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**International Court
of Justice**

**Cour internationale
de Justice**

THE HAGUE

LA HAYE

YEAR 2015

Public sitting

held on Friday 24 April 2015, at 10 a.m., at the Peace Palace,

President Abraham presiding,

*in the cases concerning Construction of a Road in Costa Rica along the San Juan River
(Nicaragua v. Costa Rica); Certain Activities carried out by Nicaragua
in the Border Area (Costa Rica v. Nicaragua)*

VERBATIM RECORD

ANNÉE 2015

Audience publique

tenue le vendredi 24 avril 2015, à 10 heures, au Palais de la Paix,

sous la présidence de M. Abraham, président,

*dans les affaires relatives à Construction d'une route au Costa Rica le long du fleuve San Juan
(Nicaragua c. Costa Rica) ; Certaines activités menées par le Nicaragua
dans la région frontalière (Costa Rica c. Nicaragua)*

COMPTE RENDU

Present: President Abraham
 Vice-President Yusuf
 Judges Owada
 Tomka
 Bennouna
 Cançado Trindade
 Greenwood
 Xue
 Donoghue
 Gaja
 Sebutinde
 Bhandari
 Robinson
 Gevorgian
Judges *ad hoc* Guillaume
 Dugard

 Registrar Couvreur

Présents : M. Abraham, président
M. Yusuf, vice-président
MM. Owada
Tomka
Bennouna
Caçado Trindade
Greenwood
Mmes Xue
Donoghue
M. Gaja
Mme Sebutinde
MM. Bhandari
Robinson
Gevorgian, juges
MM. Guillaume
Dugard, juges *ad hoc*

M. Couvreur, greffier

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as Agent and Counsel;

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Mr. Alain Pellet, Professor at the University Paris Ouest, Nanterre-La Défense, former Member and former Chairman of the International Law Commission, member of the Institut de droit international,

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Ms Shara Duncan, Adviser to the Ministry of Foreign Affairs and Worship,

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Mr. Rafael Saenz, Minister Counsellor at the Costa Rican Embassy in the Kingdom of the Netherlands,

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Ms Elisa Rivero, Administrative Assistant at the Ministry of Foreign Affairs and Worship,

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Mme Ana Patricia Villalobos, fonctionnaire du ministère des affaires étrangères et des cultes,

comme conseils adjoints ;

Mme Elisa Rivero, assistante administrative au ministère des affaires étrangères et des cultes,

comme assistante.

Le PRESIDENT : Veuillez vous asseoir. La Cour entendra maintenant les experts cités par le Costa Rica, qui sont au nombre de deux. Le premier d'entre eux est Monsieur Cowx, que je prie de bien vouloir prendre place à la barre. Bonjour, Monsieur le professeur. Je vous invite à faire la déclaration solennelle prévue pour les experts et dont l'énoncé figure à l'alinéa *b*) de l'article 64 du Règlement de la Cour.

Mr. COWX:

“I solemnly declare upon my honour and conscience that I will speak the truth, the whole truth and nothing but the truth, and that my statement will be in accordance with my sincere belief.”

Le PRESIDENT : Merci. Je me tourne maintenant vers le conseil du Costa Rica, qui va vous demander de confirmer l'exposé écrit qui se trouve devant vous. Madame.

Ms PARLETT: Good morning, Professor Cowx. Thank you very much for being here. I understand you flew in yesterday evening from Vietnam. Could I ask you to confirm whether the two documents in front of you — that is, your summary prepared for the purposes of this hearing and your report of 11 December 2014, prepared in the context of this case — reflect your honest, expert views?

Mr. COWX: They do.

Ms PARLETT: I believe counsel for Nicaragua now has some questions for you.

Le PRESIDENT : Merci. Je vais maintenant donner la parole à Monsieur Loewenstein, conseil pour le Nicaragua pour le contre-interrogatoire. Monsieur Loewenstein, vous avez la parole.

Mr. LOEWENSTEIN: Good morning, Mr. President, and good morning to you, Professor Cowx. It is a pleasure to meet you. If I may, I would like to begin by discussing the ways in which elevated levels of sediment may impact fish.

Professor Thorne provided expert testimony in the *Certain Activities* case in which he listed a number of effects that elevated sediment levels can have on fish. I understand that whether elevated levels of sediment will have impacts, and to what extent, may depend upon the specific

species of fish under consideration. But I would like to see whether you agree with Professor Thorne about what types of impacts might occur.

Would you agree that sediment can clog and damage the gills of fish?

Mr. COWX: I do, at very high levels of sediment, yes.

Mr. LOEWENSTEIN: Would you agree that sediment can reduce the ability of fish to recover from wounds?

Mr. COWX: Mostly, but many fish are able to recover regardless because they have antiseptic in their skin which helps them to recover anyway, irrespective of sediment load.

Mr. LOEWENSTEIN: Would you agree that sediment can disrupt reproduction in some fish by damaging or smothering eggs or larvae?

Mr. COWX: It is less so eggs and larvae, it is more some of the gravel spawning areas or habitats that are affected.

Mr. LOEWENSTEIN: Would you agree that sediment can affect adult fishes' reproductive behaviour, for instance, by impacting visual mate recognition?

Mr. COWX: In very, very few species *this* occurs. Mostly the multiple species groups, such as in Lake Victoria, where they use colour recognition for identifying their mate, but very rarely in riverine fisheries.

Mr. LOEWENSTEIN: Would you agree that sediment can impair the ability of certain fish to locate food as a result of decreased visibility?

Mr. COWX: Many fish are adapted to high sediment loading and are able to seek their food by sensing their movements, by using organs within the body that help them detect it, so it is very unlikely that in high sediment loading, unless it is unusually high, massively beyond clear water colourations, that you will get that effect.

Mr. LOEWENSTEIN: But you agree that, in some circumstances, it can have that effect?

Mr. COWX: It has to be huge sediment loading and the systems usually have to be clear water before that takes any impact, so always clear water.

Mr. LOEWENSTEIN: Would you agree that sediment can result in loss or reduction of macroinvertebrate populations?

Mr. COWX: They can do. Again, under circumstances of high loading, many invertebrates are adapted to sediment loading and sediment levels.

Mr. LOEWENSTEIN: Would you agree that some species of fish, during at least some part of their life cycle, are dependent upon macroinvertebrates for food.

Mr. COWX: Very much so. They are dependent on macroinvertebrates but also during the juvenile, very small life stages, they are dependent on what is called *zooplankton* and phyto-plankton, which are found in the water column and not the benthic macroinvertebrates which is what is being addressed here.

Mr. LOEWENSTEIN: Would you agree that sediment can alter the balance of fish species present in a given location?

Mr. COWX: Very rarely have I encountered that situation.

Mr. LOEWENSTEIN: Regardless of whether you have personally encountered that situation, would you agree that elevated levels of sediment can have an impact as Professor Thorne testified in his expert report?

Mr. COWX: Under extreme conditions, yes — and I am talking about extreme conditions of change in the environment, as opposed to small level changes.

Mr. LOEWENSTEIN: Would you agree that it is important to protect the balance of fish species present in Ramsar sites?

Mr. COWX: Very much. If the Ramsar site is set up for fish species which very, very rarely they are. They are usually set up for other types of organisms and *habitat types*.

Mr. LOEWENSTEIN: So you disagree with the statement that it is important to protect the balance of fish species in Ramsar sites, unless those conditions you mentioned are present?

Mr. COWX: Unless the Ramsar site is established for fish species, it is unlikely that any change in fish species will impact on the ecosystem as a whole.

Mr. LOEWENSTEIN: But as a general proposition, would you agree that it is important to protect the balance of fish species in Ramsar sites?

Mr. COWX: It is important to protect the balance of fish species in *any* site.

Mr. LOEWENSTEIN: OK. You stated in your summary report that, in total, 81 species have been described in the San Juan River basin, of which 54 are exclusively freshwater. Do you still agree with that statement?

Mr. COWX: That is based on the best available information, based on Bussing and other colleagues from Costa Rica.

Mr. LOEWENSTEIN: I see, so best available information. Does that give you some doubts as to the quality of the information?

Mr. COWX: Far from it, in fact I think it is excellent information, provided by the leading expert on Central American fish species — Dr. Bussing.

Mr. LOEWENSTEIN: You listed 11 species of fish found in the San Juan River as being vulnerable or threatened. Do you still agree with that?

Mr. COWX: Can I refer to the particular place, please?

Mr. LOEWENSTEIN: Yes, that was in table 2 of your full report.

Mr. COWX: These lists, I have no doubt, have not changed. Most of these species are estuarine species, certainly the top one, *Carcharhinus*, is a shark. So it is not particularly going to

be found in fresh waters, *Centropomus* is found in the estuarine areas, totally away from the area *associated by the row*.

Mr. LOEWENSTEIN: Professor Cowx, the question before you was whether you agree that there are 11 species of fish down in the San Juan that are either listed as vulnerable or threatened?

Mr. COWX: Well, according to the ICN List, which is the internationally-recognized list, there are only six and two of them are classed as “least concern”, which means that they are not considered vulnerable. One is considered vulnerable, the *VV*, which is the *Megalops*.

