XANADU 2000

Expedition Report

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1 Introduction

Mongolia is truly one of the last countries in the world where the pervasive forces of modern economics and technology have been kept at bay. Geographically it is kept isolated by the towering mountains ranges to its west, the inhospitable Gobi Desert to its south, and the cold barren expanse of Russian land to its north. The lack of urban modernisation in the country means most of its natural beauty has been preserved. Much of Western Mongolia is largely unmapped and unexplored, and we planned to explore this region, travelling as the locals do, as they have for thousands of years since the times of Genghis Khan – on horseback.

During the Soviet era, a series of wells and water sources were constructed by the former Soviet Union in the provinces or *aimags* of: *Arkhangai*, *Zavkhan*, *Khövsgöl* and *Övörkhangai* in Central, Northern and Western Mongolia. These wells served as convenient resupply points for people travelling within the region. However, the exact locations of these wells and pumps were lost since Mongolia regained its autonomy from Soviet influence. Furthermore, some of these wells and pumps may have fallen into disrepair or may have dried up. One of the objectives of our expedition was to re-determine the location and condition of some of these water sources. However, as our journey progressed, we realised that the local nomads no longer rely on these wells/pumps, but on Mother Earth in the form of river streams and springs. This is particularly true in the region we were travelling (central-western Mongolia). Our expedition then concentrated on identifying the locations and testing the water quality of these water sources.

3 Expedition Aims

The expedition was to be conducted in the provinces of *Arkhangai*, *Zavkhan*, *Khövsgöl* and *Övörkhangai* - all located in the central, western and northern part of Mongolia. The aims of the expedition were twofold:

a) To retrace the lost locations of water wells and pumps, to test water purity and check the status of water source.

b) To travel from *Khovd* to *Tsetserleg* on horseback covering a total distance of 1000km.

2 Contents

4 Team Members

The expedition consisted primarily of six members; three students from Imperial College and three Mongolians who were university students in their own field. The Mongolians were included in the expedition because there was a language barrier for non-Mongolian speakers. There would also be the opportunity for very enriching cultural exchange. This group size was ideal, as each of us would have our own translators, and, if necessary, the group could be easily split up. In addition, two rangers were hired to look after the horses.

The particulars of the team members are as follows:

Name: Toh Poh Joo
Date of Birth: 22 April 1975
Nationality: Singapore
Expedition Responsibility: Expedition Leader
Previous Expedition Experience:
i) Trekking, Patagonia Andes, 1999
ii) Raleigh International Mongolia Expedition, 1999
iii) Outward Bound School, Malaysia, 1994
iv) Mt Kinabalu Expedition, 1993
v) National Community Leadership Training, 1990

Name: Roy Sim
Date of Birth: 17 December 1976
Nationality: Singapore
Expedition Responsibility: Logistics
Previous Expedition Experience:
i) Trekking, Patagonia Andes, 1999
ii) Attended Explore 99 Expedition Planning Seminar
iii) Trekking Mt Ophir, Malaysia, 1996

Name: Desmond Loh
Date of Birth: 05 December 1976
Nationality: Singapore
Expedition Responsibility: Expedition Treasurer
Previous Expedition Experience:
i) Trekking, Patagonia Andes, 1999
ii) Trekking, Nepal, Kala Patar, 1994
iii) Sir Edmund Hillary Outdoor Pursuit Centre, NZ, 1993
iv) Kayaking, Round Island Expedition, Indonesia, 1993

Name: Erdenemunkh Renchinnyam
Date of Birth: 28 February 1980
Nationality: Mongolia
Expedition Responsibility: Translator
Previous Expedition Experience:
i) Raleigh International Expedition, 1999

Name: Oyunabolor Munkhtuvshin
Date of Birth: 8 May 1976
Nationality: Mongolia
Expedition Responsibility: Medic
Previous Expedition Experience:
i) Raleigh International Expedition, 1999

Name: Surv Nergui
Date of Birth: 24 November 1976
Nationality: Mongolia
Expedition Responsibility: Translator
Previous Expedition Experience:
i) Raleigh International Expedition, 1999

Name: Sukhbataar
Age: 41
Nationality: Mongolia
Expedition Responsibility: Chief Ranger

Name: Bor
Age: 39
Nationality: Mongolia
Expedition Responsibility: Assist Chief Ranger

5 Experiments Description

5.1 Introduction to *e. coli*

E. coli is the abbreviated name of the bacterium in the Family *Enterobacteriaceae* named *Escherichia* (Genus) *coli* (Species). The DelAgua water testing kit tests for the presence of thermotolerant (faecal) coliforms, which is essentially made up of *e.coli*.

E. coli is found in the intestines of humans and animals. Along with other bacteria in our digestive system, they are essential for the formation of Vitamin K and B-complex vitamins. They are generally beneficial and necessary for our well-being. However, there are some strains of *e.coli*, in particular the *e.coli* O157:H7 strain, which causes severe damage to our intestinal cells and results in haemorrhages. In extreme cases, it can even cause death.

The presence of *e.coli* in drinking water is a strong indication of faecal contamination by animals or humans. It is this contamination that the water testing kit attempts to look for.

5.2 Symptoms of *e.coli* Infection

Infection often causes severe bloody diarrhoea and abdominal cramps; sometimes the infection causes non-bloody diarrhoea. Frequently, no fever is present. It should be noted that these symptoms are common to a variety of diseases, and may be caused by sources other than contaminated drinking water.

In some people, particularly children under 5 years of age and the elderly, the infection can also cause a complication called haemolytic uremic syndrome, in which the red blood cells are destroyed and the kidneys fail. About 2%-7% of infections led to this complication.

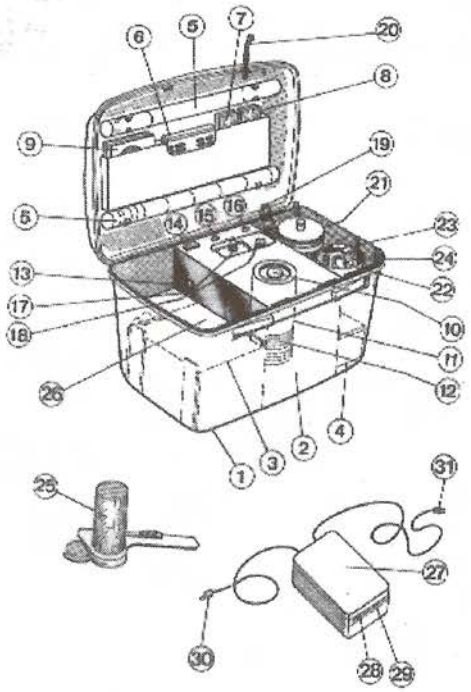
5.3 Prevention

To prevent infection by *e.coli*, simply take measures to ensure the bacteria will not enter your digestive system. Water from suspect sources should be sterilised with iodine or water purifying tablets. Boiling the water is also another way of killing the bacteria. Food should be cooked thoroughly, and hands washed before the consumption of food.

5.4 DelAgua Water Testing Kit

The DelAgua water testing kit has everything needed to determine the thermotolerant faecal coliform in drinking water. It is a compact and portable pieced of equipment devised by Prof Barry Lloyd from University of Surrey. The kit contains an incubator, which could be set to the right temperature for the proper growth of e.coli. It also contains other apparatus which could be used to determine the turbidity level of the water, its acidity and chlorine residual, and a solar charging panel to recharge the battery.

The pictorial figure of this testing kit is shown below.



The OXFAM - DELAGUA Kit Components

Water Testing Kit
1. Case
2. Incubator
3. Battery
4. Spares Case
5. Turbidity Tubes (pair)
6. Chlorine and pH Comparator
7. Chlorine Test Tablets
8. pH Test Tablets
9. Membrane Filters
10. Incubator Lid
11. Incubator Pot
12. Petri Dishes
13. Power Socket
14. On/Off Switch
15. Power 'On' Indicator
16. Heater 'On' Indicator
17. Methanol Dispenser
18. Culture Medium Bottle
19. Lighter
20. Tweezers
21. Filtration Assembly with Sample Cup
22. Vacuum Cup
23. Sample Cable
24. Vacuum Pump
25. Absorbent Pad Dispenser
26. Storage Space

Charger Unit
27. Battery Charger/Mains Power Unit
28. Power 'On' Indicator
29. Charged battery Indicator
30. Incubator Plug
31. Mains Supply Plug

5.5 Preparation of Culture Medium in the Laboratory

The following items are required for the preparation:

a) Membrane Lauryl Sulphate Broth
b) Distilled water
c) Polypropylene bottles
d) Burette with pump
e) Autoclave

The polypropylene bottles that are to be used for the storage of the prepared medium are carefully washed and sterilised to ensure they are contamination-free before the following preparation process is carried out.

1) The Membrane Lauryl Sulphate Broth powder, weighed at 38.1g, is placed in a clean beaker and 500ml of distilled water is added. The powdered medium must be well sealed before use to prevent any deterioration.
2) The powder is dissolved completely using gentle heat. The dissolved culture medium will be a bright red colour.
3) Suitable volume of the culture medium is poured into the polypropylene bottles. Each sample will require about 2.5ml of the medium.
4) The bottles filled with the medium are sterilised again with the tops kept loose at 121°C for ten minutes.
5) Upon completion, the screw caps are tightened carefully. Over-tightening will result in leakage.
6) The bottles are then stored in a cool dark place before use.

5.6 Sampling Methods

Refer to Appendix A on page 40 for the different sampling methods.

5.7 Sample Processing

Chlorine residual and turbidity are the first tests which must be carried out on any water sources. The sample must be taken in a clean, but non-sterile cup that has been rinsed several times before the sample is taken for analysis.

If the results of the first analysis are as follows:

a) residual free chlorine greater than 0.2mg/litre (0.2ppm), and
b) turbidity less than 5TU

It is highly unlikely that the sample will contain thermotolerant (faecal) coliform bacteria and therefore it will not be required to carry out thermotolerant coliform analysis. Otherwise, it would be necessary to carry out the analysis.

The procedure for the analysis is presented in Appendix B on page 43.

6 Expedition Itinerary

The expedition consisted of two stages; the first on horseback from *Uliastai* to *Khorgo som* and the second from *Khorgo som* to *Ulaanbaatar*.

6.1 Horseback Expedition

This expedition brought us to the following *aimags* (or province): *Arkhangai*, *Zavkhan*, *Khövsgöl* and *Övörkhangai* - all located in the central, western and northern part of Mongolia. The original plan to commence the expedition from *Khovd* was untenable, as there was no available flight from *Ulaanbaatar*. An alternative starting point was therefore sought. After comparing all the aimag capitals around the region, *Uliastai* stood out as the best choice. Apart from the fact that flights there were cheaper and available, it was also Möönöö's birthplace. Also, he had several relatives in *Uliastai* who could lend us a hand with some logistical matters, such as the rental of horses in particular.

Figure 6.1: On board MIAT to Uliastai

The revised plan was to head east towards *Ulaanbaatar* on horseback from *Uliastai* while fulfilling our set objectives. As was proposed, we aimed to travel on horseback across the country for about 1000km from the starting point. Riding across the country towards the capital this way had several advantages, especially with regard to the ease of medical evacuation if one was needed. As the capital offered the best medical facilities in the country, it would be the only place to seek good medical attention in case of an emergency. The time and speed of any evacuation would therefore have been greatly reduced if we were already closer to *Ulaanbaatar*, than compared to the initial plan to head west towards the end point in *Khovd*.

Figure 6.2: Breathtaking scenery from the plane

We were stranded in *Ulaanbaatar* for the first four days due to the Nadaam festival from 11th July to 13th July. It was an important national holiday and most of the country's services were shut down, including banks and airlines. The next available flight out of the capital was on the Friday after the Nadaam.

We arrived in *Uliastai* on 14th July, after a breathtaking two-hour flight with MIAT (Mongolia International Air Transport). We later found out from a friend that MIAT uses aircraft discarded from the Russian domestic fleet. Prior to the departure, we had seen some airline staff knocking on the right-hand wing with a metal bar after a leak had been spotted there. Although the leak was mended in about twenty-minutes, a safe arrival no longer seemed certain, especially as we stared at the

pool of unidentified liquid on the ground! However, the view from above the ground was picturesque and our initial worries were unfounded. In retrospect, this flight could have been the most exciting part of the expedition!

Although Möönöö had lived in the town for nine years, everything seemed to have changed after he had left ten years ago. Leaving *Uliastai* at a young age with a very vague memory of his relatives and birthplace, and Möönöö had no idea where his relatives lived or how they looked like. All he was given before leaving *Ulaanbaatar* was a scribbled note from his father, which contained no address or contact number, but instead only had the name of his maternal uncle and a brief description of his house. After asking some locals, we finally managed to locate his uncle and his family. It was a touching reunion, bringing tears to his uncle's eyes.

His uncle and cousins were of great help to us; they helped us sort out the rental of the horses and gave us valuable advice on the route we planned to take. They were also great hosts, and provided us with many a good home-cooked meal. Without their assistance, it was doubtful if we could have arranged the rental of the horses in such a short time. In the end, we got nine horses for ourselves: one each to carry the six of us and three to carry our equipment. We also arranged for two rangers to take care of the horses.

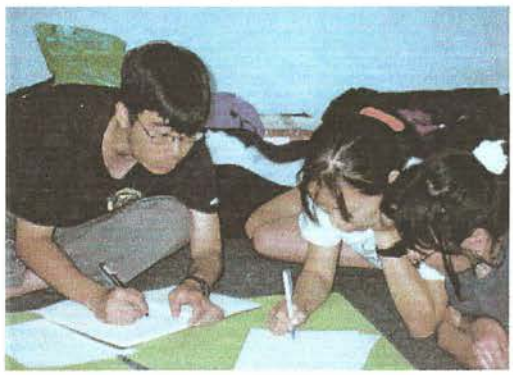


Figure 6.3: Preparing the agreement

Figure 6.4: Agreement made with the chief ranger

Our inexperience with horse riding initially raised some concern with the rangers. They were not worried about the danger of inexperienced riders attempting a long journey, but rather, our possible lack of mental and physical endurance to last through the expedition. Thus, an agreement was made to protect both parties' interests. Full payment, based on the rental of the horses for fifteen days, would still have been paid to the rangers if we had decided to give up before the due date. However, if we proceeded on after the fifteenth day, we would continue to pay them on the daily figure both parties had agreed to.

