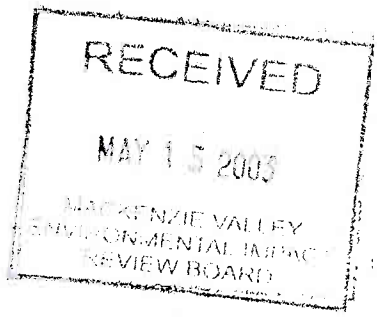

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May 15, 2003

Mackenzie Valley Environmental Impact Review Board
5105 – 50th Avenue
Box 938
Yellowknife, Northwest Territories
X1A 2N7

Attention: Alan Ehrlich, Acting Manager of Environmental Impact Assessment

RE: WesternGeco Mackenzie and Liard Rivers Seismic Program 2003
MVEIRB Information Request No. 2

Dear Alan:

Attached are responses to the MVEIRB Information Request No. 2 dated 24 April, 2003.

We trust that the attached responses address the comments and recommendations noted in the Information Request.

Yours very truly,

WesternGeco Canada Ltd.

Keith Rosindell

cc. T. M. Baker, National Energy Board
J. Allen, Inuvialuit Environmental Impact Review Board

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WesternGeco Canada Ltd.
MACKENZIE AND LIARD RIVERS SEISMIC PROGRAM 2003

MVEIRB Information Request No. 2

1.2.1 Request

Please provide answers to clarify the following:

a) What will WG do if depths of less than 3.5 m are encountered?
b) What is the basis for WG's determination that the airguns must be kept a minimum of 1 m above the river bottom?
c) How will WG know whether or not sediment is being disturbed?
d) What will WG do if sediment is being disturbed?

Response

a) WesternGeco will stop shooting when the vessel encounters water depths of less than 3.5 m, and will lift the air guns onto the barge when the operation encounters water depths of less than 3.0 m.
b) This stops the air guns from filling up with gravel, which prevents them from malfunctioning. It is also a safe guard and prevents the gun arrays being dragged over mud, gravel, sand and possibly rocks, which would severely damage in water equipment.
c) WesternGeco will not know if sediment is being disturbed. With the very high turbidity of the Mackenzie and Liard Rivers, it would be impossible to see if sediment is being disturbed.
d) The sediments will not be disturbed by the air guns (see answer IR 1.2.1 answer a through c).

1.2.2 Preamble

Section 3.2.5. says that the steamers will be towed at a depth of 3 to 5 m. However, Sections 3.2.5.2 says that the streamers will be used in water that is just 2 m or deeper.

Request

These statements seem inconsistent in that the depth of the streamer being towed may be greater than water depth. How does WG reconcile these two statements?

Response

The streamer will be towed at a depth of between 2 and 5 m from the water surface.

1.2.3 Preamble

WG writes that the airgun effects are diminished near the bottom both in terms of pressure (psi) and acoustic pressure (dB). However, this seems to be contradicted by the definition of

Transmission Loss – Depth in Water Column provided in Appendix VII. The definition says that received sound levels are generally quite low near the surface and that in some instances received sound levels can be relatively high near the bottom.

Request

Please clarify these statements regarding sound levels at the bottom of the water column.

Response

There is no contradiction between the explanation of spherical spreading set up when the air guns fire, and the explanation of transmission loss due to cylindrical spreading explanation in the glossary. These are two separate definitions and apply to two differing events.

1.2.4 Request

Please describe any mitigative alternatives to ramping up (such as alternative technologies and/or procedures) and describe their effectiveness to achieve fish and wildlife avoidance.

Response

Wright (2002) proposed guidelines for geophysical exploration to meet the requirements of Canada's Fisheries Act. WesternGeco's array of mitigation measures uses most, if not all, of those recommended guidelines to minimize risk to the environment and, in that spirit, included measures whose success has been assumed rather than fully tested.

