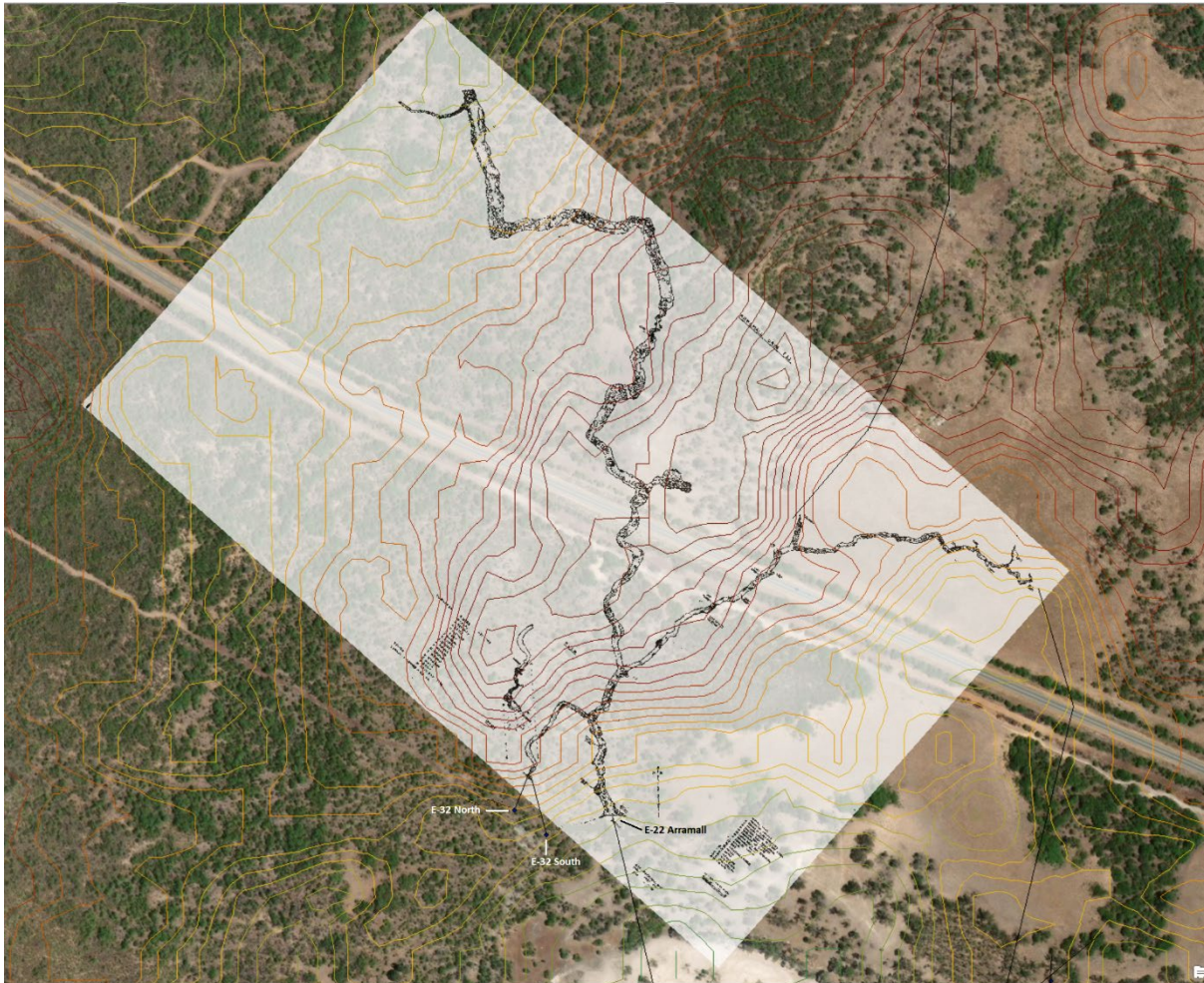


Figure 8. Arramall Cave map overlaid onto aerial image with other karst features also marked. © WASG

Area: E-91 and E-144, known bat caves

Description

Extensive known caves with multiple entrances in close proximity to each other. Surveys for these two caves are both incomplete, and while no known connection currently exists, they are expected to connect. These cave surveys pass under land without any visible surface features directly above.

Issues noted

E-91 has been recorded as bat habitat. Bats have been noted in this cave during both the 2022 visit and a previous visit in 2017. WASG has concerns the turbines may impact the bat population.

Recommendation

WASG recommends that surveys of the bat population should be conducted by suitably qualified personnel before, during and after construction because of the potential impact of the turbines on the bats. These surveys should consider the development area as a whole.



Figure 9. Overlay of E-91 and E-144 cave maps on aerial image. © WASG



Figure 10. Bat in E-91. © Marcos Silverio



Figure 11. Bat in E-91. © Marcos Silverio

Summary of recommendations

- It is expected that any significant construction would be preceded by a detailed survey and include reporting procedures for any voids found.
- Final plans should be reviewed to confirm that any works in the River Cave catchment area will not cause sediment to flow into the cave in times of flood.
- Final plans should be reviewed to confirm that the current track over River Cave will be restricted to small vehicles only.
- Final plans should be reviewed to confirm that any plans for infrastructure passing over River Cave (even overhead powerlines) consider the expected unknown voids, the risks of erosion into the multiple small cave entrances due to earthworks, and the preservation of the unique geological values of the cave.
- Trenching should not be carried out over the course of River Cave or in the vicinity of any of the known cave and karst features.
- The area around E-153 warrants further investigation for possible voids.

- WASG strongly urges relocation or elimination of turbine WP15. Additionally, no heavy vehicle road or trenching should occur between WP14 and the Sodar station.
- The line between the Sodar station and the solar array should be relocated further north, away from the known karst area, closer to the existing shed.
- Cranes or heavy vehicles required for turbine construction should not be allowed to proceed along the tracks (old or new) north of WP11 as this area contains fragile voids. Any roads between known cave locations should be restricted to light vehicles only and no trenching of power cables should be permitted.
- Current development plans show no development in the Arramall Cave area and WASG recommends that this area is never developed.
- WASG recommends that surveys of the bat population should be conducted by suitably qualified personnel before, during and after construction because of the potential impact of the turbines on the bats. These surveys should consider the development area as a whole.
- It is particularly important that speleologists should have ongoing access to the caves on the property for reference and mapping purposes.

References

Ecoscape (Australia) Pty Ltd (2021). Arrowsmith Hydrogen Project Environmental Survey, prepared for Infinite Blue Energy.

Additional images



Figure 12. Karst feature locations overlaid on IGE's map of the Arrowsmith property. © WASG



Figure 13. Passing the entrance of E-47 while en route to survey work. © Marcos Silverio



Figure 14. E-91 chamber. © Marcos Silverio



Figure 15. E-91 chamber. © Marcos Silverio



Figure 16. E-144 doline near entrance. © Marcos Silverio



Figure 17. E-144 entrance chamber. © Marcos Silverio



Figure 18. E-144 chamber. © Marcos Silverio



Figure 19. Surveying in E-144. © Marcos Silverio



Figure 20. Surveying in E-144. © Marcos Silverio



Figure 21. E-23 River Cave passage. © Marcos Silverio



Figure 22. E-23 River Cave passage at E-178 entrance hole (note the rope hanging down). © Marcos Silverio