Mr. LOEWENSTEIN: Why did you list 11 species on your table?

Mr. COWX: These are provided by the environmental diagnostic *assessment* and I was just providing and updating, or providing that information for completeness.

Mr. LOEWENSTEIN: Whether the species of fish that are present in the San Juan River are vulnerable to one or more of the impacts that we discussed before, would need to be determined on a species by species basis, taking into account each species’ habitat and environmental tolerances. Do you agree with that?

Mr. COWX: That would be the classical way of doing it, yes.

Mr. LOEWENSTEIN: No studies have been done on any of the specific species of fish found in the San Juan to determine their sensitivity to sediment. That is correct, isn’t it?

Mr. COWX: To my knowledge that is correct.

Mr. LOEWENSTEIN: Now, Professor Cowx, if you don’t mind, I would like to ask you to turn to tab 26 of the judge’s folder which I believe you have been provided by the Court. This is an article entitled “The role of catchment scale environmental management in freshwater fish conservation” that you co-authored in the journal *Fisheries Management and Ecology*. I would be grateful if you could turn to page 309 of that article.

In the section entitled “Importance of freshwater fish conservation for the environment” you state in the highlighted part, in regard to fisheries protection measures:

“The main problems with existing measures are the lack of baseline information on which to manage the fishes, lack of public awareness and weak integration of conservation in water resource management planning.”

You then state in the next paragraph:

“Although a lack of baseline data is an issue, the urgency for direct management intervention is so great for many species that decisions should be based upon the best available science and existing experience to support management options. Where information on which to make a decision remains inadequate, the precautionary approach must be adopted. This is particularly important where development schemes are likely to impact on fish communities about which little is known.”

Do you still agree with this statement?

Mr. COWX: I do agree with the statement . . .

Mr. LOEWENSTEIN: Thank you very much.

Mr. COWX: It was written some time ago but it is still highly relevant.

Mr. LOEWENSTEIN: Thank you very much. Mr. President, I have no further questions for Professor Cowx. With your permission we can now proceed with the re-examination.

Le PRESIDENT : Merci. Je me tourne vers le conseil du Costa Rica, Madame Parlett qui va conduire, si elle le souhaite, l’interrogatoire complémentaire.

Ms PARLETT: Professor Cowx, Mr. Loewenstein asked you questions about the importance of protecting fish in Ramsar sites. In your expert opinion as an aquatic ecologist, do you have an opinion as to whether the fish in this particular Ramsar site are likely or not to suffer the kind of effects that Mr. Loewenstein put to you?

Mr. COWX: There are two issues here. The first is that we do not know the species in the Ramsar site as such, and the second is that we do not know the tolerances of the species that may be there, but it is highly likely that those species are tolerant to sediment anyway, because the San Juan River system is a naturally tropical river which has got high sediment loading, particularly

during the flooding period. And therefore, these species are adapted to those conditions in any case.

This is spelt out in fact in Bussing's review of the fishes of Costa Rica; he clearly states that the fishes of the San Juan are adapted to these high levels of sediment loading. That is quoted in my statement.

Ms PARLETT: You said, Professor Cowx, that the fish in this particular Ramsar site are highly likely to be tolerant to sediment, and you referred to the study of Dr. Bussing. In your expert opinion, is there any other relevant information, or not, as to what species there are in this part of the river, and whether they are likely to suffer the kind of impacts that Mr. Loewenstein put to you?

Mr. COWX: I am afraid the problem I have is that I am not fully familiar with the Ramsar site and its extent and all the other aspects of the Ramsar site, and how it floods, how the sediment loading is delivered to it; so therefore I cannot really respond to that question.

Ms PARLETT: I think I can probably put to you that the San Juan River is included in the Nicaraguan Ramsar site and I think that is uncontested.

Mr. COWX: Then it is highly unlikely that any species in the Ramsar site will be affected by the sediment loading because they are adapted to the natural sediment loading patterns that occur in the river.

Ms PARLETT: Mr. Lowenstein took to you Appendix 2 of your report, just in front of you. Could you explain to the Court how you produced this appendix?

Mr. COWX: The appendix is produced from the Environmental Diagnostic Assessment 2014, verbatim, and that is also based on information from Bussing, and so it just provides both the international conservation status and the national conservation status, which suggest that only a couple of species are really threatened—two, three species are “endangered”, as we call them in conservation level terms.

Ms PARLETT: And on the basis of the information that you have looked at that is *underlying* in this appendix, do you have an opinion as to whether or not fish in this Ramsar site — that is, in the San Juan River — are likely or not to suffer this kind of adverse impacts that Mr. Loewenstein put to you?

Mr. COWX: Unlikely. The threatened species that you have got here, the *Agonostomus*, basically lives in mountain streams, away from the main San Juan River. So it lives in the smallest tributaries and then will go down, right to the estuary, as part of its life cycle, life history. So, it is unlikely *that* will be affected. The other species, the *Rivulus* species, is a similarly migratory species but it will be found mostly in the estuarine conditions, so probably below the Ramsar site area.

Ms PARLETT: Mr. Loewenstein asked you whether or not in your view, fish in the San Juan River are likely to suffer impacts as a result of a degradation in macroinvertebrates in the river. Are you aware of any relevant information *before* the Court about the impact of any degradation in macroinvertebrates on fish?

Mr. COWX: The information that I have received, the various documents that I have read as a result of this case, clearly state that there is very, very little impact on macroinvertebrate fauna and food. The scale of the impact is so small in comparison to the size of the San Juan River, it is inconsequential.

Ms PARLETT: You mentioned that you've seen studies on this: could you direct the Court to them, to those studies?

Mr. COWX: In terms of?

Ms PARLETT: In terms of any impact on macroinvertebrates that you just mentioned.

Mr. COWX: There are some good studies in what is called the Ok Tedi mining system which is on the Sepik River in Papua New Guinea, where the sediment loading from the mining

activity is *so* huge that you could almost walk across the river, it is that thick with sediment. A completely different level of what is going on in this river.

Ms PARLETT: And have you seen any relevant studies relating to the impact on macroinvertebrates in this river? In the context of this case, or otherwise.

Mr. COWX: In the Ok Tedi? Yes, I have seen some studies done by a colleague of mine who worked for the company for a number of years, and he was saying that the impact is so huge that basically [they have] written off the river because the damage is so great — the economic importance to Papua New Guinea is so great that they are reconciled that they . . .

Ms PARLETT: And are you aware of any studies that show the impact in this particular river, whether or not in the context of this case? On macroinvertebrates.

Mr. COWX: In the Ok Tedi's . . .? Sorry?

Ms PARLETT: In the San Juan River.

Mr. COWX: No. There is nothing in the San Juan River to indicate that there is a *loss* of macroinvertebrate fauna to justify any impact on fisheries or the food web at all.

Ms PARLETT: Thank you very much. Costa Rica has no further questions on re-examination.

Le PRESIDENT : Merci, Madame Parlett. L'un des membres de la Cour souhaite poser une question à l'expert. Je vais donc maintenant lui donner la parole et je demande à l'expert de bien vouloir répondre à la question qui lui sera posée aussitôt après qu'elle aura été posée. Je donne la parole à M. le juge Bhandari.

Judge BHANDARI: Professor Ian Cowx, I have a question for you. It regards 14 and 23 of your written statement. You appear to suggest that increased sediment delivery in the San Juan River could in fact have positive rather than negative impacts on the fish species in that river. In support of this proposition, you cite a number of scientific publications. My question to you is,

could you briefly, and in plain terms, explain the scientific basis, for why increased sediment delivery into the San Juan River could actually improve living conditions for the fish in that river?

Mr. COWX: This is based on the fact that the sediment is just not material. It actually carries with it nitrates and phosphates which are nutrients that help develop, what we call “primary production” and then “secondary production”. So they build up the algae populations, and then the macroinvertebrate populations, which then become the food of the fish. And that is carried in sediment loading. Traditionally it would carry about 20 per cent of the nitrates for the river, and about 80 per cent of the phosphates. And the phosphates are the limiting factor, so it is very important. It is bringing more of those sorts of nutrients to improve production. Starvation — in rivers where you have had starvation of sediments — the fish production has gone down, almost proportionally to the reduction in the delivery of sediments, and therefore nutrients. I have just come back from Vietnam — as Kate has informed you — and that is one of the big issues we are looking at there.

Judge BHANDARI: Thank you, Professor.

Le PRESIDENT : Merci. S’il n’y a pas d’autres questions pour l’expert, je le remercie. Ainsi s’achève, Monsieur Cowx, votre déposition. Je vous remercie encore d’avoir bien voulu comparaître devant la Cour. Vous pouvez quitter la barre. Merci.

Mr. COWX: Thank you.

Le PRESIDENT : Le second expert cité par le Costa Rica et qui sera entendu par la Cour est le professeur Thorne. La Cour souhaite éviter autant que possible d’interrompre l’audition du professeur Thorne. C’est la raison pour laquelle elle va procéder à la pause-café habituelle à un moment inhabituellement précoce dans la matinée. Elle va donc se retirer maintenant pour 15 minutes et l’audience reprendra avec l’audition du professeur Thorne. L’audience est suspendue.