Mitigation measures include: timing of data acquisition to avoid peak periods of fish migration and reproduction; travel in the thalweg to avoid nearshore concentrations of fish and wildlife; placement of the airgun array and streamer near river surface to avoid concentrations of fish at depth and impact upon substrates; environmental monitoring to assess real time effects, if any; and ramping up. Ramping up, a soft start, allows fish and wildlife the opportunity to move away or seek refugia, should that response be attributable to a species, without being unduly startled. A startle response may occur but has only been documented for a marine fish species caged near (<20m) a high energy airgun source (McCauley et al. 2000) operated at full capacity. No beneficial alternatives to this soft start (ramping up) process are known. The ramping procedure during start up may not be effective because fish endemic to the Mackenzie River showed no avoidance behaviour (change in distribution) using our methods; however, the procedure is an environmentally conservative application for airgun seismic surveys.

1.2.5 Request

In light of DCFN's identifying the Mackenzie River as a cultural resource to be protected, what additions or changes would WG make to the assessment of impacts and related conclusions presented in EA, Section 8.6.4?

Response

Through reports and from consultation in the Mackenzie valley, WesternGeco was aware of the cultural importance placed on the Mackenzie River by First Nations, prior to the DCFN's recent announcement. WG is now also in receipt of a copy of DCFN's response to MVEIRB on this topic. WG does not propose any additions or changes to the EA in this area, but would be willing to discuss any particular issues DCFN wishes to raise, on the subject of cultural value.

1.2.6 Request

Please respond to the following questions:

a) Was the 230 dB level at 2 m from the airguns a calculated or measured value?
b) Why were the measurements made at 8 m and not at 2 m?
c) Was the value of the actual exposure level at 2 m from the airguns 230 dB or 224 dB re µPa?
d) Why were the cages not placed at 25 m from the airgun arrays given that the data indicates a signal from the subarray would converge at the loudest exposure level (worst case scenario) at 25 m, as opposed to at 2 m or at the other two cage locations?
e) What is WG's rationale for expecting that the case presented in its EAR accurately represents the worst-case scenario?

Response

The Caged Fish Test, at the request of DFO, was among the first tests conducted in 2002. As a consequence, acoustic data was being acquired and data required to relate peak sound levels to distance was not completely available 22/07/2002.

a) The 230 dB level at 2 m was scaled from a measured value at 4 m made prior to introduction of test animals. The anchor system was put in place and noise measurements taken at the location. A priori collection of exposure levels minimized (physical) disturbance of test animals during the experiment from hydrophones and boats.
b) It is impractical and considered unsafe for a boat to get too close to the gun array.
c) Measured sound levels at 4 m were 224 dB re µPa. Scaled back to 1 m, the level is 236 dB re µPa. At the 1 m range you would expect to see more air than an established pressure wave (see air gun source levels 7.1.1 in the Acoustic Field Study Report Appendix II). During the fish cage study the nearest cage to the gun array was at 2 m and therefore exposed to the highest or peak amplitude and in the confines of a worst-case scenario. The measurement at 2 m scaled back from 4 m is 232 dB re µPa.
d) Data does not indicate that maximum exposure is at 25 m (see Acoustic Study page 32 figure 22).
e) The question is unclear. The maximum levels reached in the river occur in the near field (<20 m see Acoustic Monitoring of WesternGeco 2002 Mackenzie River Seismic Project). Caged Fish tests represent full exposure of confined fish during 5 minutes of ramp-up and 1 minute of firing at peak operation every 10 s (2X the normal for 2002). These exposure durations and levels are unlikely to occur for any

free-swimming fish in the Mackenzie River. Experimental animals also experienced some unknown degree of stress associated with capture, handling, transport and confinement. Because no short term mortality occurred under these exposure and experimental conditions i.e. within 6% of in-river maximum and over an extended exposure period following capture transport and handling, we expect no short term mortality of free-swimming fish.