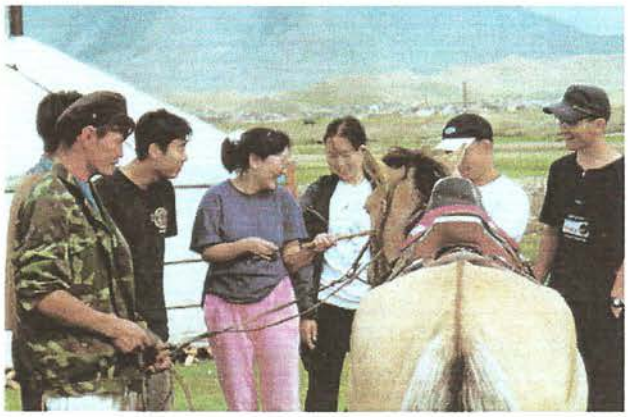


Figure 6.5: Horse orientation

We spent that weekend with a nomadic family who were friends of Möönöö's uncle, and got the chance to acquaint ourselves with Mongolian horses. Mongolian horses are like ponies compared to European horses (less than 1.5 metres shoulder height), but they are very tough. They have tremendous reserves of energy for work and can carry heavy loads for long periods. As they are generally tamer than horses found elsewhere in the world, we were therefore not expecting to encounter many problems from riding apart from saddle sores. A large amount of Vaseline was carried to deal with this problem!

Our first water test was conducted in a kindergarten where we had put up for three nights. The tap water in the kindergarten was a good representative sample of the water used by the whole town. The results are presented and discussed in Section 7 on page 22.

Figure 6.6: Learning the 'horse-knot'

At 1500 hours on 17th July, we rode out into the wilderness on our horses towards our next waypoint, *Tosonchengel*. It was a beautiful Monday afternoon as we caught the attention of the passers-by while riding across the town in a single file. Slow as our whole group moved, we managed to cover around 11km to our first campsite.

It was just before we decided to set camp when one of the horses carrying our equipment went crazy after a tent fell off from its back. The fallen tent must have disturbed the horse greatly, as it abruptly started on a wild gallop, sprinting on for miles and causing more things fall from its back, including the bag carrying all our test culture medium. It was only after the rangers had reclaimed that crazed horse that we realised the bag containing our testing accessories was missing. The bag was later found but in a devastated condition. Fortunately, most of the bottles looked fine and we managed to salvage seven of the original ten bottles.

Figure 6.7: One of the three packed horses

Tosonchengel, at some 180km away, was a good resupply point to replenish our rations, fuel and other necessary items. Skirting the western flank of *Khangai Nuruu* (*Khangai* Mountain Range – second highest mountain range in Mongolia) on the east of *Uliastai,* and moving towards *Tosonchengel* instead, was a necessary move. This was because, it was not advisable to head for higher ground as the stronger winds and colder weather would have meant increased risks and difficulty in seeking shelter at night, despite it being the summer season.

Figure 6.8: A group picture with one of the nomadic families we met

At this point, we were travelling in the aimag of *Zavkhan,* a spectacular area of forests and lakes, with streams and hot and cold springs. Having an area of 81,000 sq. km, this aimag is packed with lush valleys and hills, with grassy plains dotted with distinctive white *gers*, sand dunes, lakes and mountains. With the abundance of water sources in the region, the government did not construct any wells for the locals whose lives were very much dependent on rivers and streams. The dry summer in the last few years had caused many streams to dry up in certain parts of the aimag, leaving only one or two to serve several nomadic families. However, water testing was still carried out as planned to determine if these sources were suitable for consumption. We only spotted one well during the expedition. It was dry and had fallen into disrepair.

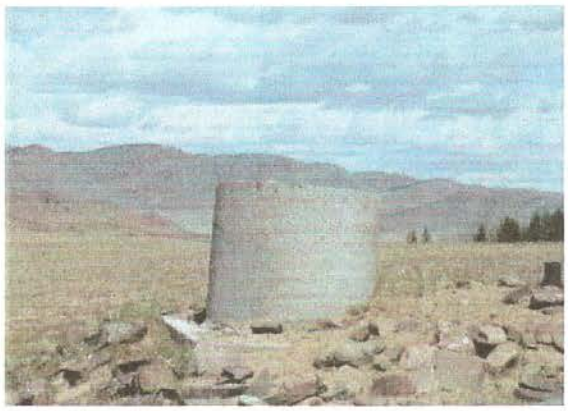


Figure 6.9: Dry well that has fallen into disrepair

The route we took to *Tosonchengel* allowed us to see some wonderful white water streams and rivers backed by pine trees and dark blue sky littered with white fluffy clouds. The abundance of fish in the rivers could easily be dished out as part of our dinner menu if we had proper fishing equipment and a little patience. Riding through the untouched and serene woods, we felt like we were transported into another world. A little road led us through peaceful woods with trees on either sides, wild flowers scattered randomly all over, melodious bird chirps, and gentle breezes which carried with them the sweet-smells of pine.

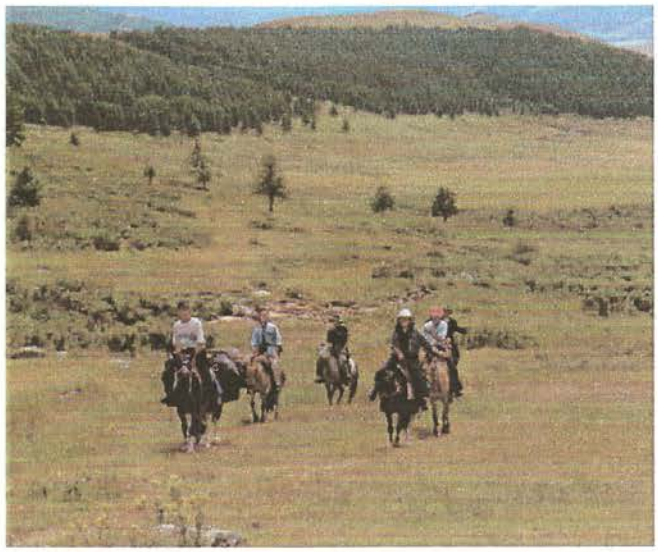


Figure 6.10: Riding through the marvellous scenery

Sometimes we found ourselves galloping in the heart of a huge plain where the roads ahead seemed limitless. The grassland stretched for miles onwards, further than what our naked eyes could see. Other times we had to cross wide shallow rivers with slow flowing currents in order to get across to where we had intended to go. There were occasions when we found ourselves riding at an altitude of about 3200 metres above sea level, which were as high as some of the ski resorts in the French Alps. Though we tried to stay low so as to minimise any unnecessary risk, the crossing of these high points were necessary and unavoidable. The scenery right at the top was breathtaking. However, these occasions were accompanied by strong and chilly wind.

Ten different water sources were collected and tested (see Section 7 on page 22) during the journey from *Uliastai* to *Tosonchengel*. The water testing procedure was simple but tedious, and careful experimental techniques were used to reduce contamination that would result in inaccuracy. Gloves were worn to eliminate contamination. Once opened, each bottle of the culture medium could only last for a day or two at the most. Having lost a substantial amount of culture to the incident of the panicked horse, testing was carried out on alternate days so that we would have enough culture to last through the whole expedition.

Figure 6.11: Our ranger taking interest in the water testing experiment

It took about half-an-hour to complete one set of testing, and each collected set could only be stored for four hours before the incubation process began. The incubation unit required an hour warming time to reach the required temperature of 44°C necessary for the proper growth of faecal coliform. This meant that we had to stop three hours after the first sample had been collected. Within this three-hour time period, we collected as many samples as possible, up to a maximum of sixteen samples, before the whole lot was incubated at the same time. Each incubation period took about sixteen to eighteen hours, to allow the bacteria to grow fully. Therefore, we worked on a nine-to-four routine, moving out at nine in the morning and stopping at four in the evening, and collection of samples began at about one in the afternoon. With this routine, the travelling time on sample collection days was reduced and the distance that could be covered was subsequently shortened. Hence, on days when water sampling was not part of the itinerary, more time would be spent travelling in order to make up the distance.

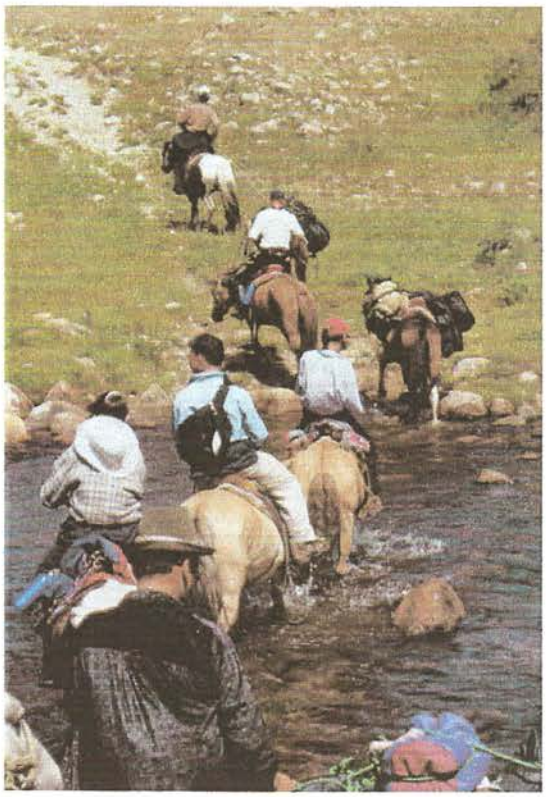


Figure 6.12: Crossing stream on horseback

The walking speed of a horse is about 5 to 6km/h, and trotting would allow us to cover about 10 to 12 km in an hour. The packed horses carrying our equipment limited us to walking speed, covering an average distance of about 35km a day. Galloping would have enabled us to cover longer distances, but we hardly had the chance to do so.

Seven days after we departed from *Uliastai*, we arrived at *Tosonchengel som* where we spent a day just outside the town recovering from saddle sores and agonisingly painful, aching knees. It also gave us some time to do some laundry and get ourselves washed. Being the second largest city in *Zavkhan* aimag, *Tosonchengel* is the heart of the timber industry in Western Mongolia, and as such it has perhaps more economical justification to be the aimag capital rather than *Uliastai*. It was a good resupply point to replenish our depleting rations and other necessary items such as batteries, lighters, matches, and fuel.

As we set out from *Tosonchengel* the next day, we quickly realised that our saddle sores had not gotten any better after the day's rest. Instead, things were more tortuous than before, and even the use of Vaseline did not solve or reduce our misery. There were eight more days to go before we came to the end of the horse rental agreement. At the speed we were travelling at, we decided not to continue with the horse riding after the initial horse rental agreement was up. Instead, we planned to look for a vehicle that could bring us a farther distance, covering a bigger area. *Khorgo som* was designated to be the end point for our horse riding phase, as the distance was far enough for seven travelling days. It was also an attractive location with a scenic lake, *Terkiin Tsagaan Nuur*, and a nearby extinct volcano where we could spend a day out hiking (we really wanted to do some walking to loosen the joints on our legs).

July usually sees the highest rainfall in Mongolia and this year was no different. Not only were we accompanied by wet weather on some days, we also experienced one particularly strong hailstorm, which pattered painfully down upon us. This sudden downpour of ice caught us by surprise; the unexpected hailstorm had hit us when the weather was bright and sunny just a few moments earlier. Perhaps it was punishment for us for lazing around the previous day. We headed straight for the nearest ger to take shelter, as our horses were showing signs of nervousness, not to mention our own rising sense of panic. The hospitable nomads did not mind our sudden intrusion to seek shelter in their home, but, in fact, welcomed us warmly by offering us hot tea and food.

Figure 6.13: The grassland backed with blue sky

We soon arrived at the *Zavkhan-Arkhangai* border. The scenery remained unchanged, and was as magnificent as that in *Zavkhan*. However, the 55,000 sq. km aimag of *Arkhangai* also housed some extinct volcanoes, lava fields and stunning lakes. The climate was generally much warmer due to the lower altitude, which allowed us to wear t-shirts and shorts even at night. The area was also more densely inhabited compared to the route we took to *Tosonchengel*, and we were able to rely more on the locals who would cook for us for a fee. We had not replenished our rations since *Tosonchengel*, as there were no towns big enough for us to restock. We soon felt that if we were to continue with the same kind of food and meals, we would eventually lose our appetites. Our rangers were especially affected because they were not used to the food we had been preparing (mash potatoes and soya). Hence, seeking gers for fresh hot meals was the preferred option. The cost of each meal of *Cuivuum* (mutton and flour noodles) or *Goulash* (mutton and rice) or *Horshuu* (mutton dumplings) was about ten sterling pounds for all eight of us, with tea and yoghurt often served after the very filling meal.

The road towards *Terkiin Tsagaan Nuur* was treacherous and in a very bad condition, and was strewn with loose rocks and dust. This 'mountain pass' enabled us to see more of the amazing mountain and wildflower scenery of the region. The steep ascents and descents that we had to make along this route made horse riding very uncomfortable, and aggravated the already agonising saddle and knee sores we were all suffering from. In, addition, each time a truck scampered pass, it would send tons of dust into the air and force us to stop or slow down. Sometimes, at the end of the day, a thick film of dirt would form on our already greasy faces and hair. This was a time when wet tissues and eye drops seem heaven-sent. We found no problem getting decent meals in the numerous ger-cum-guanz that were lined up along this busy road between *Tosonchengel*, *Tsetserleg* and *Ulaanbaatar*.

Figure 6.14: The badly paved road with loose rocks and dust

Figure 6.15: Enjoying our dinner

More water testing was carried out between *Tosonchengel* and *Terkiin Tsagaan Nuur*, adding another ten sets of data. The outcome of these tests can be found in Section 7 on pages 22 and 23. Five bottles of the culture medium had already been used at this stage of the expedition, with the remaining two being kept for use in the second phase. The DelAgua testing kit had been working perfectly and given us no problems. However, it was a bit too bulky to be packed onto the horses and too heavy for hand-carry. The battery for the incubation unit was never left drained, and was charged using the solar panel whenever the chance arose.

Although the saddle sores had persisted despite our best medicinal efforts, we eventually became more accustomed to riding the horses. We grew in confidence with every passing moment spent on the horses. Also, at the beginning, the rangers had to get everything prepared for us, such as putting on the saddle and bridle, and getting the horses ready for riding. But we gradually began to prepare our horses for ourselves. However, tying all our equipment onto the horses still required skill and experience, which only the rangers possessed. We could only stand by and watch them secure the equipment on the horses with masterful ease.

Figure 6.16: Tying our bags onto the horses

On certain nights where the temperature begin to drop significantly, the setting of the sun would be quickly followed by our setting up of a campfire to keep ourselves warm. We would usually gather around the blazing fire, cooking and consuming our dinner, singing songs, sharing our experiences, telling stories and learning Mongolian phrases. Sometimes the fire also drew visitors or passers-by, who would join us for a chat. It was the only time of the day that we could really get together and talk.