L’audience est suspendue de 10 h 25 à 10 h 40.

Le PRESIDENT : Veuillez-vous asseoir. La Cour va procéder maintenant à l'audition du professeur Thorne, second expert cité par le Costa Rica. Je l'invite à s'approcher de la barre.

Bonjour, Monsieur le professeur. Je vous invite maintenant à faire la déclaration solennelle prévue pour les experts dont l'énoncé figure à l'alinéa *b*) de l'article 64 du Règlement de la Cour. Nous vous écoutons.

Mr. THORNE: Good morning, Mr. President. Good morning, Judges.

“I solemnly declare upon my honour and conscience that I will speak the truth, the whole truth and nothing but the truth, and that my statement will be in accordance with my sincere belief.”

Le PRESIDENT : Merci, Monsieur Thorne. Je m'adresse à présent au conseil du Costa Rica, M. Wordsworth, qui va vous demander de confirmer l'exposé écrit qui se trouve devant vous. Monsieur Wordsworth.

Mr. WORDSWORTH: Thank you, Mr. President. Professor Thorne, in the folder before you, I think you have four reports: your written statement of March 2015, your report annexed to the Rejoinder of Costa Rica of February 2015, your report of November 2013, annexed to Costa Rica's Counter-Memorial, and a report prepared by you during proceedings on Nicaragua's Application for provisional measures in November 2013. Can I ask you to confirm that these reflect your honest expert views?

Mr. THORNE: Yes, they do.

Le PRESIDENT : Merci. Je donne maintenant la parole à M. Reichler pour le contre-interrogatoire. Monsieur Reichler.

Mr. REICHLER: Thank you, and good morning, Mr. President and Members of the Court, and good morning to you, Professor Thorne.

Mr. THORNE: Good morning.

Mr. REICHLER: We meet again. Since our last meeting, I hope you at least had an opportunity to go to the Keukenhof and see the tulips?

Mr. THORNE: Sadly, not yet!

Mr. REICHLER: Be sure to do that when you are done with the case. They are glorious.

Yesterday, we heard from Costa Rica's counsel about Costa Rica's mitigation efforts in regard to various sites along the road. I intend to ask you questions about three distinct subjects this morning and I would like to begin by asking you some questions about the subject of Costa Rica's remediation.

Costa Rica's counsel did not address this chart yesterday. This chart is from your February 2015 report that accompanied Costa Rica's Rejoinder. Is that correct?

Mr. THORNE: That's correct.

Mr. REICHLER: Please tell me if I am reading it correctly. There are a total of 127 sites where the road crosses watercourses?

Mr. THORNE: It might be 128. I think Dr. Weaver found one that Dr. Mende missed.

Mr. REICHLER: Of these, there were 24 where it was determined that no mitigation was necessary, is that correct?

Mr. THORNE: That's correct.

Mr. REICHLER: And there were 28 sites where mitigation has been reported as having been completed at the time of your report. Is that correct?

Mr. THORNE: That's correct. The inspection wouldn't have been undertaken at the time the report was written. It would have been taken some time before and so the statistics wouldn't be fully up to date at the time that the report was issued because it is based on information gathered in some preceding months. But with that, yes.

Mr. REICHLER: I appreciate that clarification.

Mr. THORNE: Well, because the mitigation is an ongoing process and of course we can't be absolutely up to date.

Mr. REICHLER: Are you able — and I understand if you cannot, but since you raised the subject — are you able to update this as you stand here? In other words, do you have a number in mind of additional sites that have been completely mitigated since this report was prepared?

Mr. THORNE: I don't have such a number in mind at this moment, no.

Mr. REICHLER: And, as of the time of this report and according to it, again if I am correct, there were 23 water crossings where mitigation was in progress but was not completed. Is that correct?

Mr. THORNE: That's correct.

Mr. REICHLER: And there were another 31 watercourse crossing sites where mitigation was required but, as described in the chart, it had been scheduled but not yet undertaken, is that correct?

Mr. THORNE: That's correct. That's based on my conversations with the person at CONAVI. CONAVI are the Government organization doing the works. Based on what she told me, they had 31 that they were scheduled to work on as soon as they could mobilize the people and provided the weather permitted.

Mr. REICHLER: And in the case of those 31 sites, do you know when that mitigation is scheduled to be performed?

Mr. THORNE: Only in general terms. She assured me it would be performed as soon as possible. But given the weather and given the circumstances, she was not able to give me a precise date, no.

Mr. REICHLER: So if my arithmetic is correct, according to this chart, out of a total of 127 water crossings — and for the moment we will leave out the extra one that you acknowledged that Dr. Weaver found — out of a total of 127 water crossings, there were 54 where mitigation was either required but not completed, including 31 where it had not yet been commenced, but were scheduled to begin at some — at least for you — uncertain time?

Mr. THORNE: That's correct, yes.

Mr. REICHLER: You mentioned Dr. Mende earlier in your answers to my questions. Would it be correct to say that you personally did not visit all 127 of these water crossings and decided in each case whether it was completely mitigated, mitigation in progress, mitigation was scheduled or no mitigation was necessary, or it belonged in any of these categories?

Mr. THORNE: I did not visit them physically. I visited quite a few of them physically, not all. What I did do with Dr. Mende was took a virtual tour in the Mende report, the inventory of water crossings; those pictures and maps of all of them, I went through those with Dr. Mende. And, in that regard, I visited them, but not physically on the ground, that was not possible.

Mr. REICHLER: Would it be fair to say that, in addition to your actual personal involvement as you have just described it, that you relied on Dr. Mende's work in this regard?

Mr. THORNE: I relied on it once I had discussed in depth the status and conditions as he observed it. I did not accept his initial classification of water crossing sites. I suppose the best way to describe it would be that it was negotiated, because I wanted to be sure that the tables in his records, they wouldn't be the same if I had done it myself but they would be as close as possible, and in that regard I am content to rely upon them.

Mr. REICHLER: Can we look at the other chart that comes from your February 2015 report that accompanied the Rejoinder? This has to do with the mitigation status of slopes rather than watercourses. Is that correct?

Mr. THORNE: That is correct. These are cut slopes and fill slopes, not differentiated.

Mr. REICHLER: And I am asking this, it is a slightly compound question in order to save time, but if you feel uncomfortable answering it just tell me and I will break it up into several questions. Is that fair enough?

Mr. THORNE: OK.

Mr. REICHLER: Would the same be true for this chart on slopes as was true on your chart for watercourses in the sense that the work of observing and classifying the different sites was performed by Dr. Mende, you relied on his work but you also engaged in some personal observation and some, I think you called it, virtual observation, to assure yourself that the numbers in this chart were reliable. Is that correct?

Mr. THORNE: That is correct.

Mr. REICHLER: And again, just to be sure I am reading this chart correctly, in the same way that you do, it was determined by Dr. Mende and yourself that there were 201 locations where there were cut slopes or fill slopes, is that correct?

Mr. THORNE: Correct.

Mr. REICHLER: And of those 201 slopes — may I just call them “slopes” to make it easier?

Mr. THORNE: Yes.

Mr. REICHLER: OK. Of those 201 slopes, mitigation was not required at 11?

Mr. THORNE: Correct.

Mr. REICHLER: So, at 190 of the 201 locations where there were cut slopes or fill slopes, mitigation was required?

Mr. THORNE: Correct, the slopes are the heart of the matter. They are the source of, by Dr. Kondolf’s survey, 75 per cent of the sediment. It is quite correct to focus on the slopes primarily.

Mr. REICHLER: And of these 190 locations where mitigation was required, according to this report and at the time the information was gathered, only 25 were considered as completely mitigated?

Mr. THORNE: At the time we compiled the data, that is correct. We were quite assiduous in making sure that if we put it as done, then it was done. There is a very large body of work in progress and I am sure that those numbers have changed now, but I cannot tell you exactly how much. I am sure that the 107 has come down and the 25 has come up, but I do not know how much.

Mr. REICHLER: Are you aware that, according to Dr. Mende's report — 2014, Annex 3 to the Rejoinder, Appendix B — that, of the 25 sites that he classified as completely mitigated, the only mitigation that he reported at 13 of those 25 sites was the natural regrowth of some vegetation and there was no physical activity performed by Costa Rica by way of mitigation at these 13 sites. Is that correct?

Mr. THORNE: I believe so. The story that this tells us is that nature is quite resilient and that sometimes it moves faster than the Costa Rican Government.

Mr. REICHLER: Well, I already talked about your credibility and I certainly am aware that governments sometimes move slowly and I am sure Costa Rica is no exception in that regard. And they have my utmost respect.

Mr. THORNE: Well, indeed, and I find that as frustrating as I am sure everybody else does.

Mr. REICHLER: Still referring to this chart — thank you — mitigation was regarded as still in progress and not yet completed at 107 slopes, as of the time of this report, correct?

Mr. THORNE: Yes, there was a huge effort being made in the latter third of 2014, continuing into early 2015.

Mr. REICHLER: And do you know when the mitigation that is in progress at these 107 slopes requiring mitigation, do you know when that mitigation will be completed? Can you give me a date?