1.2.7 Request

Please clarify the following issues related to study design and conclusions drawn from these studies:

a) Why was 48 hours selected as the length of the holding period? In light of published papers (such as Hastings et al. (1996) and McCauley et al. (2003)), how does this time period affect WG's confidence level in impact predictions of long-term impacts?
b) The cages were placed 2 m, 85 m and 446 m away from the airguns. Why were large bodied fish tested only at 85 m but not at 2 m? Can impacts on large-bodied fish be reliably extrapolated for close range?
c) Please explain why large-bodied fish were used in only one trial.
d) The large-bodied fish used for the tests included 28 fish from 5 species. Only 3 of the 28 fish were selected for the histopathological analysis. All 3 of these fish were flathead chub. Please explain why the histopathological analysis was limited to the flathead chub instead of including other species sampled. How does the data from these species transfer to other large-bodied species? Are flathead chub considered more or less "hardy" than other large-bodied fish?
e) Please explain why no whitefish species were used in the cage tests. Are the results from the other species transferable to the whitefish? Can the behavioural and physiological effects detected with test species be extrapolated to whitefish and bull trout? Are whitefish and bull trout more or less sensitive to noise than the species that were used? (Note the connection between this IR and IR 1.1.7 (April 7, 2003)).
f) WG uses the phrase "no significant abnormalities of the hearing structures". Were there abnormalities that were observed but viewed as insignificant by WG? Please describe the abnormalities that were observed but that were considered "not significant", if any, and explain why they were not considered significant.
g) Were the "stunned" fish separated or otherwise marked for later identification? Can WG confirm that any of the stunned fish were sent for histopathological analysis?
h) Given that WG is considering that the fish do not show any avoidance behaviour then it seems to be likely that there will be close range exposures. Please explain why WG states that fish would never have this sort of exposure.
i) How did the escape of 17 fish affect the data analysis and presentation of results?

Response

The caged fish test evaluated short term (48 h) mortality of endemic common species captured in the Mackenzie River. The experiment followed protocols discussed by Hocutt and Stauffer (1980) and commonly applied to biological monitoring of fish populations. The 2002 Test Program also was not privy to the experiments of McCauley et al. (2003).

a) Please recall that the caged fish test was designed to measure short term mortality, it was not privy to results of McCauley et al. (2003) in 2002, and the histopathology was designed to determine the organ(s) implicated in any mortality, should it occur. The short term results of the 2002 Test Program are included in, but form only a part of the basis for, predictions of long term impacts. We rely primarily upon integration of results from all – short and long term – studies to infer long-term impacts. McCauley et al. (2003) infer possible impacts from their longer term studies and state that their (extended, repeated) exposure levels did not allow determination of the threshold at which damage to sensory cells occurred. WesternGeco's confidence remains high in its prediction of long term impacts using the available information.

b) WesternGeco exposed more fish, with greater replication, than proposed in the "Acoustic and Biological Test for the Mackenzie River/Delta, 2002". The size of the cage required (see Hocutt and Stauffer 1980 for a general description of these types of tests) to contain large bodied fish precluded placement of the cage near the array (current velocity would have necessitated an elaborate anchor system that was not available) which was at the edge of the thalweg. The first exposure with pearl dace resulted in no mortality. Large bodied fish capture rates were low and exposure level of the large-bodied fish was still high (192 dB, 80% of maximum estimated). We are reluctant to extrapolate our results. However, 1) no stunned or dead fish were observed by the environmental monitors over 270 km of data acquisition, 2) pearl dace and other species exposed at high levels were not killed in the short term, 3) fish eggs and larvae are most sensitive although significant mortality of them is unlikely in the Mackenzie River and 4) no mortality of adults has been reported elsewhere for the exposure conditions expected for the majority of fish in the river and in most, if not all, of the near-field of the airgun.

c) See above: there was no mortality of other species caged at higher exposures, capture success for large-bodied fish was low, logistics of placement of large cages in high currents interfered, and we met/exceeded protocols established for the objectives presented and approved for the 2002 Test Program.