Figure 6.17: One of the many campfires we had set

Mongolia also has some of the most amazing and astonishing night skies, and the billions of glittering stars on a clear night sky never failed to astound us as we slowly drifted off into our star-filled dreams. Artificial satellites could also be easily spotted by our naked eyes, and shooting stars streaked across the skies every few minutes.

After we had crossed the domestic border into the *Arkhangai* aimag, we noticed that many of the old streams and rivers had dried up completely, leaving only limited sources of water for the nomads in certain areas. Some of the families were therefore very concerned about us camping near their only remaining source of water, and often came over to express their fears that we might pollute it. Some actually demanded that we break camp and shift elsewhere, but with the help of our rangers, who confided with the locals about our environmentally responsible habits, and with assurances that we would not contaminate the stream in any way, we managed to persuade the locals to let us stay. The episode only served to remind us how much the local nomads depended upon the generosity of Mother Earth.

Figure 6.18: The cause of our saddle sores - Mongolian saddle

Alas, it was only after we had begun to slowly appreciate the joys of horse riding, that we realised our horse rental agreement was about to expire. The lack of time stood in the way of our desire to extend our agreement, as there were only eight days left before we had to be in back in *Ulaanbaatar* to catch our flight home. The group decided to forgo the horse riding in place of using a vehicle to cover a larger area on the water testing experiment. The rangers, who probably wished to return home earlier and be with their children and wives, supported the decision. *Terkiin Tsagaan Nuur* was hence to be our end point for the horse-riding phase.

Figure 6.19: Typical Mongolian scenery in the Western provinces

Seeing the lake from a distance aroused both excitement and sadness; excitement from the sight of such gorgeous views, and sadness from the fact that our rangers were leaving us soon. Over the last two weeks, we had developed a very strong friendship with our rangers despite having a language barrier.

The dark blue water of the lake was overlooked by the *Khorgo* volcano. The lake itself was formed by lava flows from a volcano eruption many millennia ago. *Terkiin Tsagaan Nuur* was indeed an untouched paradise; an undeveloped place where only grazing livestock provided companionship.

It was only after spending some time looking for an ideal location that we had finally found a good site just next to the lake to set up our camp. As beautiful as the lake might have been, the rainy weather had dampened our mood to carry out the swimming, fishing and sun-tanning activities that we had hoped to do. Instead we spent a considerable amount of time in a nearby town for a driver who would be willing to drive us to *Ulaanbaatar*. Many of our offers were rejected before a young driver came forward to accept our proposal on a one-week contract.

Due to the gloomy and wet weather, we were unable to hike up to the nearby volcano crater to view the full splendour of *Terkiin Tsagaan Nuu* from a high vantage point. A day after we bade farewell to our lovely rangers whom we were likely never see again for the rest of our lives, we embarked on the second stage of the expedition.

The route we took for the horse-riding phase is summarised in Appendix C from pages 48 to 52.

Figure 6.20: A group photo before the rangers bade farewell to us

6.2 Vehicular Expedition

The second phase of the expedition commenced two days after the ending of the first one, which happened to fall on Tuesday the 31st of July. Mongolians believe that Tuesday should never be the day to begin any long distance travel or journey as it is regarded to be unlucky (see Beliefs and Superstitions in Section 8 on page 29). We were quite surprised that this young driver from *Khorgo som* had agreed to move out on a Tuesday, seemingly nonchalant about this traditional superstition. His vehicle was one of the Russian passenger vans which was hardy enough to manoeuvre speedily on the Mongolia cross-country terrain. Shaped like a loaf of bread, the van was able to carry up to about sixteen passengers, although that would leave hardly enough room for adequate comfort. In order for our water testing experiment to be conducted at ease on board the vehicle, we requested for no additional passengers to accompany us throughout the journey. As such, the cost of the rental had shot up but the driver had agreed to chauffeur us wherever we planned to go. With the mobility and speed, we headed towards the northernmost aimag of the country, *Khövsgöl*, to see the most beautiful lake in Mongolia, *Khövsgöl Lake*, about 265km from the starting point.

Figure 6.21: Group photo taken in the Russian van

The largely unpaved countryside road had made the ride extremely bumpy and uncomfortable, as a result our poor expedition doctor suffered from a serious bout of motion sickness (see Section 9 on page 31 for more details). However, we did see some interesting landscapes and sights along the way. One that deserves special mention was a Buddhist temple, about a hundred years old, that stood majestically on top a hill with seemingly hundreds of daunting steps leading up to it. One must be a very devout and faithful believer to overcome the strenuous uphill climb to the temple. It is very rare to come across traditional Mongolian temples especially out in the countryside as most have been torn down by the communist regime.

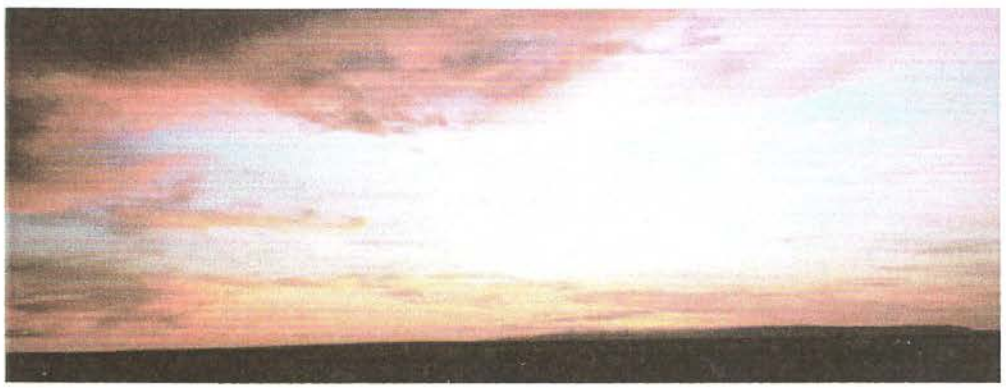


Figure 6.22: A gorgeous sunset

The lush scenery en route to the lake was especially picturesque. The abundance of water sources was responsible for the wildlife and stunning wildflowers that seemed to carpet the hilly landscape with a profusion of purple, red and yellow. However, navigation was very difficult at times. The route to the lake was seldom obvious, with detours and backtracks very common.

We arrived just after the sun had set and were not able to get a good glimpse of the Khövsgöl Lake. In the absence of any light from the moon or torch, we pitched our tents and cooked our dinner with some difficulties in the nearby woods.

Figure 6.23: The beauty of Khövsgöl lake

As our Mongolian team members had never seen such a large body of water in their lives, our visit to the lake took on special significance for them.

After spending a day at Khövsgöl Lake, we began our journey back to *Ulanbaataar*, making suitable stops along the way to conduct our tests.

In this second phase, we conducted the last 14 set of data, making a total of 34 samples. With the Russian van providing faster speed, we were able to conduct more water testing and cover a wider area. The results are presented in Section 7 on page 23.

7 Results

7.1 Experimental Data

The collections of water samples were carried out in both phases of the expedition, and were tested for their portability. The results of the tests are as follows:

No	Set No	Locations	Date	Amount Filtered (ml)	Turbidity	Acidity	Chlorine Residual	Coliform Count	Remarks
1.	Test 1	N: 47°44.565' E: 96°50.438'	16/7	100	5.0	7.0	<0.1	0.0	Murky water: clear upon standing
2.	Test 2	N: 47°55.066'	18/7	50	<5.0	7.9	<0.1	14.0	
		E: 96°59.279'		100	<5.0	7.9	<0.1	12.0	
3.	Test 3	N: 47°55.005'	18/7	50	<5.0	7.7	<0.1	0.0	
		E: 97°04.643'		100	<5.0	7.7	<0.1	0.0	
4.	Test 4	N: 47°55.917'	18/7	50	<5.0	7.7	<0.1	1.0	
		E: 97°07.242'		100	<5.0	7.7	<0.1	0.0	
5.	Test 5	N: 48°02.116'	20/7	50	<5.0	7.9	<0.1	7.0	
		E: 97°34.448'		100	<50	7.9	<0.1	9.0	
6.	Test 6	N: 48°03.763'	20/7	50	<5.0	7.9	0.1	0.0	
		E: 97°34.001'		100	<5.0	7.9	0.1	0.0	
7.	Test 7	N: 48°08.395'	21/7	50	<5.0	7.8	<0.1	0.0	
		E: 97°31.538'		100	<5.0	7.8	<0.1	0.0	
8.	Test 8	N: 48°16.665'	21/7	50	<5.0	7.8	<0.1	4.0	
		E: 97°38.487'		100	<5.0	7.8	<0.1	5.0	
9.	Test 9	N: 48°16.860'	21/7	50	5.0	8.0	<0.1	17.0	
		E: 97°38.847'		100	5.0	8.0	<0.1	13.0	
10.	Test 10	N: 48°41.142'	22/7	50	<5.0	8.2	<0.1	120	Highly Dangerous
		E: 97°54.026'		100	<5.0	8.2	<0.1	120	
11.	Test 11	N: 48°44.624'	25/7	50	<5.0	7.7	<0.1	8.0	
		E: 98°14.919'		100	<5.0	7.7	<0.1	10.0	
12.	Test 12	N: 48°30.511'	27/7	50	<5.0	7.8	<0.1	0.0	
		E: 98°40.343'		100	<5.0	7.8	<0.1	0.0	
13.	Test 13	N: 48°29.690'	27/7	50	<5.0	7.5	<0.1	22.0	
		E: 98°42.661'		100	<5.0	7.5	<0.1	21.0	
14.	Test 14	N: 48°28.743'	27/7	50	5.0	7.7	<0.1	0.0	
		E: 98°45.102'		100	5.0	7.7	<0.1	0.0	
15.	Test 15	N: 48°28.225'	27/7	50	<5.0	7.6	<0.1	5.0	
		E: 98°47.770'		100	<5.0	7.6	<0.1	7.0	
16.	Test 16	N: 48°27.014'	27/7	50	<5.0	7.9	<0.1	14.0	
		E: 98°52.444'		100	<5.0	7.9	<0.1	14.0	
17.	Test 17	N: 48°25.586'	28/7	50	<5.0	7.5	<0.1	0.0	
				100	<5.0	7.5	<0.1	2.0	

No	Set No	Locations	Date	Amount Filtered (ml)	Turbidity	Acidity	Chlorine Residual	Coliform Count	Remarks
18.	Test 18	N: 48°22.206'	28/7	50	<5.0	7.7	<0.1	20.0	
		E: 98°55.489'		100	<5.0	7.7	<0.1	17.0	
19.	Test 19	N: 48°12.316'	28/7	50	<5.0	8.0	<0.1	13.5	
		E: 99°01.101'		100	<5.0	8.0	<0.1	14.0	
20.	Test 20	N: 48°06.101'	29/7	50	<5.0	7.8	<0.1	17.0	
		E: 99°27.693'		100	<5.0	7.8	<0.1	18.0	
21.	Test 21	N: 48°13.312'	01/8	50	<5.0	7.9	<0.1	6.0	
		E: 99°24.205'		100	<5.0	7.9	<0.1	6.5	
22.	Test 22	N: 48°18.991'	01/8	50	<5.0	7.6	<0.1	0.0	
		E: 99°23.894'		100	<5.0	7.6	<0.1	3.0	
23.	Test 23	N: 48°20.182'	01/8	50	<5.0	7.5	<0.1	7.0	
		E: 99°27.553'		100	<5.0	7.5	<0.1	7.5	
24.	Test 24	N: 48°21.241'	01/8	50	<5.0	7.8	<0.1	9.0	
		E: 99°28.312'		100	<5.0	7.8	<0.1	10.5	
25.	Test 25	N: 49°03.540'	02/8	50	<5.0	7.8	<0.1	24.0	
		E: 99°34.587'		100	<5.0	7.8	<0.1	25.0	
26.	Test 26	N: 49°26.608'	02/8	50	<5.0	7.7	<0.1	16.0	
		E: 99°58.666'		100	<5.0	7.7	<0.1	16.0	
27.	Test 27	N: 49°28.238'	02/8	50	<5.0	8.0	<0.1	5.0	
		E: 100°06.250'		100	<5.0	8.0	<0.1	6.5	
28.	Test 28	N: 50°17.402'	02/8	50	<5.0	7.6	<0.1	0.0	
		E: 100°05.036'		100	<5.0	7.6	<0.1	0.0	
29.	Test 29	N: 50°30.275'	03/8	50	<5.0	7.7	<0.1	12.5	
		E: 100°09.102'		100	<5.0	7.7	<0.1	13.0	
30.	Test 30	N: 49°38.622'	04/8	50	<5.0	7.7	<0.1	0.0	
		E: 100°09.955'		100	<5.0	7.7	<0.1	0.0	
31.	Test 31	N: 49°27.498'	04/8	50	<5.0	7.8	<0.1	3.0	
		E: 100°00.878'		100	<5.0	7.8	<0.1	3.0	
32.	Test 32	N: 48°24.782'	05/8	50	<5.0	7.6	<0.1	0.0	
		E: 99°24.737'		100	<5.0	7.6	<0.1	0.0	
33.	Test 33	N: 48°18.873'	05/8	50	<5.0	7.7	<0.1	0.0	
		E: 99°23.606'		100	<5.0	7.7	<0.1	0.0	
34.	Test 34	N: 48°09.091'	05/8	50	<5.0	8.2	<0.1	23.0	
		E: 99°57.712'		100	<5.0	8.2	<0.1	21.5	

7.2 Discussion of Results

From the results presented in the section above, it can be seen that in general, water from sources in Mongolia is fit for drinking, and there is no need for purification. It is especially so for the sources which have little or no human activities within their proximity.

The fact that the countryside is largely undeveloped contributed to the zero Chlorine Residual in all the water samples we had tested. This also explains the low turbidity levels of less than five. These results are further strengthened by our observations during the tests confirming that the water from none of the streams or rivers was murky.

The acidity of the water samples range from a pH of 7.5 to 8.2, with the average at 7.8. There are various explanations for this alkalinity in the streams and rivers, with one possible cause being the use of soap and detergents by the nomads. Although it is not common practice for them to use these chemical agents, there is a rising trend in the usage of these products as the country develops its economy and tourism industry. Out of the 34 water samples we took, there were about 7 streams sighted with soap bubbles flowing from upstream. Closer investigation revealed that the locals were using soap to wash their laundry. Another explanation could have been the presence of natural minerals in the water that made the water slightly more alkaline. However, the lack of equipment to test the actual mineral content in the water would render this reason as pure conjecture at this stage.