Mr. THORNE: I cannot. I probed CONAVI quite hard about this and quite honestly, it does depend on the weather, it does depend on the funding being continuous. There are factors that are beyond their control. I am reassured they are doing it as fast as they can.

Mr. REICHLER: And there are, according to the chart, if I am reading it correctly, there are 58 slopes that require mitigation, where mitigation has been scheduled but, as of the time of this chart, the mitigation had not yet commenced. Is that correct?

Mr. THORNE: That is correct. CONAVI are rushing, I am not sure that is entirely a good thing, their agenda is being driven by the need to complete this work very quickly. When I visited some sites, the last time I visited some of the active sites was in November, and they were working very hard and under the kind of health and safety regulations that I am used to in the United Kingdom and the United States, the work would not be allowed. They are taking chances to get the work done at a time when I would have suspended the work because of the wet season weather. Haste may not be absolutely the best thing here. Sorry, that is a long answer.

Mr. REICHLER: At these 58 sites, these particular 58 sites that require mitigation, and where it says that mitigation has been scheduled, do you know when mitigation at these 58 sites is scheduled to commence?

Mr. THORNE: I do not.

Mr. REICHLER: And, would it also be correct that you do not know when that mitigation will be completed?

Mr. THORNE: I do not know that either.

Mr. REICHLER: You mentioned budget or financing a moment ago, I would just like to ask you a question about that. Do you know what budget has been established by Costa Rica to complete the mitigation in progress at these water crossings and slopes, and to carry out mitigation at the sites where it is scheduled, do you know what budget has been established to do all that work?

Mr. THORNE: I do not know the sum in colones or dollars. I could quote one or two figures for individual sites where I have discussed them with the individual engineers when I have been on site, as you do. What I do know about the budget is that it is continually having to be increased because this work is expensive. It was underestimated; the budget is being increased and each time it is increased there is a slight delay whilst the paperwork is done. I find that just as frustrating, I am sure, as the people who want to do the work on the ground.

Mr. REICHLER: Thank you. I would like to recall for you a statement that you made in your December 2013 report that accompanied Costa Rica's Counter-Memorial, and since you are opening it let me give you the site, it is at paragraph 11.19.

Mr. THORNE: Sorry, could you say that again?

Mr. REICHLER: It is paragraph 11.19 of that document. I will give you a moment to find it.

Mr. THORNE: 11.19?

Mr. REICHLER: That is correct.

Mr. THORNE: Yes, got it.

Mr. REICHLER: Right. I am not going to read the whole paragraph, but if you need to do so for context — I do not want to read the whole thing because it would take too long — you are allowed to refer to anything in any of your reports if it would assist you, and I do not mean to stop you from doing that.

Mr. THORNE: I understand.

Mr. REICHLER: The words that I am particularly going to ask you about are these: "these are temporary works that mitigate but do not permanently solve erosion problems, and a permanent solution will not be achieved until design, planning and construction of the Road are completed". Do you still agree with that statement?

Mr. THORNE: Absolutely.

Mr. REICHLER: How do you, as an expert, distinguish between mitigation works that are temporary, on the one hand, and mitigation works that are permanent, on the other?

Mr. THORNE: There is a huge difference: in terms of the mitigating works CONAVI are using standard designs; so they have a design for a road-crossing culvert; they have a design for these gutters that they put at the base of slopes; they have designs that they use for stabilizing the slopes themselves, in the way that Dr. Del Mar showed you yesterday.

Mr. REICHLER: My question, Professor Thorne, is simply: can you give us examples of what are temporary mitigation works, what are they, and what are permanent works? Just to recall, you have just told me that you agree with your statement in your December 2013 report referring to Costa Rica's mitigation works: "these are temporary works that mitigate but do not permanently solve erosion problems and a permanent solution would not be achieved until design planning and construction of the road are completed". So, I wanted you to tell the Court some examples of the kinds of mitigation works that you consider temporary and contrast those with the kinds of mitigation works that you would consider permanent.

Mr. THORNE: I understand. Those standard designs are just taken out of a manual and used because there isn't time to do the hydrological analysis for a micro basin, so each micro basin may be 1 km sq and a culvert has been put there to replace a log bridge or a fill segment, and that culvert will work for a couple of years — but it's a standard sized culvert; it's whatever they've got on the van, basically, that they are using.

The permanent solution will be to use a hydrological analysis to calculate the design flood for a culvert; perhaps it's the 100-year event — Dr. Weaver knows a lot more about this than I do — but you would then have a different sized culvert at each road crossing that is correctly designed to handle the run-off at that road crossing. That's part of detailed design; that's part of the permanent solution, which is proceeding but, again, slower than we would all like. But they have to get it absolutely right, you will appreciate.

Mr. REICHLER: Thank you, Professor Thorne. Can you also give us — again you can refer to what Costa Rica is doing or you can answer the question generally, I will leave it up to you. But, you very helpfully explained for the Court the difference between temporary remediation works, as Costa Rica is doing, and permanent remediation works as Costa Rica hopes to do in regard to mitigation of the watercourse crossings. I wonder if you could help us in regard to slopes, cut slopes and fill slopes, mitigation again the question, just to be clear; I am not trying to limit you, but I just want to make sure that you answer the question properly — I know you are trying to give responsive answers; I have no problem with anything you were saying; I just want to make sure that my question is clear to you on the record and so that it will be clear to the judges, if they decide to consult the transcript.

Mr. THORNE: I understand exactly.

Mr. REICHLER: So, the question is: can you give us some examples of the differences between what you consider temporary mitigation works and permanent mitigation works in regard to the mitigation at the slopes and cut slopes?

Mr. THORNE: So, if we took an example of the fill slopes, where material has been side-cast off the side of the road and it is not compacted, a temporary solution may be to cover that with coconut matting and protect it from raindrop impact and run-off. The permanent solution may be to take it away because it hasn't been properly compacted, it hasn't been vibro-compacted and built up in layers in the proper fashion, and the only thing you can do with that fill slope is take it away and start again. So, that is the difference for a fill slope between protecting it for a year or two and mitigating and then actually the cure for that site; it may not be possible to stabilize that fill slope in that location. *In extremis*, the permanent solution may be to re-route the road and, again, Dr. Weaver — I wouldn't argue with a lot of his recommendations; he knows what he is talking about.

Mr. REICHLER: I believe you have already said this but, just to be sure, in your December 2013 report you said: "In my opinion, the necessary work should proceed as soon as possible, with the work expedited to the greatest degree . . ." That remains your opinion?

Mr. THORNE: That remains my opinion; it was stated at that time in the context of the position of Nicaragua which was that all work should cease and I was keen to make it clear that all work shouldn't cease; the remediation should continue and, in my opinion, the completion of the road, the permanent solution, should proceed as soon as possible.

Mr. REICHLER: In regard to the type of mitigation that you regarded as sufficient to achieve a permanent solution to the problem?

Mr. THORNE: Well, the permanent solution wouldn't mitigate it, it would permanently solve the problem of instability on the road.

Mr. REICHLER: You are absolutely right, and I am sorry that I misspoke. What you are recommending that Costa Rica do is not just mitigate, but perform the works necessary to permanently resolve the problems at these sites.

Mr. THORNE: Yes, Route 1856 should be brought to the same standard as all other comparable roadways in Costa Rica, many of which are built to an extremely high standard and this one should be too, but *it's* not *been* built that way.

Mr. REICHLER: Yesterday, before we leave this subject and move on to my second subject, counsel for Costa Rica, Ms Del Mar, said — I must quote from the uncorrected version of the transcript, so bear that in mind — “the original dates . . . estimated for the conclusion of the final designs . . . have been delayed”. And that CONAVI, the agency in charge, has still not even received any designs for these works. Is that your understanding as well?

Mr. THORNE: Yes, in broad terms, yes.

Mr. REICHLER: Thank you, Professor Thorne. With your kind indulgence, I would like to move on to the second topic of the three that I wish to ask you about today.

This topic I will call “suspended sediment concentrations, or suspended sediment levels”. Do you still agree with the statement that you made in your December 2013 report, which accompanies Costa Rica's Counter-Memorial, that “extreme natural variability in sediment

concentrations, and associated levels of turbidity are characteristic of rivers in the Río San Juan-Colorado system”? That is correct, isn’t it?

Mr. THORNE: Can we go to it, to just see the context.

Mr. REICHLER: Oh, of course, any time . . . I am referring to your December 2013 report and particularly to paragraph 6.31.

Mr. THORNE: Yes it is, and it is illustrated graphically in the *scatter graph* that Dr. Kondolf referred to, figure 18, which shows that suspended sediment concentrations in parts per million measured over a long period: 2,409 individual measurements range from less than ten to more than 10,000.

Mr. REICHLER: And that is what you referred to as “extreme natural variability in sediment concentrations”.

Mr. THORNE: Yes, it is not the most extreme that occurs — these are just the measured ones. A paper by my good friend Ian Douglas, from Manchester University, in 1996 reports concentrations in excess of 100,000 parts per million in volcanic basins around the Pacific Rim, just like Costa Rica, but not actually in Costa Rica.