d) A variety of tissues and organs were selected for histopathological examination that would elucidate the organ systems that might contribute to any observed mortality. No mortality attributable to air guns occurred among test animals. Flathead Chub were the most abundant large-bodied species. From Popper and Fay (1993), we suspect that flathead chub are likely to be hearing specialists (less hardy).

e) Our 2002 Test program was designed to address specific objectives and we are reluctant to "stretch" the results by developing a species specific interpretation of effects. Whitefish were almost certainly among the array of fish species that were counted and their position in the water column determined by hydroacoustics; there was no indication that a species specific response by whitefish overwhelmed the (lack of) response by the community that we assessed. A DFO staff person suggested, and we concurred, that coregonids would be particularly sensitive to handling stress in summer. As well, we captured approximately 100 juvenile coregonids but those fish had lost scales, appeared "stressed" and were released. When conducting an "exposure" experiment or bioassay, healthy animals must be used to minimize results from extraneous (i.e., handling and other uncontrolled) stressors. We are reluctant to extrapolate our results to other species. Salmonids (we assume coregonids as well) have no swim bladder connection to their inner ears and

are referred to as hearing "non specialists" (Popper and Fay 1993). Please also see our response to IR 1.1.7 (April 7, 2003).

f) Dr. J. Lumsden indicated that abnormalities were the result of anomalies associated with preservation, sectioning and tissue preparation, parasitism or physical damage from handling or later dissection. Abnormalities associated with hearing structures were assumed by Dr. Lumsden to be the result of the preservation method or sectioning.
g) "Stunned" fish were not separated or marked. Because fish sacrificed for histopathological examination appeared healthy, we cannot unequivocally state that stunned fish were among those sacrificed.
h) Capture, handling or confinement does not stress free-swimming fish. Free-swimming fish usually avoid stressful situations. Most free-swimming fish in the Mackenzie River were nearer the river bottom and in the thalweg where exposure to air gun noise levels would be lower. River current, survey vessel travel and airguns operating near the river surface combined with the above to reduce exposure levels.
i) We assumed that, to escape, fish had to be alive and mobile. All fish were present, alive, apparently healthy, swimming upright and responded to stimuli when transferred to holding cages at the reference location post-exposure. None of the dead fish found in the holding cages were from the highest airgun exposure and escapees (17 of all exposed fish) were from the range in exposure levels.

1.2.8 Request

Please respond to the following questions:

a) Explain why the two studies that used hydroacoustics produced results that differed from other studies. Do hydroacoustics not detect the avoidance behaviour? Are hydroacoutics more sensitive than the methods used in the other studies? Are the conclusions made by the others incorrect due to their methods?
b) On page 7 of Appendix III, WG writes that "The data that we present, therefore, is a conservative estimate of the size and abundance of fishes...". As the term "conservative" varies with perspective, did WG mean to say that its estimates were low?

Response

We suggest that "avoidance behaviour" may be a misleading phrase and we will attempt to clarify WesternGeco's, and other, results. "Startle" responses, "milling" and "eddying" are behaviours observed directly or recorded by camera and evaluated. These visual observations may or may not be related to known exposure levels from airguns. McCauley et al. (2000) assigned a "behavioural" response to caged fish exposed to measured source levels from video records and it provides helpful information about short term behavioural responses of some marine species. In other cases, catch rates may decrease (Engas et al. 1996, Lokkeberg and Soldal 1992, Skalski et al. 1992) or temporarily increase (Lokkeberg and Soldal 1993) and a change in behaviour is assumed to have caused these changes in catch rates. WesternGeco in 2002 and Dalen and Knutsen (1987) used acoustics to quantify abundance and location in the water column and related these measures of fish populations to sound levels. We measured the consequence of fish behaviour and not behaviour per se.