The thermotolerant (faecal) coliform count ranges from zero to as high as 120. Zero counts were taken in spots where there were no livestock sighted in the vicinity, hence the unlikelihood of any *e.coli* present. In particular, one small but fast flowing stream (Stream 11), accounted for the high 120 *e.coli* count. Many gers were seen along this stream, with countless numbers of livestock roaming the wide plain, which easily explained the high bacteria count. Our immediate reaction upon attaining the results was to inform the nearby gers about the high content of faecal coliform in their drinking water, and to advise them to boil their water before consumption.

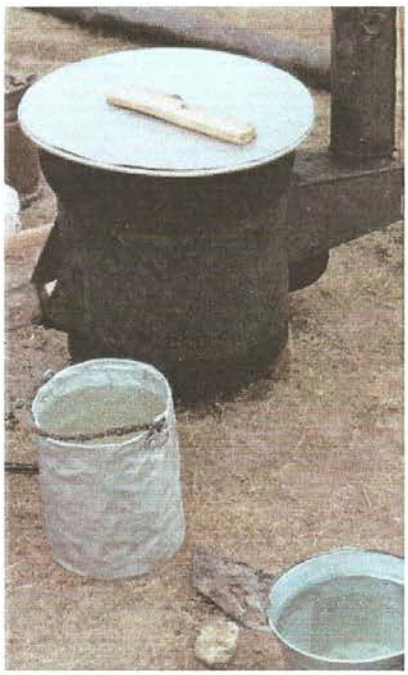


Figure 7.1: Boiling water before drinking

However, it must be noted that Mongolians, as a fact, hardly drink directly from a water source. Their main source of hydration is from drinking boiled milk tea (see the section on Food on page 27).

We have observed that the various sources of e.coli in Mongolia come from the domesticated animals such as yaks, horses, sheep and goats. The locals do not dump their own waste near the water sources, as they regard water a gift from heaven.

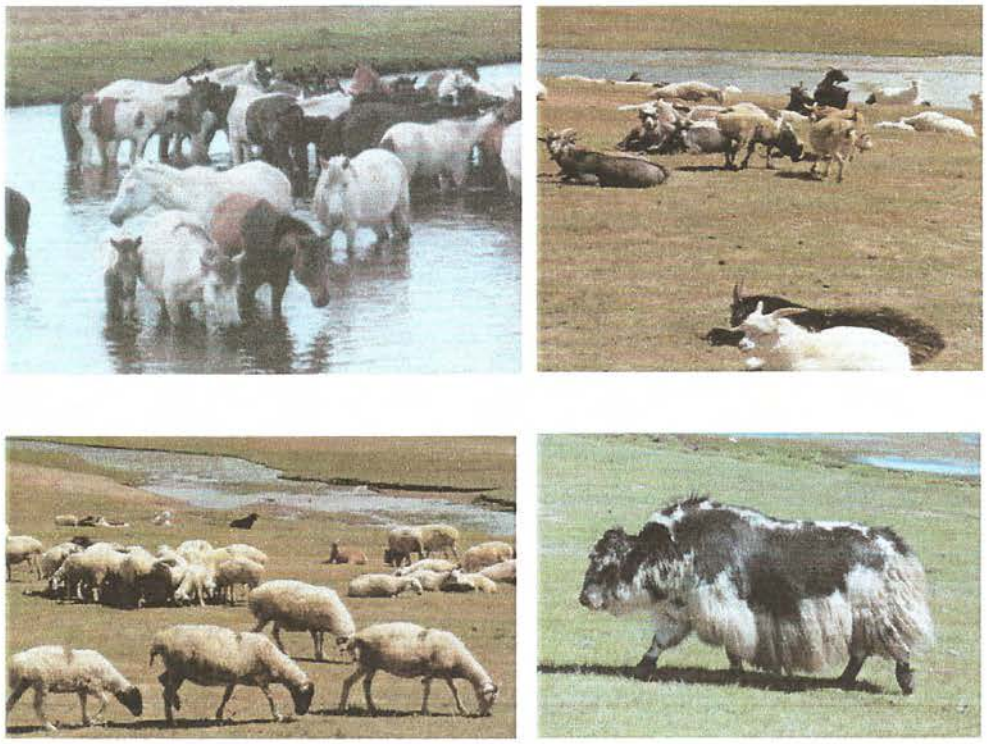


Figure 7.2: Domesticated animals that are the main source of e.coli

The only water sample tested from a pump house (in *Murun*) did not produce any undesirable results. The water was probably pumped directly from an underground stream, because the water was so clean, with a zero count of *e.coli* and without a trace of Chlorine present

The cleanest source of portable water inevitably came from an underground source or spring. Therefore, we did not bother to continue taking samples from any of these sources, so as to conserve our culture medium.

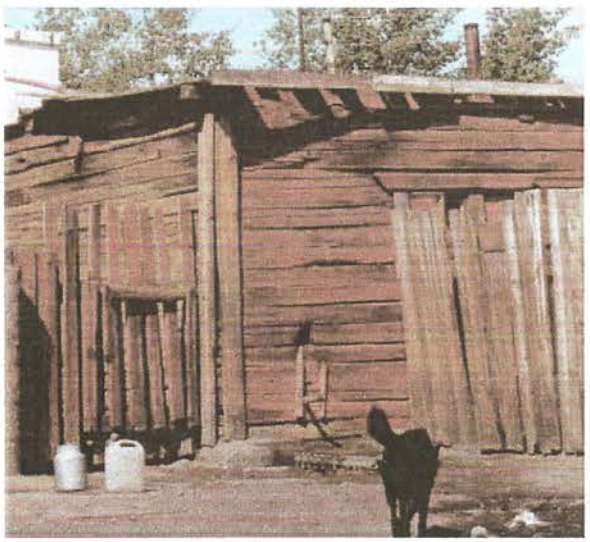


Figure 7.3: Pump house in Murun

On the whole, the results seem fairly consistent, and we can safely conclude that they are accurate. However, inasmuch as the *e.coli* count is a very good field indication of how safe the water is for consumption, the fact that the DelAgua does not detect other forms of potentially harmful organic (viruses) and inorganic contaminants means that further tests have to be carried out to obtain a full picture on the quality of the sampled water.

8 Cultural Exchange

8.1 Nadaam Festival

Usually, on the second week of July, Mongolia celebrates its longest national holiday, which lasts for three consecutive days, and is known as the Nadaam Festival. The highlights of this festival are the exciting competitions in the country's three national sports – archery, horse racing and wrestling.

There are no age restrictions in the game of the archery, neither is there any categorisation of any sort, apart from gender differences, to group the competitors. Competitors of all ages will pit their skills against one another, with the best emerging as the champion. This game differs slightly from the international one, most noticeably in the target board used. International archery uses the round target board with different colour markings to indicate the accuracy of the archer. However, in Mongolian archery, the target is made up of two rows of cylindrical blocks with only two colour schemes – red and dark brown or black. A line is drawn a few metres (approximately 3 metres) in front of the target. Points are only awarded when the arrow, which follows a trajectory, lands between the line and the target hitting the blocks or a direct hit. A group of judges will stand next to the targets waiting for the arrows to fly in their direction. A hit on the target will bring about a spontaneous guttural chant from the judges, complete with outstretched hands and waving arms. A fascinating sight altogether!

Figure 8.1: Archery Competition

Figure 8.2: The landing arrow on the unique target

Figure 8.3: Horse racing involving only little kids

Mongolians are arguably the best horsemen in the world, and horse racing is an integral part of the national identity. The jockeys are their three to eight year old children. Unlike archery, this game is categorised into different groups. The grouping is based on the age of the horses, usually ranging from one to five years old, and not that of the jockeys. Starting some 30km away from the end point, the riders gallop at a speed of about 70km/h towards the finishing line.

Mongolian wrestling involves only the men, and women are strictly forbidden from participating in this sport. The attire designed specially for this game strongly deters females from taking part. It consists of only a top-piece worn on the arms, and a lower piece which looks like a pair of swimming trunks. Legend has it that the special attire was introduced after a woman won the wrestling tournament after masquerading as a man. The rule of the game is to ground the opponent first. Apart from the feet and the palms, the rest of the body must be kept from the ground, otherwise the wrestler will be disqualified. There is no weight categorisation, and even a 50kg wrestler has to compete with a gigantic 100kg player.

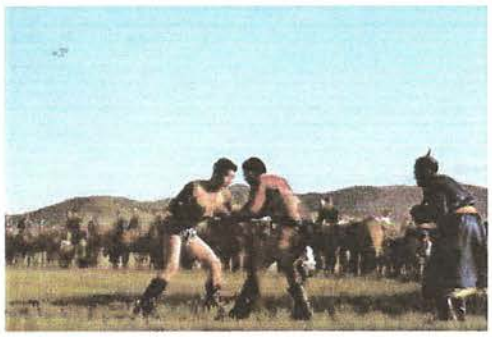


Figure 8.4: Mongolian wrestlers in action

8.2 Food

Mongolia is hell for vegetarians. The extreme weather conditions, with hot dry summers and cold harsh winters, make the proper growth of vegetation difficult at the least. Fresh vegetables can be found only in the cities or big towns, and are limited and seasonal. However, bottled preserved vegetables are readily available in most supermarkets and shops.

Figure 8.5: The bloodless way to kill a sheep

Mutton is the main source of meat for the Mongolians during summertime. On average, it takes about two weeks for a family of about five to eight to consume an entire sheep. Most parts of the sheep are used. Apart from its meat, the Mongolians also eat the sheep's head, kidneys and intestines. The stomach is used to make their cheese products. The fats are their favourite portion. Wool is made into cashmere, which is either sold, or used to make the protective insulating layer around their gers in winter. The knuckles are used as a national game for the kids. The slaughtering of a sheep, when done in an expertly manner as shown in Figure XXX, can be extremely painless, clean and bloodless.

Figure 8.6: Food samples from the nomadic families

Fermentation is the only form of food preservation available to the nomadic families. Different forms of dairy products were served to us at various gers. It was really amazing how these products were all made from the same source – the cow's milk. Even more amazing was the countless number of ways the milk products and milk by-products could be combined to form so many vastly different dishes and foods. Some samples of these foods are shown in Figure XXX.

Milk tea is a common drink served to visitors. Usually served hot in a small bowl, it is prepared by using a few litres of cow's milk, some salt, boiling water, and Russian tea leaves. This drink not only quenched our thirst during hot days, it kept us warm during the cold nights as well. It takes about ten minutes to prepare a big pot for around twenty-five people.

Figure 8.7: Preparing tea for her visitors

To keep warm in the winter, Mongolians love to drink vodka and *airag*, a alcoholic drink made from horse's milk. Drinking *airag* is an acquired taste, as it tastes extremely sour, a result of being left to fermentation for months. It is difficult to describe how sour the drink is, and it is probably about ten times as sour as natural yoghurt.

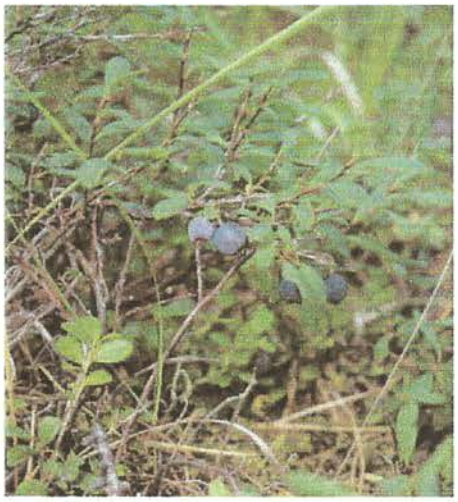


Figure 8.8: Wild blueberries

The *Zavkhan* aimag has an abundance of fertile topsoil and water which supports the abundant growth of wild berries, particularly strawberries and blue berries. The strawberry season had just ended when we arrived in Mongolia, but it was the beginning of blue berry season. This was fortunate because some of the gers we visited served us their delicious home-made blueberry jam, together with their home-made bread. Blueberry yoghurt is another popular dessert commonly served in the months of July and August

Figure 8.9: A cooked marmot

The hunting of marmots only occurs in summer when an abundance of these fury mammals roam the grassland. Hunting and eating of these marmots are illegal in certain parts of Mongolia as they carry with them the plague that has cost the lives of many locals. With the increasing death population due to plague, the government has imposed laws to forbid the hunting and consumption of marmots in these affected regions. Fortunately we were out of the affected zones, and managed to catch the glimpse of marmot hunting. We even got a taste of this animal. The figure below shows a cooked marmot before we laid our hands on it.

8.3 Language

The once frequently used Mongolian national script is no longer practised in daily correspondences in today's Mongolia. Instead, it has been replaced with Russian Cyrillic. However, Mongolian is still the national language, and is spoken widely across the republic.

It is a difficult language to learn, and our attempts to learn this new language often brought out laughter from the locals and ourselves. The commonly used terms, which are essential for everyday conservation, are as follows:

	English	Mongolian
1.	Hello	*sain bainuu*
2.	Fine	*sain sain bainuu*
3.	Goodbye	*bayartai*
4.	I hope your animal is fattening up nicely?	*mal süreg targan tavtaiyuu*
5.	Call the police!	*tsagdaa duudaarai!*
6.	What's your name?	*tany ner khen be*?
7.	My name is ___.	*minii ner _____.*
8.	I'm sorry.	*uuchlaarai.*

8.4 Superstitions and Beliefs

A vast country with poor infrastructure, harsh climatic conditions, treacherous landscape and sparsely inhabited areas means that travelling in Mongolia is extremely difficult and dangerous. There are therefore several superstitions and beliefs that the locals hold on to ensure a safe journey:

Tuesday is a bad day to commence any extended journey. It is perfectly fine to travel on that day but not to begin on it. We were not told the reasons behind this superstition, but the Mongolians believed that any journey that began on a Tuesday would be likely to encounter many unpleasant incidents.

Wolves are never regarded as an auspicious animal, but the Mongolian think otherwise. The sighting of a wolf while travelling, especially on horseback, is a good sign for a safe journey. Wolves are hard to come by in Mongolia and one must be extremely lucky to see one, hence the belief. Indeed, our rangers sighted one big black wolf (which fortunately it did not approach us) on the third day of the horse-riding phase, and we did have a wonderful trip without much difficulty. On the other hand, the fox is regarded as an unlucky animal that brings misfortune to whoever sees one.

Figure 8.10: Pouring cow's milk on the stirrup to bless for a safe journey

Milk from a cow is commonly used by the nomadic families as a blessing for a safe journey. Sprinkling cow's milk into the air at the travellers before they leave for their journey, and pouring the milk on the stirrup (if the travellers are on horses) are two ways in which the Mongolians strongly believe can bring good luck to the travellers. Möönöö's aunt in *Uliastai* blessed us at the start of our expedition using both the methods, and later, his grandparents in Tosonchengel also blessed us.