Mr. REICHLER: And the data that has been at your disposal reveal that measurement uncertainty, together with natural fluctuations in rainfall, discharges, catchment sediment yields and suspended sediment concentrations (SSCs) mean that suspended sediment levels (SSLs) are likely to vary inter-annually by 5 and 10.5 million tons. That is correct?

Mr. THORNE: Yes, the sediment load and the sediment concentration are conditioned by the water flow and the availability of sediment. They vary due to the weather, they vary due to seismicity, volcanoes; high variabilities are characteristic of this river. The problem is compounded because we do not have very much data and it is also compounded because the data we do have comes from the Río Colorado and then there is, what I think you referred to as a “witches’ brew” of statistics to try and work out from the data that we have got on the Colorado,

what the data for the Río San Juan would look like. I think a “witches’ brew” is a bit harsh, but there are perhaps some analytical gymnastics that go on and that means the uncertainty . . .

Mr. REICHLER: I will accept your description and withdraw “witches’ brew” in deference to you, Sir.

Mr. THORNE: Thank you.

Mr. REICHLER: When there is lower rainfall, that produces less catchment run-off and generates less erosion and therefore a smaller suspended sediment load, that is correct?

Mr. THORNE: A smaller suspended sediment *load*, yes. Even in a light year, there will still be very heavy downpours. We are in the tropics. There will be some high SSCs, sediment concentrations, but the annual load will be much lower as Dr. Andrews indicated for the Jabillos Station in his very exhaustive mental and analytical gymnastics.

Mr. REICHLER: And because the post-road period — that is, since the road construction began — has been drier than usual, meaning there has been lower rainfall than usual during this 3- or 4-year period, that would have the effect of reducing the annual sediment load?

Mr. THORNE: It has had that effect. The loads in 2012, 2013, 2014 are 8 million, 8.5 million, 6 and a bit. That is quite a big variability. It is nothing compared to the variability you would find if we had 30 years of record.

Mr. REICHLER: Based on the natural variability in sediment loads and the other factors that you have mentioned, you have concluded that “no possibility exists for using measured loads to estimate how much sediment derived from erosion of the road has been added to the Río San Juan due to the very high natural variability in those loads”. This is the same report, your December 2013 report, paragraph 8.17.

Mr. THORNE: Yes, I thought it was a ways away. Yes, that is right but I think you have to read 8.17 in conjunction with 8.12, where I was referring to measurements made prior to the road in a joint programme between 1974 and 1976 and then measurements made by ICE in 2010 to

2013. I agree with Dr. Andrews, and he was fairly hard on me in saying two years of records are too short to draw big conclusions, and he is right and I agree with him and I stopped doing it after this. But, no, you cannot do it on the basis of such short records, especially not when you are making these leaps of faith of taking Colorado data and trying to use it for the Río San Juan. If we had really good data on the Río San Juan you could do it but that is not possible for Costa Rica.

Mr. REICHLER: And do you agree with Dr. Andrews that having really good data on the Río San Juan would mean data collected over some years prior to the construction of the road, let us say numerous samples over a period of several years, say up to 2010, before the construction of the road began, to use as a baseline and if you had those data, you might be able to draw some conclusions from measurements of sediment loads after construction of the road, is that correct?

Mr. THORNE: No! Would you like me to tell you why?

Mr. REICHLER: Go ahead, I have no alternative, do I?

Mr. THORNE: Okay, so doing it that way would be great if we had a time machine and we could go back and start data, but we do not. What we can do though is we can set up a measuring station upstream of the road, which is completely unaffected by the road and we can collect data there and we can take data downstream, in fact Nicaragua has done this at least on three occasions when it has made measurements at El Castillo and upstream of Boca San Carlos, and Mr. Wordsworth discussed that with Dr. Kondolf. That is still going to be tough. If I were doing this and I had a free hand, the first thing I would do is set up stations just upstream and just downstream of the 17 severely eroding sites identified by Dr. Kondolf and I would expect to be able to see a signal from that sediment that comes in between two stations, if there was indeed any sediment coming in.

Mr. REICHLER: Fair enough. But you have concluded — and I am not going to go into your conclusions or your calculations, I am certainly no match for you there — but you have drawn conclusions that sediment is going into the river from the road and as a result of the construction of

the road, just you and Dr. Kondolf have come to very different conclusions as to the amount, is that correct?

Mr. THORNE: That is correct. We cannot both be right.

Mr. REICHLER: I am not going to ask you as to who is right or why, or how you got there, my only question is that you have made your own determination that sediment, in whatever amount, is coming into the river from the road.

Mr. THORNE: I think there is some *actual* sediment, yes.

Mr. REICHLER: That is all I am asking, thank you. Well Professor Thorne, I have saved my third and most exciting topic for last: channel morphology. I am sure just the mention of those two words will make hearts in this room beat faster.

Mr. THORNE: It is really important.

Mr. REICHLER: Well, I agree and I know that you are *a fluvial* geomorphologist, so this is your stuff and my heart is beating faster too, I have become so interested in it. For purposes of these questions, may we assume, as you have in some of your reports that, at the delta, 90 per cent of the San Juan River's waters flow into the Colorado River and 10 per cent of those waters flow into the Lower San Juan? For the purpose of these questions, can we start there?

Mr. THORNE: No!

Mr. REICHLER: That is a pity. Let me refer you to your February 2015 report that accompanied the Rejoinder and this is across several paragraphs. Let us start at paragraph 4.74. Please let me know when you have found it.

Mr. THORNE: Yes.

Mr. REICHLER: In the fifth line down, there is a sentence that begins with these words and, again, please feel free to look at the context. And it says "it is believed that about 90 per cent of the discharge of the Rio San Juan passes to the Rio Colorado". It is believed by you? Or by others?

Mr. THORNE: Well, it definitely is not believed by Dr. Andrews because, again, he took me to task after the 2013 report, and pointed out that the way that I had come to that conclusion by comparing measurements from 1974 to 1976, to 2010 to 2013, was unfounded because they are different periods, it is a different . . . — Confucius said you cannot cross the same river twice, it is a different river today to what it was then — and he was right to do so, and I accept it. So, what we did, and if you just turn the page, we did it for 95, 90 and 85, to reflect the fact that we do not know. Ninety is a common wide-held belief, it is probably not bad, but it certainly is not 90, it varies.

Mr. REICHLER: I appreciate that explanation. Since 90 per cent is not bad, let us use it for the next few questions. And if you find that it is unfair to you, to continue using it for the purpose of the next questions, just tell me and we will move on. But I think you will find that even your characterization of 90 per cent is not bad, will be sufficient to make progress here.

Mr. THORNE: I agree. Absolutely.

Mr. REICHLER: Now, under that assumption, would it be the case that approximately 80 per cent — approximately — of the sediment that is carried by the San Juan River upstream of the delta — did I say 80 per cent?

Mr. THORNE: You said 80 per cent.

Mr. REICHLER: I am sorry, my eyes started playing tricks on me, and I apologize for that. Let me start the question again, with your indulgence. So, under the assumption of the 90/10 split in the flow between the Colorado and the Lower San Juan, would it be the case that approximately 80 per cent of the sediment carried by the San Juan River, which includes both coarse and fine sediment of course, would flow into the Colorado River, and approximately 20 per cent of the sediment would flow into the Lower San Juan? Approximately.

Mr. THORNE: Well, based on diagram 4.14 and 4.15.

Mr. REICHLER: Now, you will have to give me a second to catch up with you, if you do not mind. I think that is called “equality of arms”, you get to look at your report, I get to look at it also. Which figures are you talking about?

Mr. THORNE: On page 198, and you took me to page 196. So it is just very, very close, and it is relevant to the text.

Mr. REICHLER: So, which paragraphs again?

Mr. THORNE: It is figures 4.14 and 4.15.

Mr. REICHLER: Oh, yes. OK, I am with you.

Mr. THORNE: There is a pie chart showing that the split of the water . . .

Mr. REICHLER: Pardon me, can I just, for the convenience of the Court, this figure 4.14 is at paragraph 4.78, of your report of December 2013. And figure 4.15 is also in that paragraph, just at the next page.

Mr. THORNE: Yes. And this is where we unpack the fact that we do not actually know how much water goes down each branch, and therefore we certainly do not know how much sediment goes down each branch. But, we can model it, and that is what we have done.

Mr. REICHLER: Correct. And, in figure 4.14 — which is at the bottom of the page, I think this page is 198 of the Counter-Memorial, page 54 of your report — and it has three models, (a), (b) and (c), correct?

Mr. THORNE: Yes.

Mr. REICHLER: And under the model (b), which corresponds to a 90 per cent/10 per cent distribution of the flow: this model shows that 84 per cent of the fine sediment goes to the Colorado and 16 per cent of the fine sediment goes to the Lower San Juan.

Mr. THORNE: That is what the model shows.

Mr. REICHLER: That is all I am asking.

Mr. THORNE: OK.

Mr. REICHLER: And then figure 4.15, again, figure (b) or item (b), shows how the coarse sediment would be distributed between the Rio Colorado and the Lower San Juan. And, if I am reading this figure in your report correctly, with a 90 per cent split — that is, 90 per cent of the water goes to the Colorado, 10 per cent to the San Juan — then, 80 per cent of the coarse sediment goes to the Colorado and 20 per cent of the coarse sediment goes to the Lower San Juan, according to this model. Is that correct?