a) WesternGeco and Dalen and Knutsen (1987) found that there was no statistically significant change in fish abundance (density) and location in the water column as a result of proximity (and exposure level than could be estimated from the sound level, directivity, and distance relationships) to airguns. Both foregoing studies measured/quantified a response at the population level. Individual fish responses – startle reactions, milling, etc. – that contribute to the behaviour of fish are not apparent in acoustic data.
Available results from the diverse behavioural studies are, in our view, compatible. Individuals (depending upon species) may exhibit a short term (first few seconds) behavioural response (startle, mill, etc.) depending upon hearing ability and exposure level. That catch rates change is equivocal and, if catch rates increase or decrease, the change may be species specific and may occur over hours or a few (<5) days. These short term responses, if they occur, do not appear to manifest themselves into a consistent response at the population level (fish densities and distribution are naturally variable). For example, there is no apparent herding (increases in density in advance of the seismic survey vessels) or swimming deeper (increase in fish abundance at depth). Catch rates may or may not change for a species and no obvious change was noted for catches in the Mackenzie River, 2002. WesternGeco sees no inconsistencies among these conclusions.
b) As we stated in Appendix III, our hydroacoustic system was not used when depth precluded its safe use near the river surface, and we edited out the bottom c/w fish <1 pulse length from the bottom. As a consequence, our measurements are accurate and repeatable for the portion of the river that we assessed but does not include all fish in all portions of the river.

1.2.9 Request

Please respond to the following questions:

a) What is the width of the survey swath at different depths? It is assumed that they are three-dimensional as the data is presented as fish/cubic meter.
b) Please describe measured transects as a percent of the volume of the cross-section of the river with the same width as the measured transect. What percentage of the river width did each transect cover?
c) What is the accuracy of the GPS tracking system used?
d) How much effect did river current have on performing consistent transects?
e) Please comment on the effectiveness of using hydroacoustic monitoring to detect fish movement given that the bottom 1 m of data was excluded and the monitoring revealed that most fish were located in the deepest part of the channel.
f) Please discuss and explain the following issues, raised by DCFN, regarding WG's experimental design.
    i. WG's experimental design seems to assume that all fish in front of the seismic vessel will be pushed upstream as the seismic vessel moves upstream and so if there is fish herding, the number of fish in front of the vessel will steadily increase. In other words, the design assumption seems to be that the seismic vessel noise would form an impermeable barrier across the width of the river. Is this an assumption of the study design? If so, how is it justified in light of the potential for fish to move around the sides of the vessel?

ii. How does the experimental design account for potential intra-day variability in fish presence and density? For example, measuring a transect at 10 a.m. for the "before ramp-up" sample and again at 5 p.m. for the "immediately in front" sample and concluding that there is no herding because the abundance of fish is the same does not acknowledge that there could be intra-day variability in the fish population at that location. Could a certain percentage of the fish present in the 5 p.m. sample would not have been present if the airguns had not been going off earlier?

iii. Typically, impact assessment requires the establishment of a baseline for comparative purposes. Please explain why WG did not establish a baseline for the transects by measuring the fish abundance the day before and/or after the tests.

g) What is the source of the numbers used in the first three lines on page 26 of Appendix III?

h) Please explain why on 5 occasions in Figures 5 to 7, there are two data points shown for the Pre Ramp.

Response

a) Data were partitioned within a transect by depth strata and sorted into "files" as we travelled from shore to shore (see 11-3 of Appendix III). The width of the "swath" will vary with depth (see your Preamble), will differ for each data file, and will differ among Test Areas. The width of some nominal depths can be calculated as R using the narrow beam width (7.4°) and depth as H in the formula used to calculate the volume of a cone. (Please also see 11-1 of Appendix III)

b) We fail to see the benefit from this exercise. As stated, the study design used a repeated measures approach and the distribution free method of statistical analysis is concerned with the distribution of variates, not the mean. River width varied among transects and among test areas as did depth; however, because the river at transects was wide and deep we were usually able to get within 30 m of the shore. For the percentage of the river width that each transect covered, please see Table 4 (Transect Parameters) in Appendix III.

c) When navigating a transect on the river, our trained coxswain used a GPS, land markers, and took the river current into consideration. GPS units are accurate to within 5-10 m. Therefore, the repeatability of our transect was within approximately 5-10 m.