An *ovoo* is a shaman shrine, and can be seen easily in the countryside. It is used to ensure an auspicious journey across the great distances in Mongolia. It is made up of a collection of stones, piled up to look like a pyramid, with wooden poles and blue silk scarves placed on top of the stones. Rubbish, broken vodka bottles, and skeletons of dead livestock can also be found on this shrine. Walking clockwise around the shrine three times followed by the throwing of a stone onto the pile is meant to bring good luck, and sometimes, a wish can be made. These *ovoos* can be seen almost on every high point of a hill or a mountain as an offering to the god of the mountain. Tying of the mane of a horse to the *ovoo* also brings good luck to the travellers.

Figure 8.11: Our chief ranger tying the mane of the horse onto the ovoo

9 Medical

9.1 Pre-expedition Preparation

Medical issues were seriously looked into due to the lack of proper hospital amenities in the countryside. The vast travelling distances also meant difficulties in organising any emergency evacuations resulting from life threatening situations. Prior to the expedition, we took the necessary vaccinations against rabies, typhoid, tetanus, hepatitis A and B.

Dr Oyunaa, a qualified doctor, was to be our expedition medic. She had gained some experience from the Raleigh International Expedition in 1999 by understudying and helping the expedition medics then. She was aided by Suvd, a medical undergraduate, and was responsible for our health and hygiene. Her experience with horses, as well as the knowledge of local environment, allowed her to perform the task confidently.

9.2 Expedition

There were a few diarrhoea cases reported to our doctor but the situation was fortunately under control. Roy had a few accidents, especially with horses. He suffered a sprain on his right thumb during a game of volleyball with the locals in *Uliastai* just before the start of the expedition. Midway through the expedition, he fell off his galloping horse when the stirrup broke. That fall caused him to twist his right wrist. The twist was later worsened when he fell two more times from his wild-mannered horse. Fortunately the twist was not a serious one and he managed to continue the expedition without much pain. Poh Joo suffered from a serious bout of blocked nose, and even the use of a nasal spray did not seem to have any effect.

Figure 9.1: Our medic at work

During the second leg of the expedition, our doctor herself suffered from motion sickness. She was not used to travelling long distances on a vehicle. Hence, after the first couple of hours, she fell ill and threw up numerous times. Unfortunately we did not have any anti-motion sickness pills to ease her misery, but her condition became better after a day. She got used to the ride and her illness slowly subsided.

9.3 Post Expedition

There were no major illness or accidents throughout the expedition. Everyone was healthy and happy when we reached *Ulaanbaatar*. Famished stomachs was probably the only threat all of us faced. On the day we returned to Ulaanbaatar, our immediate destination was the buffet table for a most satisfying meal. We gobbled all the food we could, and downed pints after pints of Coke to ease our craving for soft drinks. All the weight lost during the expedition was quickly regained as we headed for restaurant after restaurant. No diarrhoea case was reported since the conclusion of the expedition. Our stomach must be pretty strong to undergo such a bout of gluttony.

10 Logistics

10.1 Equipment

No special equipment was needed for this expedition apart from the DelAgua Testing Kit (see the Experimental Description section) and a solar panel to charge the incubator contained within the kit. Proper saddle bags would have been of great convenience for horse riding to keep all the delicate items, food, medical pouch, etc. However they were hard to come by. We anticipated that tying rucksacks to the horses would have been too difficult, and the loose straps would have gotten caught while we rode through woods and thick vegetation. We decided to try using big and cheap Chinese duffel bags (bought in a Beijing street market), which actually ended up giving us more problems. These bags tore easily because of the poor quality of the materials they were made of. Broken zips and handles were also common problems encountered. Hence, we were constantly sewing and fixing broken zips throughout the journey. Fortunately, we had with us a complete sewing kit.

MSR cookers were ideal as they were lightweight and portable, which allowed meals to be cooked quickly and efficiently. Fuels such as petrol or diesel could be used, but the only drawback when using these lower quality fuels was the constant maintenance that was required to remove the quick build-up of soot. One bottle of fuel lasted us about four to five days as we only had one cooked meal a day, occasionally two. Hence we had sufficient fuel to last us easily during the expedition and did not face any situation where we had to resort to using dung as a cooking fuel.

10.2 Rations

Our rations were a good mix of both European and Asian foods. From London, we had dehydrated rations like soya, cup-a-soup, powdered mashed potato and instant pasta which are available from Sainsbury's supermarket. Chocolate bars, cereal bars, various food seasonings and teabags were also brought from the UK. A black market in *Ulaanbaatar* provided us with a wide range of European and Oriental groceries, such as instant noodles, canned beef and veggie, canned fruits, sachet drinks, broiled sweets, spaghetti, rice, biscuits and egg powder.

Sachet fruit drinks came in useful to mask the awful taste of iodine, which was added to purify the stream water for consumption. It not only gave flavour to the water but also provided a good source of sugar intake for the body. Boiled sweets were ideal bait to make the cute and lively local children sing for us.

Bread and soup, English tea, and sometimes, mashed potato, were usually served as breakfast. Occasionally, scramble eggs or fried eggs were cooked to replace the routine breakfast diet. Lunches were made simple as we usually had them while on the move, and hence, biscuits, chocolate bars and cereal bars were ideal. Mars, snickers and twist could be purchased from the shops in most of the *soms*. Dinners were the usual mashed potatoes or rice with canned meat, spaghetti with soya, and instant noodles for those who were still hungry for seconds. These foods were easy to cook and provided sufficient nutrition and energy to keep us going.

Gers could also provide alternative sources of rations as the families would cook for us for a fee. However, in the first couple of weeks, we relied mostly on our ration since gers were fairly hard to come by. In the later part when our rations were depleting, we dined in gers for almost every meal. It cost around ten sterling pounds for a proper meal for the eight of us. The food we usually had was fried noodles with chunks of mutton, served together with hot tea and sometimes yoghurt. Other times we had *khuurshuur*, a Mongolian-equivalent to meat pasties, or *buuz* that is steam mutton dumplings. If *guanz* were available, we would head there for a meal and usually fried noodles were the only dish on the menu. Other times we had rice with stir-fried mutton and veggie.

10.3 Navigational Aids

We were well equipped with navigational aids such as detailed maps (1:500000) of Mongolia, a Global Positioning System (GPS) and a simple magnetic compass. However, the latter was hardly used. The GPS was used mainly to locate points and track the distances covered. The best form of navigation, we soon realised, was by asking for directions from the locals. The locals, especially the older generation, having lived in the region for their entire lives, not only pointed us to the right direction but also gave other information such as weather, road conditions, terrain, water sources, towns, etc. The information they provided was usually accurate.

10.4 Transportation

The poor infrastructure in Mongolia made it difficult to get around the country. The infrequent domestic flights were regular, but were restricted to limited destinations, and fairly expensive for foreigners. The prices for one way ticket from *Ulaanbaatar* to *Uliastai* cost around US$125 for a non-Mongolian passport holder, whereas the same ticket for a Mongolian passenger would cost a third of that.

Russian jeeps or vans were common land transport. They were hardy and able to overcome the cross-country terrain and bumpy country roads. Petrol of grade 76 was the only fuel available across the whole nation at a price of about US$0.50 per litre. As distance between petrol kiosks were great, many drivers had spare fuel in their vehicles, or topped up their tanks to full whenever the opportunity arose.

In the city, we thought that the unlit streets at night would impede driving but the local drivers still drove as fast and confidently as they would in the day. It was like taking a roller coaster ride at night- thrilling but dangerous.

11 Pre-expedition Preparation

The pre-expedition preparation was carried out after the approval from the Exploration Board was given. Besides waiting eagerly and hopefully for all the sponsors we had written to, we also had to liaise with our Mongolian counterparts via emails and letters to provide us with the necessary information and logistical support. Of course, we first had to seek their voluntary participation in this expedition. Fortnightly updates with them took place on Saturdays using email messages.

At the beginning of the year, CNN reported that many parts of Mongolia had suffered from serious famine and drought, particularly in the regions where we had planned to hold our expedition. This brought our attention closer to the deteriorating situation there, and we in turn requested our friends in Mongolia to update us on the extent of the crisis. However, replies from them gave us the impression that things were not as serious as the situation depicted in news reports. The crisis was the result of the dry summer the previous year, when there was not enough pasture for the livestock to last them through this year's exceptionally harsh winter, and hence, many died of hunger. A viral outbreak among the livestock was reported shortly later in March, after many livestock were found contaminated by the virus in the southeastern part of Mongolia. Both crisis had subsided by May and normal nomadic life resumed for the locals. However, some of them had suffered serious losses of livestock. Neither disaster affected our expedition.

Research on the scientific aspect of the expedition was carried out to determine which onsite water testing methods or devices were appropriate to gain an accurate indication of the condition of the water sources. Many testing methods and equipment were suggested from books obtained from the college library. After speaking to Prof. Nigel Graham from the Imperial College Civil Engineering Department, we decided on the DelAgua testing kit developed by Prof. Barry Lloyd from the University of Surrey. It was a portable testing kit that allowed three critical parameters to be tested. The test results would be sufficient to determine the state of drinking water recommended by WHO (for more details, please refer to Section 5 on page 6).

We spent one afternoon in the University of Surrey, Guildford campus, to learn how to use of the testing kit. A demonstration was conducted by Ms Caryn Jones from the Centre for Environmental Health Engineering department, and was followed by some hands-on practice, which allowed us to get familiarise ourselves with the device. More practice sessions were carried out during our free time to ensure that we had sufficient knowledge and skill to conduct the experiments in the field. The culture medium or 'food for the bacteria' was prepared using the autoclaving facilities in our college Biology Department. All preparations were conducted in a controlled and sterile environment to ensure that the prepared culture was contamination free.

A checklist of items was drawn up to ensure we had everything needed for the expedition. Air tickets were purchased well in advance so as to get the cheapest deal to fly us into *Ulaanbaatar*, however we later encountered one major problem with this flight (refer to the Section 12 on page 35 for more details). Travel documents, such as Mongolian Visa, personal insurance, etc were also prepared to avoid any last minute delays.

12 Problems Encountered

Getting into Mongolia was the major problem we encountered, even before the expedition had begun. The pre-booked flight with the Russian national carrier – Aeroflot, bumped the three of us off the flight. Many Russian government officials needed to be flown over to Ulaanbaatar at the last moment's notice to attend an urgent conference. We were the unfortunate victims of this bureaucratic haste. Our flight was originally due to fly on the 4th July and the next available flight was a week later. We could not afford to wait that long and starting looking around for alternative ways to get into Mongolia as soon as possible.

The best and cheapest option turned out to be to fly into Ulaanbaatar via Beijing. Air China offered direct flights from Beijing to Ulaanbaatar, and several airlines had available flights to the Chinese capital. But before we could book the flights, we had to get hold of Chinese visas. Fortunately, the Chinese Embassy in London had an express service where we could get the visa within a day. We flew off from Heathrow on Wednesday, 6th July to Beijing and got another flight departing Beijing Capital Airport to Buyant Ukhaa in Ulaanbaatar on 8th July. This change in flight schedule effectively doubled our budgeted expenses to be spent on the airfare.

13 Expedition Expenditure

No	Items		Credit (£)	Debit (£)
Funding				
01	Funding from Expedition Board		3500.00	
02	Personal Contribution		1500.00	
03	Imperial College Mechanical Department		300.00	
		Sub-total	**5300.00**	
Transportation				
04	International Air Fare			2427.30
05	Domestic Air Fare			312.50
06	Horse Rental			463.10
07	Jeep Rental			250.00
		Sub-total		**(3452.90)**
Food				
08	Groceries in London			111.46
09	Chinese Spices			16.92
10	Groceries in Ulaanbaatar and Mongolia (countryside)			100.00 (approx.)
11	Fresh Food (in the countryside)			100.00 (approx.)
12	Meals (in Beijing and Ulaanbaatar)			200.00 (approx.)
		Sub-total		**(528.38)**
Equipment				
13	Camping Equipment			198.31
	a. sleeping bags	£89.97		
	b. roll mats	£16.50		
	c. duffel bags/saddle bags	£27.00		
	d. ground sheets	£23.97		
	e. tent pegs	£5.98		
	f. compass	£12.99		
	g. tents	£21.90		
14	Medical Equipment			80.90
	a. boots	£67.91		
	d. dry bag	£12.99		
15	Photography Equipment (Polaroid Film for Instant Camera)			60.00
16	Water Testing Kit			1100.00
17	Solar Charger			250.00
18	Maps			73.95
	a. air charts of Mongolia	£68.00		
	b. general map of Mongolia	£5.95		
		Sub-total		**(1763.16)**
Accommodation				
19	In Beijing			47.30
20	In Mongolia			150.00
		Sub-total		**(197.30)**
Others				
21	Chinese Visa			135.00
22	Mongolian Visa			75.00
23	Mongolian Visa extension			28.20
24	Airport Tax in Beijing Capital Airport			45.00
25	Airport Tax in Ulaanbaatar Buyant-Ukhaa Airport			23.40
26	Vaccination			82.00
27	Travel Insurance for Mongolians			145.41
28	Photocopy Cards (for photocopying maps)			10.00
		Sub-total		**(544.01)**
		Total	**5300**	**(6485.75)**
		Cost Incurred		**(1011.75)**

14 Conclusions

The results from the field experiments show a strong correlation between the levels of *e.coli* contamination in the water source and the number of livestock in the immediate vicinity. Other tests show that the water is generally not turbid and free from any Chlorine. However, high water alkalinity in certain spots was discovered, and this was probably due to the increasing use of commercial detergents and cleaning agents there.

Where *e.coli* contamination was evident, steps were taken to advise the nomads to take the necessary precautions against infection. However, we observed that the nomads seldom drank straight from a water source and always boiled the water that they had collected before consumption. This practice minimised their chances of *e.coli* infection. We also discouraged the locals from using detergents too close to a river, as the run-off would pollute the river and could have a serious health and ecological impact on the nomads living downstream.

Wells were no longer used in the region we were travelling because of the abundance of natural water sources such as rivers, streams and springs. The only well we found was dry and in disrepair. However, due to the dry summer, many of the marked rivers and streams reflected in the aerial map had dried up. We therefore sought to update the condition and status of the rivers and streams we had bypassed along our route of travel. The results of this can be seen in Appendix C on page 48, together with the route of advance in Appendix D on page 55.