Mr. THORNE: According to the sediment transport model, that is correct.

Mr. REICHLER: So, somewhere, then, between 16 per cent — which is the fine sediment figure — and 20 per cent — which is the coarse sediment figure — would go to the Lower San Juan River under the model we are talking about, where 90 per cent of the river's flow goes to the Colorado and 10 per cent of the river's flow goes to the Lower San Juan. Correct?

Mr. THORNE: According to the uncalibrated model, although Nicaragua's measurements indicate otherwise.

Mr. REICHLER: But this model has been developed by ICE of Costa Rica? Is that correct?

Mr. THORNE: Correct. By Costa Rica based on the available Costa Rican data for the Colorado.

Mr. REICHLER: And you thought it was good enough to put in your report of December 2013. I assume if you thought it was worthless, you would not have included it in your report.

Mr. THORNE: I thought it was the best we had — at that time.

Mr. REICHLER: Now, if 84 per cent of the fine sediment flows into the Colorado River, and 16 per cent of the fine sediment flows into the Lower San Juan, and 20 per cent of the coarse

sediment flows into the San Juan and 80 per cent of the coarse sediment flows into the Colorado, would it be correct to say that according to these models — produced by Costa Rica's ICE, and reproduced in your report — that roughly four times as much sediment flows into the Colorado River as flows into the Lower San Juan?

Mr. THORNE: At least four times, yes.

Mr. REICHLER: So, the magnitude of the sediment flowing into the Colorado River is at least four times the magnitude of the sediment flowing into the Lower San Juan? Correct?

Mr. THORNE: According to the model, yes.

Mr. REICHLER: Now, would you agree that, despite the fact that it receives at least four times as much sediment as the Lower San Juan, the Colorado River is not plagued by the accumulation of sediment to such a degree, that navigation between the delta and the mouth of the river is seriously obstructed? You would agree with that, wouldn't you?

Mr. THORNE: Yes, I would. The Colorado is a much bigger river.

Mr. REICHLER: Now, by contrast, in the San Juan, although it receives less sediment than the Rio Colorado does — you said by less than one fourth of the sediment, according to the models, than the Colorado does — the San Juan by contrast with the Colorado — we are talking about the Lower San Juan — is unable even to accommodate this load of sediment. That is correct, isn't it?

Mr. THORNE: Can we go to that?

Mr. REICHLER: We can. Can you — and I can take you right there — but is it possible for you to give me an answer to the question and then we go to it, or would you rather go to it?

Mr. THORNE: Now, you see, I was not listening properly because I was thinking about where was . . .

Mr. REICHLER: Did your counsel not tell you to always listen to the question? You have to listen carefully to the question, that is the first rule for every witness.

Mr. THORNE: I apologize.

Mr. REICHLER: Well, let us then go to the data and I can ask the question again.

Mr. THORNE: Context is everything.

Mr. REICHLER: Context is everything, I agree with that. We go to... here... It is actually your 2011 report that was submitted with Costa Rica's Memorial in the *Certain Activities* case, and this is II-27, the page is numbered II-27. Is there a reason you are looking over there? You need the report? I am sorry, I would be happy to furnish you with...

Mr. THORNE: I would like to read the paragraph that...

Mr. REICHLER: I am happy to provide it for you. Thank you, Costa Rican counsel for facilitating this.

Mr. THORNE: And it is II, which page?

Mr. REICHLER: I think II-27.

Mr. THORNE: Got it.

Mr. REICHLER: OK? I refer you in particular to the next to last paragraph on that page and, again feel free to explore the context, but the words that I am looking at are these:

“The situation in the Río San Juan branch of the deltaic is quite different [compared to the Colorado which is discussed in the previous paragraph]. Although this river receives less of the sediment delivered to the Delta than the Río Colorado does, it is unable to accommodate even this load.”

True?

Mr. THORNE: In the context of the comparison between the Colorado and the Lower Río San Juan, that is correct. And in the context of accommodating sediment, yes.

Mr. REICHLER: You have described the Lower San Juan River as a “response reach”. Is that correct?

Mr. THORNE: Correct.

Mr. REICHLER: I am going to be asking you two or three questions, maybe two, about your discussion of response reaches in your December 2013 report that was submitted with the Counter-Memorial, in case you want to consult it. I am navigating between paragraphs 6.12 and 6.15, in that general area. I will give you a moment. Mr. President, while the witness is looking for the reference, is it possible for the Court to advise me of how much time I have left or how much time I have used?

Le PRESIDENT : Vous disposez encore d'une demi-heure.

Mr. REICHLER: Thank you, Sir. I will finish well before that.

Mr. THORNE: 6.12?

Mr. REICHLER: Yes, it is — again feel free . . .

Mr. THORNE: It begins with Professor Cowx?

Mr. REICHLER: Let me look at it, I have it here but let me just consult the actual page. OK. I am looking in paragraphs . . .

Mr. THORNE: This is the 2013 report?

Mr. REICHLER: Yes, this is December 2013. And actually, you first discuss response reaches between paragraph 6.12 and 6.14 and then you say, in paragraph 6.15, that you consider the Lower San Juan River to be a response reach, is that correct?

Mr. THORNE: Yes, I do.

Mr. REICHLER: So now, we will let everybody in on the secret as to what a response reach is. I believe you have defined a response reach as — and you will find this at paragraph 6.12 — a “morphologically sensitive channel[where] the actual rate of sediment transport is limited by the

capacity to transport sediment rather than the supply from upstream and local sources”. That is your view?

Mr. THORNE: That is my opinion, yes.

Mr. REICHLER: And, continuing in that paragraph, these “transport-limited conditions mean that the river has no unfilled capacity to transport additional sediment and morphologic adjustments are likely to occur in response to changes in sediment supply”. Do you see where you wrote that?

Mr. THORNE: Yes.

Mr. REICHLER: And that is true?

Mr. THORNE: It is true of all response reaches of which there are three downstream of the road, so *two* in the Río San Juan and one in the Lower Río San Juan.

Mr. REICHLER: Morphologically speaking, the bed of the Lower San Juan River is not flat and smooth like a bowling alley, is it?

Mr. THORNE: No, it is not.

Mr. REICHLER: In fact, there are what you described as “continuous bed level changes associated with the migration of ripples, dunes with amplitudes of up to half a metre, and bars with amplitudes greater than one or even two metres”. Correct?

Mr. THORNE: Correct, and obviously we would now add to that, a 2-metre-deep, 30-metre-wide trapezoidal trench.

Mr. REICHLER: That is what Nicaragua has dredged?

Mr. THORNE: Has dredged.

Mr. REICHLER: So, it would be correct to say that when sediment accumulates in the Lower San Juan River, it does not spread out evenly across the entire bed of the river, does it?

Mr. THORNE: No, it does not. It mostly settles out in the two-metre-deep, 20-, 30-metre-wide trench.

Mr. REICHLER: But I believe you said that much of the sediment that flows into the Lower San Juan is “deposited in and along a mainly meandering channel in the form of shoals, islands, point bars and natural levees”, is that correct?

Mr. THORNE: That is correct, as long as everybody knows what a shoal, a levee, an island and the other thing . . . a point bar, everybody knows what a point bar is.

Mr. REICHLER: Maybe we can discuss this outside, I think we may be pressing the limits of everyone’s patience in terms of fluvial geomorphology. Let me move on to the next question if I may.

Mr. THORNE: Yes, and if . . .

Mr. REICHLER: If you would like to, again I am sorry if I . . .

Mr. THORNE: Just to clarify . . .

Mr. REICHLER: If you would like to say what a shoal is, what a sandbar is, what a . . .

Le PRESIDENT : Monsieur le professeur. Pardon. Monsieur le professeur, je m’adresse également à vous. Si vos échanges sont trop rapides, si les questions et les réponses s’enchaînent trop vite, les interprètes ont un peu de mal à suivre. Je ne voudrais pas enlever à ces échanges le caractère vivant qui permet de soutenir l’attention de la Cour, mais il faut penser aussi un peu aux interprètes. Donc, faites-en sorte qu’entre une réponse et la question qui suit, il y ait une toute petite pause pour que les interprètes puissent suivre, sans ralentir à l’excès naturellement. Merci.

Mr. REICHLER: Thank you very much, Mr. President. My time is running out, Professor Thorne, however, in the interest of fairness to you, if you would care to give a— hopefully brief— description . . .

Mr. THORNE: Very brief.

Mr. REICHLER: . . . description of a shoal, what is a shoal, what is a sandbar, what is a point bar, what is a natural levee, if that is what you wish to do, I am happy to allow you to do it.

Mr. THORNE: Well, I would just like to focus a bit more because natural levees are not in the channel, they are above the channel so they do not affect navigation. Islands are above the water level, unless you are flying a flying boat they do not affect navigation. The shoals are the problem. The point bars, as every geographer knows, are on the inside of the meanders; the navigation channel is on the outside of the meanders. But the shoals are the problem.

Mr. REICHLER: As well as sandbars would you say?