d) The drift induced by river current was minimized because the Sprint followed a GPS course that was stored and travelled each time that the transect was sampled.

e) We did not measure movement but did measure location in the water column as stated. Fish location is detected ±1 pulse length, 0.4 ms. We assume that fish in the water column would change location and we can see no reason to assume that fish near the river bottom change position more or less than fish in the water column.

f) (i) Please see "Acoustic and Biological Test for the Mackenzie River/Delta, 2002". The Ho was, as is usual, that there would be no change in density or location as a result of seismic vessel passage. As discussed in the test program outline, we indicated that our repeated measures at a transect would detect differences, should

differences attributable to the survey occur. The method is consistent with the Ho and original objectives.

(ii) All measures were made in the daylight but at different times of the day, related to passage of the seismic survey vessels. Our approach was to relate data at the transect to proximity (exposure) of the airguns. We believe that the methods (essentially a before-after experimental approach c/w in-built options for statistical analysis - see Kelso et al. 2001 for use of these experimental designs to test for difference) were the best available to test the original hypotheses and meet the original objectives.

(iii) See above and original program objectives. There are many options available in experimental design. We opted to reduce the time period over which data collection occurred and relate measures at transects to vessel passage (exposure). Divorcing baseline data from the survey procedures (as suggested in iii) seems contradictory to items (i) and (ii) above.

g) The source of these numbers is Table 7, Appendix III, pages 23-25.

h) These are essentially duplicate measures because we reversed course and re-collected data at the same transect within minutes. See (iii) above. These data add to "baseline" conditions or measurements and, we think, reinforces our conclusion of Dalen and Knutsen (1987), that fish densities and distribution patterns are naturally variable and that no detectable (statistical) difference in these natural conditions results from the passage of airguns.

1.2.10 Request

Please respond to the following questions:

a) Please identify where the horizontal acoustic monitoring was done and how many times it was done.

b) It is possible that a reaction would be obtained more readily from a fish coming from the upstream direction towards the noise than from a fish moving downstream away from the noise. Why was only the downstream direction monitored?

c) The transducer was placed on the port side of the vessel and about 4 m to the side of the airgun array. Why wasn't a transducer placed on both sides to obtain a more complete view of the water behind the airguns?

d) Please estimate the volume of water monitored by the horizontal acoustics taking into account the effective monitoring distance and the diameter spread of the acoustic signal. Using the effective monitoring distance, please calculate the volume of water in the cross-section of the river with the same width as the effective distance of the acoustics. Please calculate the percentage of the cross-sectional river volume that was monitored by the horizontal acoustic monitoring.

e) The fish movement was marked as being a) moving towards the airguns; b) moving away from the airguns; or c) continuing along their original path down river. A weakness of this system seems to be that if a fish was moving away from the airguns but moved faster due to the noise without changing direction, this would not be recorded as an effect. Please comment.

f) Did WG consider using four transducers for horizontal monitoring (downstream port, upstream port, downstream starboard and upstream starboard)? If not, why? If it was considered, why was it not incorporated into study design?

Response

a) These data were collected in the South Test Area and, as indicated in Table 9, Appendix III, on 4 occasions.
b) These data are from free-swimming fish and they "chose" the direction in which they travelled. Fish travelling in either direction would be detected.
c) We had only 1 transducer and we fail to see why fish would react differently on the port and starboard side.
d) We fail to see the value in performing these calculations. We provided, earlier, the formulae for doing so. The volume is constant among trials and, as described in the "Acoustic and Biological Test for the Mackenzie River/Delta, 2002" the Ho was that there is no movement to/away from the airguns as they fire (i.e., no response).
e) This is correct. We would not/did not determine or measure rate of travel. As discussed above and in the test program outline, the objective was to determine "if the general direction of fish movement changes in the river course when airguns are fired (i.e., fish move away from the airgun array when fired). We tested that hypothesis and found that 1 of 36 fish altered its path when the airguns were firing. Fish were few and small near the river surface. For further detail, please see Appendix III.
f) WesternGeco did not consider using four transducers. Objectives, cost and logistics led us to propose the test program as described and subsequently approved. Our results indicate no significant response of fish by moving to/away from the airguns as they were firing (i.e., Ho was accepted and there was no effect of airgun discharge on the response measure that we used). We suggest that it is not appropriate to redesign a past study but more appropriate to design new studies that address important untested hypotheses.