15 Afterthoughts...

We were ecstatic at being given the chance to go for an expedition in Mongolia. So much was heard about its dramatic landscapes and hospitable people, we were keen to experience this first-hand. The fact that the Imperial College Exploration Society was subsidizing the expedition, and that we were to be involved in field research only added to our excitement and interest in the project.

By the end of the expedition, Mongolia was to leave an indelible impression on us. We had expected to enjoy breathtaking scenery, make new friends and experience the many challenges associated with planning an expedition, and with conducting experiments in the field. But what we had not expected was to feel such fondness for our newfound Mongolian friends, and to take away with us memories of a country struggling with change.

With a set of values, and a way of life so different from what is the norm in many parts of the world, Mongolians showed us what it was to share unconditionally. It was truly amazing to witness the generosity of Mongolians in the countryside, who readily provided shelter, food and company for total strangers. In that one month, we felt as if we had been transported into a different world. Our Mongolian expedition mates were equally kind, and had a helpful and selfless quality about them that was infectious. Very soon, we felt constantly compelled to think of the others in the expedition before we thought of ourselves! In this sense, the expedition was really enjoyable because we felt that we could always count on one another.

Working (and playing) closely with our Mongolian friends gave us the opportunity to interact with them at a much deeper level than otherwise possible. We were able to gain a better understanding of their circumstances and outlook on life, which was a big eye-opener. For example, to learn that freshly graduated doctors earned at most US$30 a month really put into perspective how widely different their social and economic conditions were from ours.

What really struck us, however, was the fact that they made do, and still lived in relative contentment, with what they had. Of course they had their share of aspirations, but, with the depressed economic climate and lack of opportunities for economic development in Mongolia, many of their dreams could remain unfulfilled. This profound thought made us realise that we had to be thankful for the opportunities that we already had, and that we could not take the things they strive so hard for for-granted!

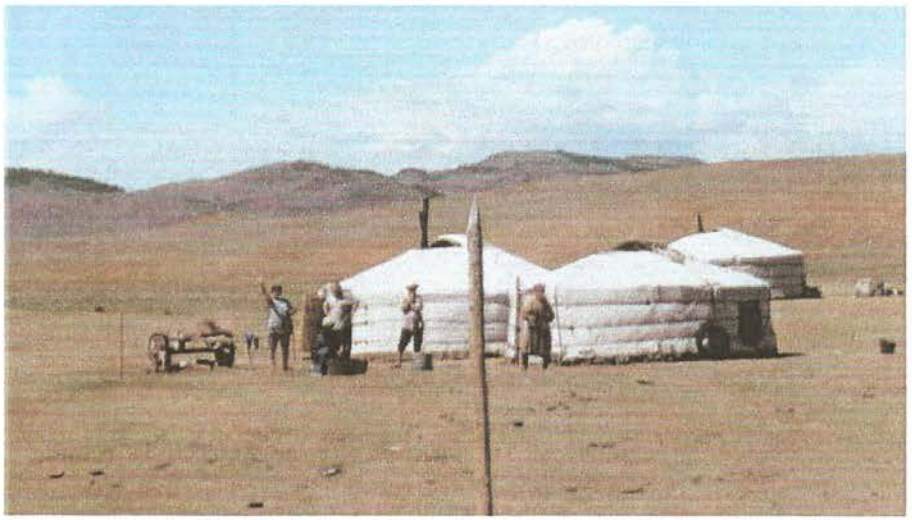


Figure 15.1: The hospitable nomadic families

However, the Mongolian people, in many ways still untouched by the cynicism of modern society, are struggling to hang on to their traditional values. We had several vivid encounters with younger Mongolians who were either disillusioned with the lack of prospects in the countryside, or so blinded by the lure of making money that they thought nothing of taking advantage of the goodwill and generosity of others.

Another disturbing trend was the increase in tourist traffic and its impact on the countryside. Mongolians who were in constant contact with foreigners were distinctly less trusting, and more calculating and 'capitalist' than others in more remote areas. Considering that the beautiful nature of Mongolians is perhaps the country's main attraction, this is indeed ironic! Furthermore, in a landlocked country with few natural resources, tourism has the potential to be the country's main export. The dilemma of developing this industry to alleviate the pressing need for economic development, and potentially sacrificing the character of the Mongolian countryside is a tough one indeed!

On a lighter note, we are extremely thankful for the chance to explore this beautiful land and learn more about it. We are sure nothing will quite compare to the experiences we had during the expedition and hope that others like us would continue to have the opportunity to learn more about the world and themselves in this way.

Appendix A
Sampling Methods (based on the DelAgua Portable Water Testing Kit Instruction Manual)

A1) Sampling from a Tap

a) Any attachments such as nozzles or pipes must be removed from the tap. The tap must not leak and all seals are checked to see if they are in good conditions.

b) The mouth of the tap is cleaned with a clean cloth or tissue to remove any dirt or grease. The tap is left running for at least a minute before the samples are taken to ensure any deposits in the pipes are washed out.

c) The water sample is taken using the non-sterile vacuum cup for analysis of chlorine residual and turbidity level.

d) If the chlorine residual and turbidity results indicate that further testing is required, then a second sample for bacteriological analysis using the sterile sample cup is taken.

Figure A-1: Collecting water sample from the tap

A2) Sampling from Lake, Reservoir or Other Water Source

a) Collection of water samples by hand is possible if there is adequate access to the source. The sample cup is held firmly and dipped into the water, about 30cm below the surface of the water, and the water sample scooped up.

b) This scooping action ensures no external contamination enters the sample cup.

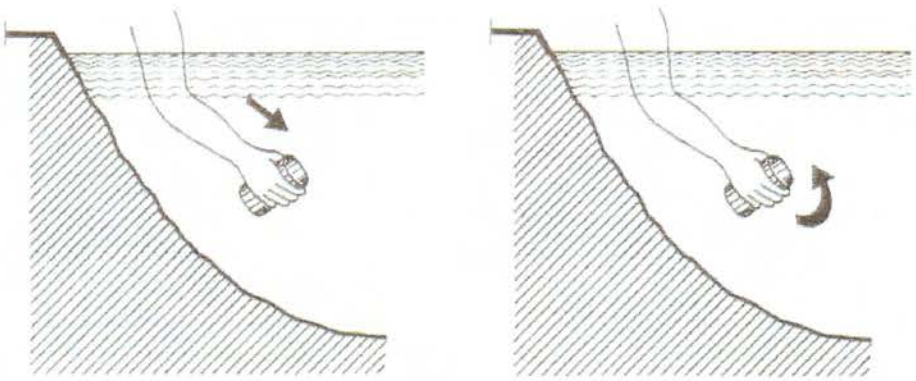


Figure A-2: Scooping action to prevent external contamination

c) The sample should be taken against the current flow in areas such as rivers and streams.

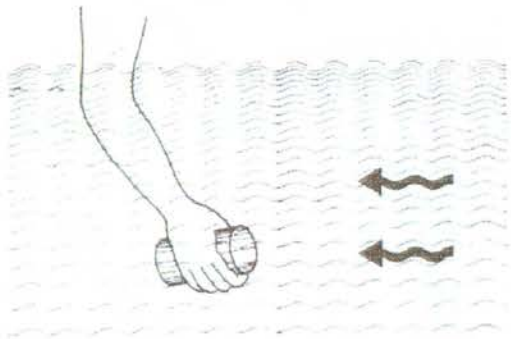


Figure A-3: Collecting samples against the flow of the current

d) When sampling from a river, the quiet and stagnant areas near the bank must be avoided as these did not represent the main body of the water, and external contamination might be present. Sampling with the aid of the cable supplied with the kit was used.

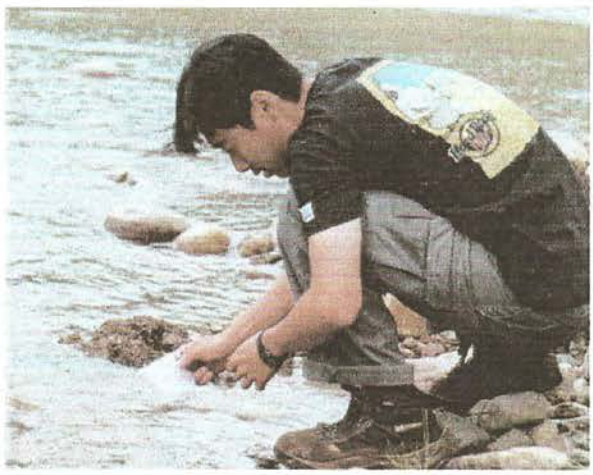


Figure A-4: Collection of water samples

A3) Sampling from an Open Well or Storage Tank

a) The sampling cable is fastened to the hole in the lip of the sample cup using the clip on the end of the cable.

b) Increasing the length of the cable is carried out by attaching a rope or string to the sample cable.

Figure A-5: Extending the cable

c) The sterile sample cup was lowered into the well or tank without touching the walls of the structure. The cup was submerged to a depth of 30cm from the water surface.

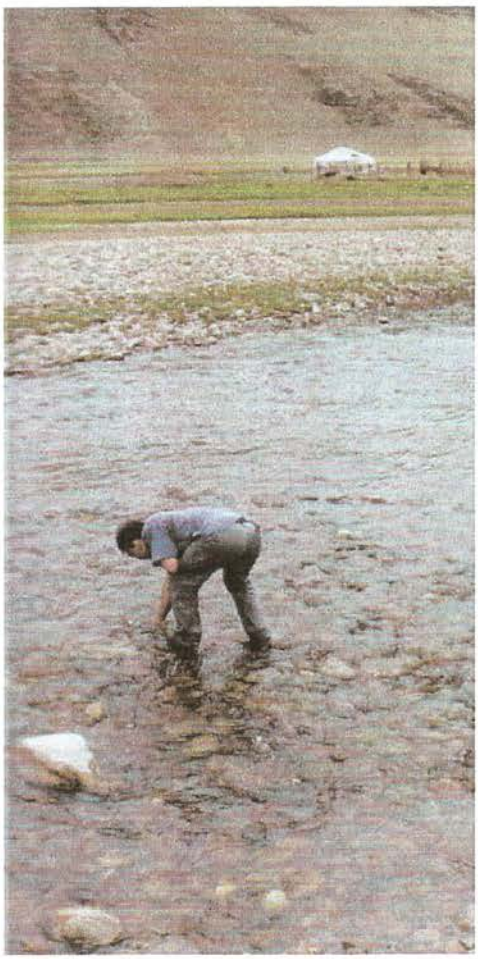


Figure A-6: Collecting of water samples from a flowing river

Appendix B
Sampling Process (based on DelAgua Portable Testing Kit Instruction Manual)

B1) Analysis of Chlorine Residual and pH

a) The comparator cell is washed three times with the water that is to be analysed, after which it is filled with the water sample.

b) The DPD No 1 tablet is dropped into the right-hand cell (marked 'Cl_2') and the phenol red tablet into the left-hand cell (marked 'pH').

c) The lid of the comparator is replaced and pushed down firmly to seal. The comparator is then inverted repeatedly until the two tablets are completely dissolved.

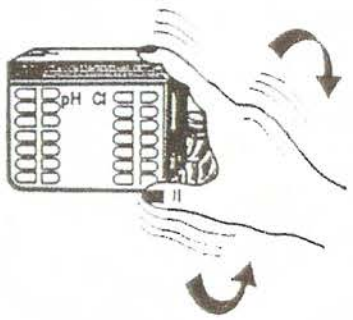


Figure B-1: Dissolving the tablets in the comparator

d) The chlorine residual and pH concentrations are read immediately by holding the comparator up to daylight and matching the colour developed in the cell with the standard colour scale in the central part of the comparator.

Figure B-2: Reading off the chlorine and pH values

B2) Turbidity Analysis

a) The two turbidity tubes are carefully assembled with the upper tube pushed into the lower one. A black circle printed on the base of the tube should be seen through the open end. Good illumination is necessary for this test; normal daylight is adequate for this purpose.

b) The water sample is poured into the tube from the sample cup until the black circle just disappears when viewed from the top of the tube. Bubbles must be avoided as they cause false readings.

c) The turbidity tubes are graduated in logarithmic scale with the most critical values. The result is the value of the line nearest to the water level which permits a reasonably exact estimation of the turbidity of the water sample.

d) The sample is taken against the current flow in areas such as rivers and streams.

e) When sampling from a river, the quiet and stagnant areas near the bank are avoided as these do not represent the main body of the water, and external contamination might be present. Sampling with the aid of the cable supplied with the kit is used.

B3) Sampling for Thermotolerant (Faecal) Coliform Analysis

a) The sample cup and filtration apparatus are first sterilised. The sample cup and filtration assembly is cleaned with a dry tissue or towel.

b) 1ml or twenty drops of methanol is poured into the sample cup, and the methanol carefully ignited using a lighter.

c) The methanol is allowed to burn for several seconds. The filtration apparatus is placed over the sample cup and pushed firmly into place to form a good seal when the methanol is almost completely burned off.

d) The filtration apparatus is kept for at least 15 minutes before the sample is processed. The sample cup and filtration apparatus are considered sterilised.

e) The absorbent pad is placed into each petri dish using the dispenser. This is usually done at the base before leaving for the field.

f) Enough culture medium is poured onto the pad in the dish to soak it leaving a slight excess. The excess is given to prevent the drying of the pad during incubation. The bottle cap is replaced immediately.

g) Once opened, a bottle of culture medium should be used within a day, two at most.

h) The tips of the tweezers are flamed with a lighter and left to cool.

i) The heel of the tweezers is placed into the test kit case as indicated to ensure that the tips are kept away from all sources of contamination whilst analyses are in progress.

j) The sterile filtration cup is removed from the filtration apparatus. It is pushed firmly onto the vacuum cup. The assembly is then placed in an upright position in a convenient place in the kit. The apparatus must not be soiled.

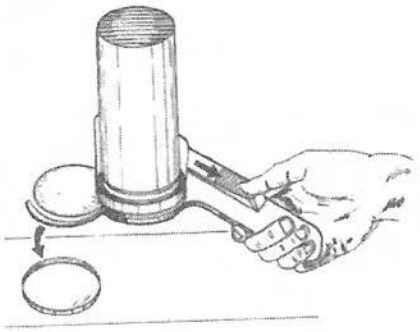


Figure B-3: Using the dispenser to place the absorbent pad into the petri dish

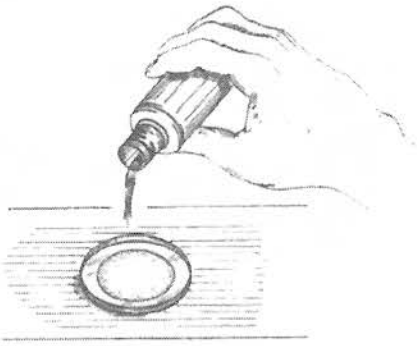


Figure B-4: Soaking the pad with the culture medium

Figure B-5: Placing the heel of tweezers to the kit case to prevent contamination

k) The plastic collar and filtration funnel are removed, but the collar base must not be placed on any surface to prevent contamination.

l) The sterile membrane filter is removed with caution from its packet using the sterile tweezers.

m) The membrane filter is placed onto the bronze disc filter. The funnel and collar are replaced immediately without any external objects to come into contact with the filter.