Mr. THORNE: Well sandbars are mobile bed features. We call them sandbars or megadunes, so ripples and dunes and sandbars form spontaneously in a mobile sand-bed, they indicate that the bed is sand and they indicate that it is mobile. A shoal is the static feature that gives you the problems.

Mr. REICHLER: And sometimes they merge, the dunes and the sandbars?

Mr. THORNE: Yes, they are wave forms and wave forms can interact and reinforce each other or cancel each other out.

Mr. REICHLER: Thank you. Actually, that turned out to be quite painless and I appreciate your brevity as well as your clarity in describing them. You have referred to Dr. Andrews several times. I would like to ask you if you would agree or disagree with this statement of his? "Sediment will be not be distributed evenly along and across the delta channels. It will instead tend to form bars, creating reach-wise instabilities and obstructions to navigation that will need to be removed through dredging." Do you agree with Dr. Andrews's statement.

Mr. THORNE: No!

Mr. REICHLER: Why do you consider him wrong?

Mr. THORNE: The evidence from field studies, some at Redwood Creek by learned colleagues Mr. *Hagans* and Dr. Weaver, show that when there is an excess sediment load due to say, large-scale deforestation, in Redwood Creek the first thing you do is you fill in the pools, which is really, really bad for habitat. The bars do not grow in amplitude or *riffles*, as they are in the Redwood Creek, the first thing you do is you fill in the pools. And, in the case of the sandbars, when the flow goes over a sandbar, the depth reduces and the velocity increases and the top of the sandbar, the elevation of the sandbar becomes self-limiting. It cannot grow out through the water surface. The reason navigation is so difficult in the dry season is because it is the dry season, the water depth reduces massively.

Mr. REICHLER: I think you also said the shoals are a problem for navigation?

Mr. THORNE: Now shoals are depositional centres and they do accumulate sediment. They are preferential sites and may be what Dr. Andrews was referring to was shoals, more than bars *but* this is ~~is~~ nomenclature.

Mr. REICHLER: May I ask you, if we substituted the word “shoals” for “bars” in Dr. Andrews’s statement, you would agree with that?

Mr. THORNE: I would agree entirely: in the three response reaches between the severely eroding sites and the Lower Río San Juan. There are two other response reaches. In the last few days I have looked: there are six major shoals, each of which will trap 60/70 per cent of the bed load before you get to the delta, so, yes, shoals collect sediment. It is not a problem for navigation because the Río San Juan is a much bigger river.

Mr. REICHLER: In the *Río* San Juan but not in the Lower.

Mr. THORNE: The Lower Río San Juan is a problem, I agree.

Mr. REICHLER: Would you agree that Nicaragua’s *present* dredging programme, at its recent or current levels, has very little effect on the flow of the Lower San Juan River? In part because, although Nicaragua keeps dredging sediment out of the river, just as much if not more

sediment keeps arriving from upstream, accumulating in the channel Nicaragua was attempting to maintain, requiring repeated dredging of the same areas?

Mr. THORNE: I would not agree, no. I think it has a highly deleterious effect on the channel.

Mr. REICHLER: But my question is whether there is, to *maintain* the channel that you described before, that is, the object of Nicaragua's dredging programme, you would agree that that requires repeated dredging just to maintain that channel?

Mr. THORNE: Yes, but there are much better ways of maintaining that channel than repeatedly dredging it, which clearly is not working.

Mr. REICHLER: And the reason it is not working is because the channel keeps filling up with sediment as they dredge it?

Mr. THORNE: Yes! As I stated before, if there is a pool, if you dredge a deep hole in the channel, it will refill very quickly.

Mr. REICHLER: Especially if there is a lot of sediment coming from upstream sources, whatever they may be.

Mr. THORNE: Yes! We have got 11 live volcanoes putting sediment into the river. In my opinion, the road-derived sand has not got there yet.

Mr. REICHLER: I had a feeling you would sneak that in at one point, so *touché!* Do you stand by the statement in your 11 October report that: "Maintaining navigation in the Río San Juan for vessels with draughts greater than, say, about 1 m, will require not a single capital operation but repeated dredging and the removal of hundreds of thousands of cubic metres of sediment year after year." You still agree with that?

Mr. THORNE: That would be the catastrophic result of trying to dredge this river to maintain passage, yes.

Mr. REICHLER: Well, in order to maintain passage for vessels with draughts greater than 1 m, whether you think it is a good idea or a bad idea . . . ?

Mr. THORNE: I think it is a terrible idea.

Mr. REICHLER: OK, but it would require not a single capital operation but repeated dredging and removal of hundreds of thousands of cubic metres of sediment, year after year? That is what you said in your 2011 report in the *Certain Activities* case. Is there any reason why you would disagree with your prior statement now?

Mr. THORNE: No, this is Sisyphean; they are going to be doing it forever.

Mr. REICHLER: Professor Thorne, once again I thank you immensely for your co-operation, for your openness and your candour. Really — and I say this with all sincerity — it has really been a pleasure getting to know you and I hope that we will remain friends after this session ends. Thank you very much.

Mr. THORNE: Thank you very much. That is my wish too and thank you for your forbearance and for the Court's forbearance. I am new to being an expert witness and I have not followed the rules exactly. I apologize!

Mr. REICHLER: Thank you, Mr. President, Members of the Court.

Le PRESIDENT : Merci, Monsieur le professeur. Mais la Cour a encore beaucoup de patience à sa disposition. Nous n'avons pas terminé. Et je vais maintenant donner la parole à M. Wordsworth qui va me dire s'il souhaite procéder à un interrogatoire complémentaire et, dans l'affirmative, qui va pouvoir maintenant procéder à cet interrogatoire complémentaire. Monsieur Wordsworth... Monsieur Wordsworth, pouvez-vous parler dans un micro qui soit allumé ? Pour l'instant, ce n'est pas le cas. On ne vous entend pas bien. Est-ce que le micro est branché ? Oui ?

Mr. WORDSWORTH: Is it now working? Very good. Professor Thorne, in the first part of that cross-examination, you will recall you were asked and shown various slides on mitigation

works and you were asked questions in relation to mitigation works. Now, can you explain to the Court how, or the extent to which, you have taken mitigation works into account in your estimates of how much sediment is coming from the road?

Mr. THORNE: We have not taken them into account at all.

Mr. WORDSWORTH: And why is that?

Le PRESIDENT : Monsieur Reichler?

Mr. REICHLER: As you probably have observed, I have not stood up to object to any questions, yet — either on cross-examination by counsel for Costa Rica, or re-examination. If Mr. Wordsworth will recall, I asked the witness questions about three distinct subjects: the mitigation efforts or mediation efforts; suspended sediment loads and concentrations; and channel morphology. If Mr. Wordsworth is intending to take the witness into his calculations or Dr. Kondolf's calculations regarding sediment going into the river, I did not ask any questions about that. Furthermore, I think you will recall that Mr. Wordsworth made a similar protest during the re-examination of Professor Kondolf. So, in order to avoid having any difficulties as we go forward, I just wanted to make clear for Mr. Wordsworth's benefit, what the subject areas were and our understanding that the subjects to be covered on re-examination should not be those other than were covered on the cross-examination. Thank you, Mr. President.

Le PRESIDENT : Merci. Monsieur Wordsworth, vous pouvez poursuivre.

Mr. WORDSWORTH: Mr. President, thank you very much. I would just respond very briefly to that, although I don't see it in any way as a properly made objection. First of all, Mr. Reichler has not stood up to object before but he has had no basis to object — so that is hardly surprising. Secondly, I asked Professor Thorne, quite correctly, a question about mitigation. He was shown various slides on mitigation and the implication behind all those slides is that mitigation may be important to the task before this Court. I am simply asking Professor Thorne a very specific question about *how* he has taken mitigation works — the fact of the mitigation works —

into account into the calculation of his estimates of sediment coming from the road. That is plainly a question that comes out of cross-examination.

Le PRESIDENT : C'est une question à laquelle le professeur Thorne va maintenant pouvoir répondre.

Mr. THORNE: I am sorry, Mr. President, this was not on.

Le PRESIDENT : Vous pouvez répondre à la question.

Mr. THORNE: No, we did not make any reduction in our estimate to account for the effect of mitigation.

Mr. WORDSWORTH: Thank you very much. Now you were asked whether approximately 20 per cent of the sediment upstream of the delta goes into the Lower San Juan, with 80 per cent going into the Río Colorado, and you referred to figures 4.14 and 4.15, and you said that this was an attempt to model the division of flows and division of sediment as well, as I understand it. How would you obtain actual figures as to where the flow and the sediment goes?

Mr. THORNE: They would be obtained using the USGS standard methods to which Dr. Kondolf referred, with a section being measured upstream of the bifurcation and a section being measured downstream of the bifurcation in each of the branches.

Mr. WORDSWORTH: And are there uncertainties in the model to which you referred at figures 4.14 and 4.15?

Mr. THORNE: There are very large uncertainties.

Mr. WORDSWORTH: Why are those uncertainties there?