1.2.11 Request

Please respond to the following questions:

a) Please provide details regarding the research design and protocols for evaluating changes in catch, beyond anecdotal evidence. How many local fishers provided information in this regard? How often were the nets checked during the seismic program? Were their fishing efforts directed to coincide with the approach of the seismic vessel in order to determine what the difference in catch was prior to, during, and after the seismic vessel had been in the area? What was the research protocol for this?
b) Please explain why WG's research results contradicted other research results.
c) Given that other research has indicated impaired fishing success, would it be appropriate for WG to attach a length of time qualifier to its conclusion of no impact? If yes, then what time period is reasonable?

Response

a) There was no research program related to changes in catch. Monitoring by community-based monitors is described in Appendix V, which included discussions with people on the river and at fishing camps.

b) WesternGeco's test program results do not, in fact, contradict other research results. Good summaries of research assessments of effects of seismic activity on commercial fish catch rates are provided by Kenchington (1999) and Turnpenny and Nedwell (1994). Both authors indicated that catch rates may increase or decrease and that the change or its absence may be related to species and capture gear. Both authors indicated that the change, if any, was transient, that catches returned to normal within days and that their data was limited. Chamberlain (1991) also stated that effects on catch rates were equivocal but that "if reduced catch rates result from the exploration activity" there may be an impact.
c) The above 3 reviews of possible effects on commercial catch rates suggested that the transient effects are reduced to normal within days if not hours. We suggest that with the low fishing effort observed during the period of the 2002 Test Program, it will be difficult to assess effects upon catches of native fishers and that the effect, if any, on catches would likely not be detectable.

1.2.12 Request

Please respond to the following questions:

a) Has WG identified any sensitive nesting sites in the Deh Cho and what are the sensitive periods? What will WG do around these sites? What are the potential impacts?
b) Please identify the key migratory bird terrestrial habitat sites potentially impacted by this project. What are the potential impacts?

Response

a) The Southeastern Mackenzie Mountains in the Deh Cho Region have been identified as an important waterfowl area. This area includes the floodplains between the Nahanni and Camsell ranges along the east edge of the Mackenzie Mountains. It abuts the west bank of the Mackenzie River north of the North Nahanni River. A significant proportion of the Canadian population of Trumpeter Swans (appproximately 15%) nests in this area. Swans likely arrive in early June and depart by late September. During the 2002 Wildlife Monitoring Test Study (Appendix IV), the affects of the project on waterfowl and birds was studied, and it was found that the project had no affect on birds on the water or on the shore. WG is confident that the project will not interfere with nesting habitats or migratory bird terrestrial habitat sites.
b) Refer to the "Ecologically and Culturally Significant Areas within the Deh Cho Region" map, Appendix I, Deh Cho for the key migratory bird terrestrial habitat sites which occur in parts of both the Mackenzie and Liard watersheds. As stated above, it was found that there were no impacts to key migratory bird terrestrial habitat sites in the 2002 summer Test Study (Appendix VI), and WG predicts there will be no impacts during the 2003 survey program.

1.2.13 Request

In the interests of identifying the reasonably foreseeable developments that may be induced please answer the following:

a) How wide will the strip of collected seismic data be?
b) Will the seismic data strip be confined to the area under the river or will the path of the seismic vessels also allow data to be collected from under the land as well? Please identify ant areas within the Deh Cho region where seismic data under land will be collected.
c) As the Interim Land Withdrawals will prohibit land-based seismic and oil and gas drilling within the 1 km wide buffer zone, please comment on the effect this will have on the sale and usefulness of the seismic data that is collected with this program.
d) Please comment on the potential of using directional drilling to gain access to oil and gas deposits identified by this program without breaching the 2 km wide buffer zone. Would directional drilling be possible without additional land-based seismic to refine drilling targets (i.e., is the seismic data collected from this program going to be good enough to define drilling targets on its own?)