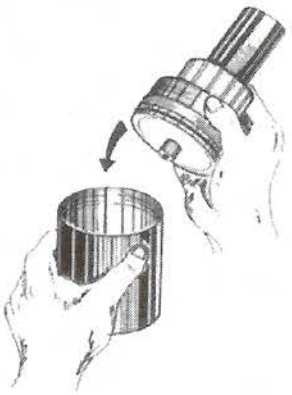


Figure B-6: Removing the filtration cup from the filtration apparatus

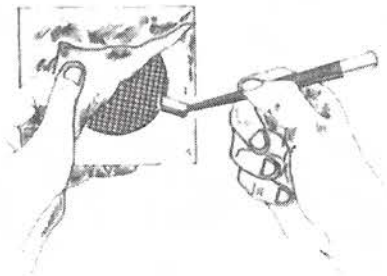


Figure B-8: Removing the membrane filter from its packet

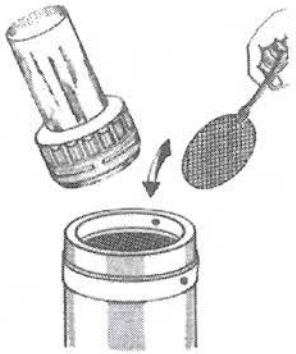


Figure B-7: Placing the filter onto the bronze disc filter support

n) The plastic collar is screwed down tightly to hold the membrane and provide a water tight seal.

o) The sterile sample cup is rinsed once with the water to be tested and is then filled up with the water.

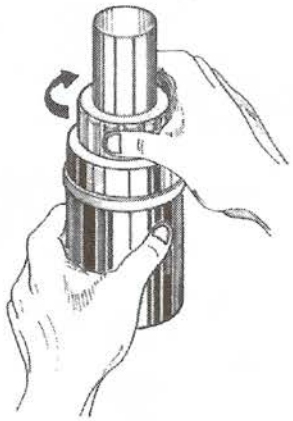


Figure B-10: Screwing the plastic collar down

Figure B-9: Pouring the water sample into the filtration funnel

p) The sample is poured into the filtration funnel to the appropriate mark (10, 50 or 100ml) engraved on the internal surface of the funnel.

q) The plastic connector of the vacuum pump is inserted into the vacuum connection on the filtration base. The pump bulb is squeezed several times to draw a vacuum and allow all the water to be drawn through the membrane filter. The pump is later disconnected when all the water has passed through the filter.

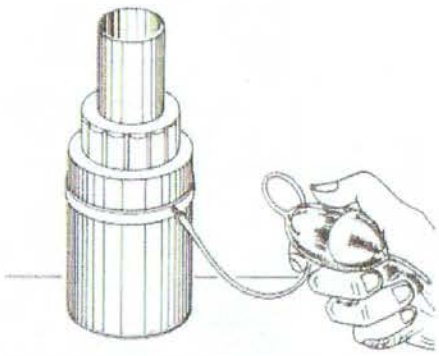


Figure B-11: Drawing water through the membrane filter using the vacuum pump

r) The membrane filter is then removed from the filtration base.

s) The lid of the prepared petri dish is removed and the membrane filter (grid side uppermost) is placed onto the absorbent pad soaked in culture medium. The membrane is 'rolled' on to the pad so that any air bubbles could be avoided.

t) The lid of the petri dish is replaced and marked with the sample information such as volume filtered, source, time and date.

u) The petri dish is then into the carrier in the uppermost position, and the carrier returned to the incubator pot for the incubation process to take place.

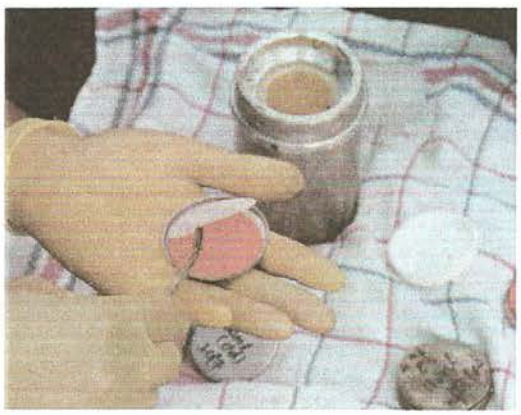


Figure B-12: The membrane was placed onto the absorbent pad

Appendix C

GPS Locations

No	*Name*	*GPS Code*	*Northings*	*Easthings*	*Remarks*
1.	Field Base (UB)	F-BASE	47°54.160'	106°55.909'	
2.	Uliastai	ULY	47°44.565'	96°50.438'	Test 1. The first water testing conducted in the kindergarten, which we spent three nights before moving out into the wilderness.
3.	Tragic	TRAGIC	47°47.833'	96°54.191'	
4.	Campsite 1	CAMP01	47°50.225'	96°54.859'	Nearby stream provided us with water for cooking and washing. However no testing was carried out due to the lack of time.
5.	Stream 01	STRM01	47°55.066'	96°59.279'	Test 2. A wide stream with slow current. Gers and livestock were sighted in the upstream.
6.	Stream 02	STRM02	47°55.005'	97°04.643'	Test 3. Quiet stream with little human activities.
7.	Stream 03	STRM03	47°55.917'	97°07.242'	Test 4. A wide fast flower river with little human activities in the vicinity where we had set up tents for the night. Thick vegetation along the riverbank.
8.	Spring	SPRING	47°56.005'	97°16.228'	Fresh underground spring water.
9.	Campsite 3	CAMP03	47°58.116'	97°27.827'	Surrounded by hills, we camped next to a river source. Cold nights as we were about 9000 ft above sea level.

10. Pond 01	POND01	48°00.696'	97°33.848	First pond ever during the expedition. Ducks were spotted. Discarded human waste was also seen in nearby vicinity.
11. Stream 04	STRM04	48°02.116	97°34.448'	Test 5. Stream with livestock grazing nearby.
12. Stream 05	STRM05	48°03.763'	97°34.001'	Test 6. Fast flowing stream with no sights of livestock or gers. We had set up our Day 4 campsite.
13. Stream 06	STRM06	48°08.395'	97°31.538'	Test 7. Wide stream with fairly strong current with no livestock in sight.
14. Stream 07	STRM07	48°13.134'	97°35.465'	
15. Stream 08	STRM08	48°16.665'	97°38.487'	Test 8. A tributary that led to a river some distance downstream. Fast flowing stream with rocky waterbed.
16. Stream 09	STRM09	48°16.860	97°38.847'	Test 9, co-located with our fifth campsite. Slow flowing stream with livestock and many nomads replying on the only water supply in nearby proximity.
17. Stream 10	STRM10	48°21.900'	97°45.641'	
18 Point 01	P01	48°34.443'	97°45.892'	
19 Stream 11	STRM11	48°41.142'	97°54.026'	Test 10. Small stream shared by many gers and lots of animals were grazing and drinking from the source. Shallow but sandy riverbed, fairly dirty in comparison to previous streams seen. We set up our sixth campsite near this stream.
20 Point 02	P02	48°41.589'	97°59.767'	

21	Dry Well	WELD01	48°41.883'	98°00.306	The only well seen by far but was totally dry, and has fallen into despair.
22	Stream 12	STRM12	48°42.861'	98°05.617'	
23	Point 03	P03	48°43.420'	98°10.462'	
24	Stream 13	STRM13	48°44.624'	98°14.919'	Campsite 7 which was just outside Tosonchengel som. We had a rest day here to recuperate from the exhaustive saddle and knees sores. A chance to get our laundry and us washed. Test 11.
25	Point 04	P04	48°42.486'	98°22.676'	
26	Point 05	P05	48°37.264'	98°22.440'	
27	Stream 14	STRM14	48°31.827'	98°32.277'	We pitched our tents just next to a river source with many livestock grazing just next to it. Many gers were located at the downstream.
28	Stream 15	STRM15	48°30.511'	98°40.343'	Test 12. Medium size stream with reasonably fast river current that flowed through vegetated riverbank.
30	Stream 16	STRM16	48°29.690'	98°42.661	Test 13. Fast flowing river with shallow riverbed but wide. Livestock were seen in the proximity of the testing site and gers were spotted on the upstream of the river.
31	Stream 17	STRM17	48°28.743'	98°45.102'	Test 14. Another fast flowing river with shallow riverbed. A couple of gers spotted of the upstream, no livestock during time of testing.

32	Stream 18	STRM18	48°28.225'	98°47.470'	Test 15. Slow flowing river with rocky riverbed.
33	Campsite 9	CAMP09	48°27.014'	98°52.444'	Camped next to a lush forest with many wild berries for picking. Very miserable and stagnant water source nearby which needed filtration to remove the debris and dirt. A bandana was used for this purpose. Test 16 was conducted.
34	Stream 19	STRM19	48°25.586'	98°54.211'	Test 17. Crystal clear water flowing down the rocky bed.
35	Stream 20	STRM20	48°22.206'	98°55.489'	Test 18. River with about 1 metre wide, supporting livestock and nomadic families.
36	Point 06	P06	48°18.531'	98°55.229'	
37	Mountain Pass	HP01	48°17.093'	98°58.054'	The highest point in the area which about 9,700 ft above sea level. We were accompanied by strong and chilly wind.
38	Point 07	P07	48°15.464'	98°59.609'	
39	Stream 21	STRM21	48°12.316'	99°01.101'	Test 19 and campsite 10. A wide stream with shallow but sandy waterbed.
40	Point 8	P08	48°08.877	99°04.768	
41	Lake 01	LAKE01	48°07.980'	99°08.571'	
42	Stream 22	STRM22	48°07.394'	99°11.015'	
43	Stream 23	STRM23	48°07.334'	99°12.161'	
44	Point 09	P09	48°05.645'	99°17.385'	
45	Point 10	P10	48°05.286'	99°22.424'	

46	Stream 24	STRM24	48°06.101'	99°27.693'	Test 20 and campsite 11. A shallow and narrow stream with clear running water.
47	Point 11	P11	48°07.512'	99°31.772'	
48	Point 12	P12	48°06.951'	99°38.303'	
49	Point 13	P13	48°07.851'	99°40.695'	
50.	Terkiin Tsagaan Nuur	TSNUUR	48°08.613'	99°47.941'	The conclusion of our horse riding expedition. We spent two days camping next to this lovely lake. Time was spent to look for vehicle to chauffeur us through the second phase of the expedition.
51.	Drive Point 1	DP01	48°05.270'	99°30.304'	
52.	Drive Point 2	DP02	48°08.524'	99°26.000'	
53.	Stream 25	STRM25	48°13.312'	99°24.205'	Test 21. Fairly wide stream with slow flowing current. Fairly shallow waterbed too.
54.	Stream 26	STRM26	48°18.991'	99°23.894'	Test 22. Slow flowing stream with no human activities in nearby proximity.
55.	Stream 27	STRM27	48°20.182'	99°27.553'	Test 23. Wide stream supporting many gers and countless number of livestock.
56.	Stream 28	STRM28	48°21.241'	99°28.312	Test 24. Fairly wide stream that meandered through a plain, supporting the locals and their animals.
57.	Drive Point 3	DP03	48°27.758'	99°22.319'	
58.	Drive Point 4	DP04	48°28.562'	99°22.333'	

59. Stream 29	STRM29	48°32.966'	99°22.178'	
60. Orgil Som	JARGAL	48°34.667'	99°21.452'	
61. River 01	RVR01	48°35.554'	99°18.617'	Huge river with a wooden bridge spanning about 8 metres across. Fairly murky.
62. Drive Point 5	DP05	48°42.858'	99°23.055'	
63. Drive Point 6	DP06	48°51.045'	99°25.880'	
64. Drive Point 7	DP07	48°56.464'	99°31.972'	
65. Campsite 13	CAMP13	48°58.058'	99°31.755'	
66. Stream 30	STRM30	49°03.540'	99°34.587'	Test 25. Shallow and sandy river with fairly thick vegetated riverbank. Clear water.
67. Drive Point 8	DP08	49°14.917'	99°43.627'	
68. Pump House 1	PUMP01	49°17.329'	99°48.000'	An abandoned pump house.
69. Drive Point 9	DP09	49°21.884'	99°52.238'	
70. Steam 31	STRM31	49°26.608	99°58.666'	Test 26. Narrow stream with fast flowing and sparkling water on the rocky streambed. Only a couple of gers were spotted further upstream.
71. Stream 32	STRM32	49°28.238'	100°06.250'	Test 27.
72. River 02	RVR02	49°35.146'	100°09.132'	
73. Murun	MURUN	49°38.617'	100°10.024'	
74. Drive Point 10	DP10	49°47.553'	100°03.116'	
75. Drive Point 11	DP11	50°02.519'	99°58.649'	
76. Stream 33	STRM33	50°17.402'	100°05.036'	Test 28