Mr. THORNE: The model is based on measurements made only in the Colorado branch. We don't know the approach sediment load or the sediment load in the Lower Río San Juan. If we knew two of the three, we could calculate the third by continuity, but we only know one of the three so we have to surmise what one of the other ones is. In the case of bed load, we have no

measurements at all; that is purely a theoretical model. Since writing this report, I have looked at Annex 16 in Nicaragua's Counter-Memorial in *Certain Activities*, which does have measurements made on the other two branches, in January 2011 and in May-April 2012. On those particular days — and they are only two measurements — and Professor van Rhee is pretty happy to go with three measurements, or two measurements — I honestly wouldn't be — but they are what they are, they're snapshots: on those days when they measured those loads, the amount of sediment going into the Lower Río San Juan was on the first occasion 7 per cent and on the second occasion, 14 per cent, so rather lower than the model would predict. If we had more data and could calibrate the model, the uncertainties would reduce enormously.

Mr. WORDSWORTH: Thank you. You were later on taken to page **II-27** of your report in *Certain Activities*, and you were asked questions about whether the Río San Juan, particularly the Lower Río San Juan, can accommodate its sediment load. And you were also taken to paragraph 6.12 of your 2013 report on the road: in your response, you referred to response reaches of which, as I understood it, two are in the San Juan proper and one is in the Lower San Juan. Now, do those response reaches have any impact in terms of where sediment coming from the road might go?

Mr. THORNE: For sediment coming from the road upstream of Boca San Carlos, which is where most of the slopes — we have seen quite a lot — are located, that sediment must pass through two response reaches before it reaches the delta. Within those response reaches are innumerable sandbars, point bars, natural levees and channel marginal areas, all of which tend to trap sediment. There are also six depositional centres — we might call them shoals: each of those has a trap efficiency of at least 50 per cent for coarse sediment moving as bed load or near bed load. So do not think of the Río San Juan as a slurry pipe where actual sediment comes in and the actual sediment goes out. Actual sediment comes in and it goes into a shoal and it stays there for a year, five years; it goes into a marsh: it stays there for a thousand years. Now sediment comes out of the other end but it is not the same sediment. In terms of the bearing on this case, what we did in 2013 and 2014 was look at quantum: we looked at the sediment transport and we did not differentiate between sediment derived from the road, or the Irazu volcano, or the Cinchona

earthquake of 2009. We just said sediment *is* sediment. *Really* thanks to Mr. Reichler for prompting this thought train, I started to think a lot more about the actual sediment and the fact that both those response reaches also have a tendency to aggradation, just as does the Lower Río San Juan: it is not as strong as it is in the Lower Río San Juan because of geology and that is why I say the Lower Río San Juan cannot accommodate this sediment in the way that the other rivers can because they are much bigger. They have more hotel rooms for sediment; the sediment can stop there without clogging anything up. The Río San Juan is just small and it is pinched by geology.

Mr. WORDSWORTH: Now you were asked some questions about dredging and where sediment would be settling in the Lower San Juan. You said that sediment is settling into the trench dredged by Nicaragua. Now, can I understand it, by reference to the answer just given, what sediment are you referring to there that is settling into the trench dredged by Nicaragua?

Mr. THORNE: The sediment I am referring to there, the actual sediment, 3,000,000 cubic metres of it, comes from the San Carlos; 2,500,000 cubic metres of it comes from the Sarapiquí; and particularly from rivers like the Sucio — the Sulphur *River* — the sulphur river drains a volcano and it carries about a million cubic metres per year. Up until 1971 it confluenced with the Rio Colorado, it then avulsed and now confluences upstream of the delta. It is putting in an additional million tons per year. That is a sediment perturbation and that is going to give a problem for navigation. It does not give a problem for the river because the Lower Rio San Juan is not a sick river — it is wrong to characterize it that way — it is an old river, it is an old distributary, but that does not mean it is sick. It just means that it accommodates its sediment in a different way to the youthful and vigorous Colorado.

Mr. WORDSWORTH: Now, you were also taken to a passage from your 2011 report where you say that sediment is settling in shoals, levees and the like. Now, what I want you to clarify is that, on the one hand, you said to Mr. Reichler that sediment reaching the Lower San Juan is settling into the trench dredged by Nicaragua. On the other hand, you said in 2011 that sediment is settling in shoals, levees and so on. So, are you able to explain to the Court how those two statements fit together?

Mr. THORNE: Yes, I think so. When there is a heavy and variable sediment load, the river cannot transport that material all at once. During high periods it accumulates sediment; during lean periods — when there is less sediment coming into the river because there has not been an earthquake, or the volcano has not erupted, or sediment is not coming from 10,000 other sources in this basin — then the river quietly chips away at that store of sediment that is built up, and so the bed aggrades and then it comes down and that is the natural rhythm of things. If you come and dig a big hole in it, it will fill up very quickly. If you keep on digging that hole, it will fill up probably more quickly. And if you disturb the width — and I have read the EPN report on the dredging programme to come, which involves clearing all vegetation from islands and banks that is obstructing the natural flow of the river — if you do that and the river widens, your bed will shoal very significantly. My prediction would be — and I was right with what I predicted in 2011, I hope I am not right now — that the wider shoaling of the bed due to its widening as more sediment comes in, you unlock the natural levees, you unlock the stores of sediment in the islands, will massively overwhelm the dredging capacity. The bed will aggrade, the Rio San Juan will become not a perennial distributary, but a seasonal distributary. And that would be a disaster. So, digging a hole actually has an unintended consequence. The problem with the Rio San Juan is navigation. Let us deal with navigation, not trying to change the river. Do we have to have boats with drafts greater than 1 m? Couldn't we use different boats?

Mr. WORDSWORTH: Thank you, Professor Thorne. I have no further questions in re-examination. The Court may have questions for you.

Le PRESIDENT : Merci. Je me tourne vers mes collègues. Je ne crois pas qu'il y ait de questions à adresser à l'expert. Si. Monsieur le juge Tomka, vous avez la parole.

Judge TOMKA: Thank you very much, Mr. President. First of all, I just wish some clarification. I have understood one of your answers to maître Reichler's question that dredging is not the best way of dealing with, as he admitted, problems in the San Juan, the lower part of the San Juan, to be more precise. What, in your view, would be the appropriate way of maintaining

navigability, if dredging is not the appropriate one, because, as I understand, you also see this as a kind of Sisyphus work? Thank you very much.

Le PRESIDENT : Monsieur le professeur.

Mr. THORNE: Professor van Rhee is an expert on dredging and I have read his report very carefully. His colleague, Professor Huib de Vriend, I know very well. He is not here this week. Professor de Vriend has retired from Deltares; he is now the Director of Ecoshape, a foundation utterly devoted to working with natural processes. I urge Nicaragua to talk to Professor de Vriend about the alternatives, he is a Dutch expert. My recommendation would be to copy what happens in other places — and Professor van Rhee referred to some of them — where in-stream training structures are used to maintain a navigation channel that is open all year. Sometimes they are made out of inappropriate materials, concrete and steel. I would not use those, I would use wood — and the wood, provided it is kept below the water level, does not rot. It would last for many decades. I have not had access to look at the Rio San Juan in detail. I have seen it, I have been there. I think rather than pulling all the wood out, I might re-arrange it. I would re-arrange it in ways that created shoals in places I did not want to navigate and which focused the remaining flow of the wet season, which is still considerable — it is still 150 cubic metres per second, that is a lot of water — but focus it in the navigation channel, as our friends at the Corps of Engineers do on the Lower Mississippi. The dredging requirement on the Lower Mississippi in the 1970s was horrendous, they were spending a billion dollars a year dredging the river, the outcome of that was to destroy the Mississippi delta, because it starved of sediment. If you dredge out 730,000 cubic metres of sand from this river, they will starve the delta. And if you look back at figure 2 in my summary in *Certain Activities*, you will see the overlay of the maps. Just look at the coast, it has retreated 1 km since 1840. The dredging programme, if it cuts off the sediment supply, will starve the delta, the Caribbean Sea will take it away, we will lose hundreds of hectares of wetland due to coastal erosion. We need that sediment. Every grain is precious. It needs to be kept in the river, but let us move it on its way by appropriate river training works and spot dredging — I am not saying there is no dredging requirement, there is — but spot dredging of the tops of the shoals during the low

season when you just need to knock the top off to get your 2 m draft boat through. That is what I would say.

Judge TOMKA: Thank you very much. Merci, Monsieur le président.

Le PRESIDENT : Merci Monsieur le professeur. S'il n'y a pas d'autres questions, je vais remercier le professeur Thorne. Votre déposition s'achève et je vous remercie d'avoir bien voulu comparaître devant la Cour. Vous pouvez quitter la barre. Merci.

Mr. THORNE: Thank you very much, Mr. President. Thank you very much, judges, Mesdames, Messieurs. It has been a privilege to be here and thank you for your forbearance with me on this second occasion.

Le PRESIDENT : Merci. Le calendrier des audiences dont les Parties ont eu communication prévoit que la matinée d'aujourd'hui est consacrée à l'audition des experts du Costa Rica. Tel a été le cas et que les plaidoiries du Costa Rica pour le premier tour reprendront cet après-midi à 15 heures. La Cour se réunira donc de nouveau cet après-midi à 15 heures pour entendre la suite du premier tour de plaidoiries du Costa Rica. Je vous remercie. L'audience est levée.

L'audience est levée à 12 h 10.