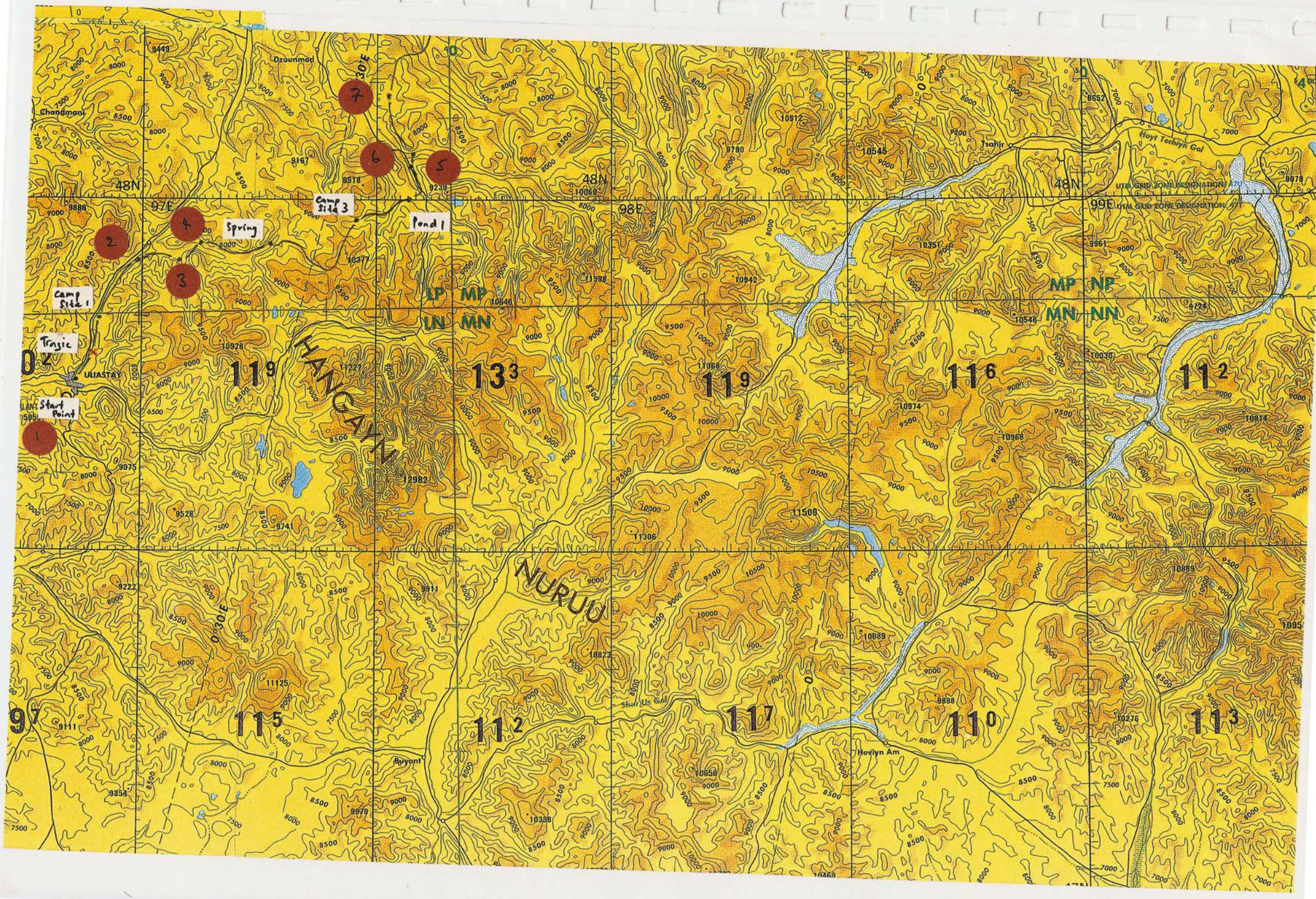
77. Khövsgöl Lake	TOP	50°30.275'	100°09.102'	Tested the clear fresh water lake. Test set 29.
78. Pump House 2	PUMP02	49°38.622'	100°09.955'	Test 30. Located next to a black market in Murun. Served the community in the aimag capital. Built on wooden planks and drawn water from underground spring.
78. Stream 34	STRM34	49°27.498'	100°00.878	Test 31. Campsite 15.
79. Stream 35	STRM35	48°24.782'	99°24.737'	Test 32.
80. Stream 36	STRM36	48°18.873'	99°23.606'	Test 33.
81. Stream 37	STRM37	48°09.091'	99°57.712'	Test 34.
82. Gorge	GORGE	48°07.700'	100°16.735'	A beautiful gorge with a wide river flowing some 20 metres down our feet.
83. Drive Point 12	DP12	47°23.509'	102°24.758'	
84. Drive Point 13	DP13	47°37.085'	104°52.312'	
85. River 03	RVR03	47°52.262'	105°12.140'	
86. Drive Point 14	DP14	47°54.674'	105°39.123'	
87. Drive Point 15	DP15	47°53.329'	105°58.285'	
88. Drive Point 16	DP16	47°54.901'	106°16.349'	
89. Field Base	F-BASE	47°54.160'	106°55.909'	

Appendix D

Maps

Map A	Map of Mongolia
Map B	Route of advance showing testing sites 1 to 7
Map C	Route of advance showing testing sites 7 to 25
Map D	Route of advance showing testing sites 26 to 33


KHÖVSGÖL
SELENGE
BULGAN
ARKHANGAY
ZAVKHAN
TÖV
BAYANKHONGOR
ÖVÖRKHANGAY
DUNDGOV'
Khövsgöl Nuur
Khövsgöl Nuur National Park
Khangayn Nuruu
Khamar-Daban Mountains
ALTAY
Gusinoozersk
Kyachta
Sükhbaatar
Сүхбаатар
DARKHAN
ДАРХАН
ERDENET
ЭРДЭНЭТ
ULAANBAATAR
УЛААНБААТАР
Mörön
Мөрөн
Bulgan
Булган
Uliastay
Улиастай
Tsetserleg
Цэцэрлэг
Bayankhongor
Баянхонгор
Arvaykheer
Арвайхээр
Mandalgov'
Мандалговь
Altay
Алтай
Zakamensk
Tosontsengel
Kharkhorin
Karakorum
Erdene Zuu Monastery
Shankh Monastery
Orkhon Waterfall
Khar Balgasyn Tuur
Taikhar Chuluu Rocks
Shivert Hot Springs
Tsenkheryn Khaluun Us Hot Spring
Uran-Togoo Tulga Mountain Nature Reserve
Ancient Mongol and Uighur burial sites
Amarbayasgalant Monastery
Khorgo-Terkhiyn Tsagaan Nuur National Park
Otgon Tenger Uul Nature Reserve
Khustayn Nuruu Nature Reserve
Batkhaan Uul Nature Reserve
Khuisiyn Naiman Nuur Nature Reserve
Altan Els Nature Reserve
Galuutyn Canyon
Volcanic formations, cave paintings
Shargaljuut Water Springs
Baga Gazaryn Chuluu
Khukh Burd Süm
Gimpil Darjaalan Monastery
Tsogt Taij Chuluu
Ikh Gazaryn Chuluu
Ongiyn Monastery
Manzshir Monastery
Mother Rock
Camp site
Cave
6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Pond 1
Camp Site 1
Tsagic
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Start Point
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NURUU
Shar Us Gol
Buyant
Hoviyn Am
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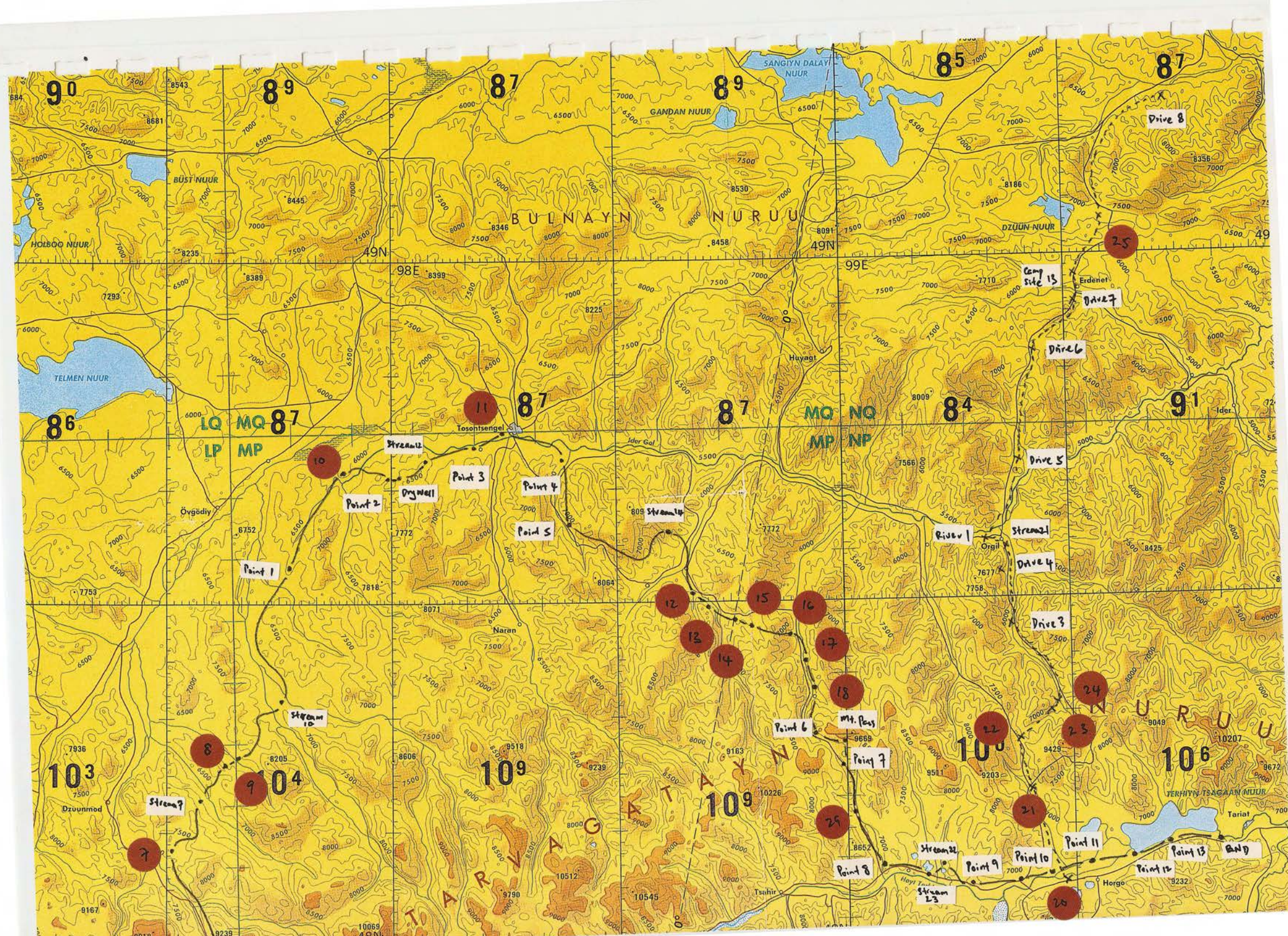
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TERHIYN TSAGAAN NUUR
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Tosontsengel
Huvagt
Idor Gol
Övgödiy
Dzuunmod
Naran
Orgil
Erdenet
Tariat
Horgo
Tsahir
Hoyt Tsahir
Camp Site 13
Drive 8
Drive 7
Drive 6
Drive 5
Drive 4
Drive 3
Drive 2
Drive 1
Point 1
Point 2
Point 3
Point 4
Point 5
Point 6
Point 7
Point 8
Point 9
Point 10
Point 11
Point 12
Point 13
Stream 2
Stream 4
Stream 7
Stream 10
Stream 21
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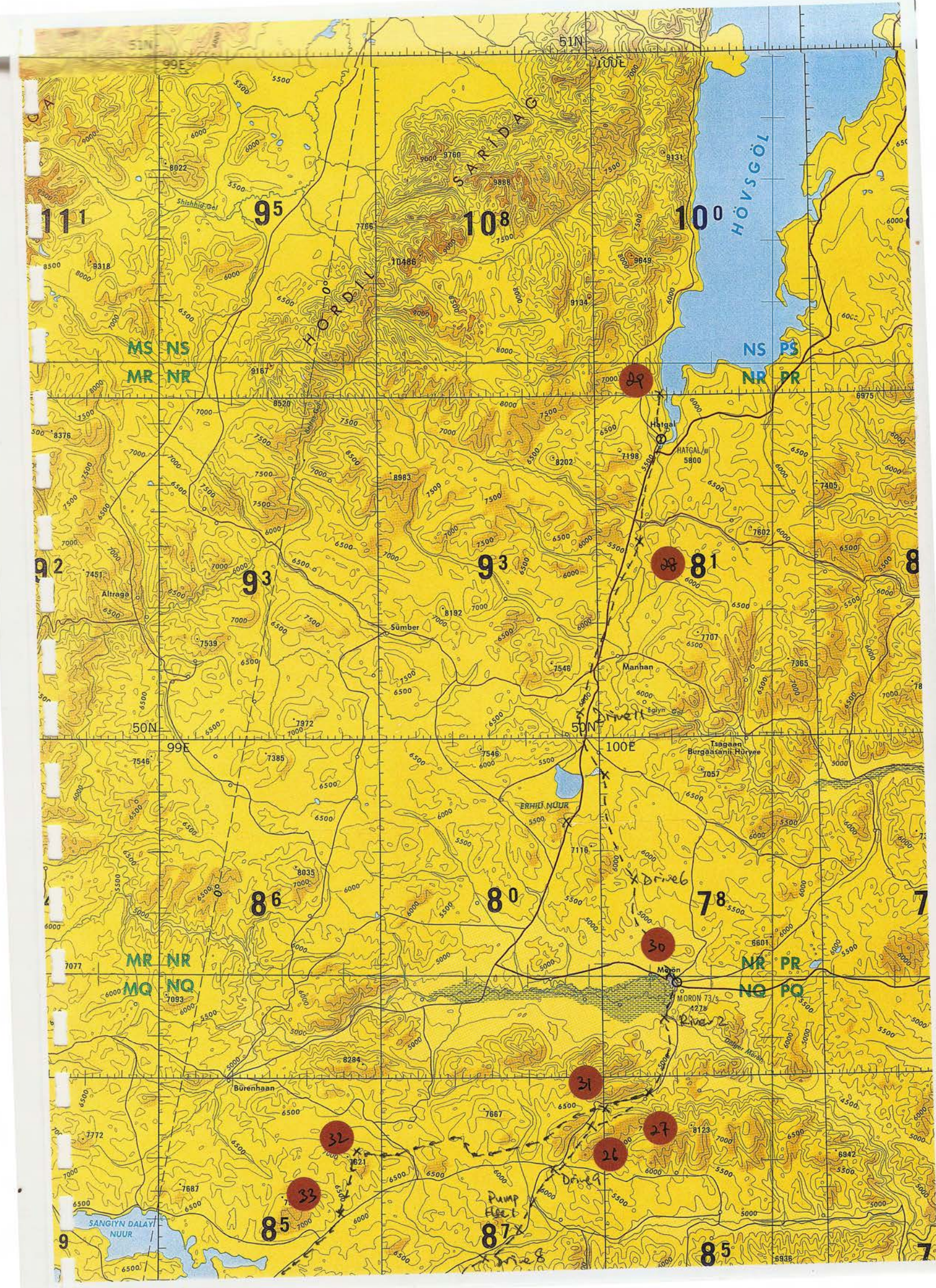
Stream 23
Dry well
Mt. Pass
BND
LQ MQ
LP MP
MQ NQ
MP NP
TARVAGATAY NURUU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Drive4
Drive6
Drive8
Drive9
Pump Fleet
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