Response

a) The strip of data is a linear measurement without width. Although the data would in theory represent one bin width or 15 to 25 m depending on the fold coverage.
b) No data will be collected under land. That isn't the objective of this Regional Survey.
c) It will have no impact on the sale or usefulness of the collected data.
d) This program is not intended to identify drilling targets. WesternGeco can not speculate on potential future drilling decisions by exploration companies to drill or not to drill.

1.2.14 Request

Besides the lack of a legislative requirement for doing so, please explain WG's rationale for developing and submitting a Benefits Plan to DIAND for approval without consulting with the Deh Cho communities specifically on the contents of that Plan.

Response

As the Deh Cho well know, following the meeting between the Deh Cho and WesternGeco in May 2002, the DCFN did not allow these meetings to proceed until after the Benefits Plan had to be submitted. The business benefits of this program to the DCFN are separate and ongoing discussions between the DCFN and WesternGeco, and not part of the EA process. WesternGeco declines to discuss legislative issues the Deh Cho may have with regards to the requirements of the submission of a Benefit Plan.

1.2.15 Request

Please describe in detail (i.e., discuss procedure, liability, burden of proof, dispute resolution, etc.) how WG will handle any requests for compensation.

Response

WesternGeco can not see the validity in discussing the Benefits Plan as part of this EA process. The Benefits Plan is a requirement of the EA process and has to be submitted by WesternGeco to

DIAND. Community issues with the contents of the Plan should be addressed to DIAND. There is however a section in the EA addressing Emergency Response Plans, spill response, reporting procedures and liability insurance. The program is governed under Regulatory, Territorial, Government and Maritime Law. Any request for compensation would be directed through the appropriate Agency.

1.2.16 Request

Please respond to the following questions:

a) Has WG identified any areas within the Deh Cho region where the program will shut down for the prevention of environmental impacts or to avoid navigational problems? If yes, please identify those areas and describe the potential impacts/problems that WG is attempting to avoid.

b) Regardless of the reasons why, in the event that the Deh Cho communities identify exclusion zones where the communities do not want WG to operate, will WG agree to the communities' requests?

Response

a) Inspection of information available for the Deh Cho region did not indicate areas where fish or wildlife exhibited behaviour different (i.e., spawning times, spawning habitat) than that presented in the EA. The general caveats associated with safe and responsible navigation will, of course, be observed. As well, environmental observers will provide the required information that will affect the survey process.

WesternGeco has proposed to the DCFN that WesternGeco compiles a map of the Liard River showing areas of shutdown for the prevention of environmental impact or to avoid navigational problems. This map will incorporate cooperation between DCFN, local and traditional knowledge, DFO and WesternGeco. WesternGeco will identify areas of potential navigational problems using existing knowledge, and may require a bathymetry survey of areas identified. This survey would be done in advance of the acquisition stage of the program, and would be conducted under an Aurora Research Permit.

In areas of possible fish concentration WesternGeco will follow the recommendations of the EIRB Panel for mitigation in the Delta. This mitigation requires that WesternGeco use a broad beam fish finder to determine if fish are collecting in the suggested areas. If there is a collection of fish detected then WesternGeco will not fire the gun array within 1 km of that area.

WesternGeco also proposes having the Community Liaisons visiting fishing camps before during and after the operation ascertain what if any action is needed (i.e., fish net avoidance or shut down).

b) WesternGeco feels that it is reasonable to be given a reason why communities would request exclusion zones, and is considered part of the EA process. WesternGeco would work with the communities to come up with mitigation much like those implemented for the Delta Project in the ISR.

1.2.17 Request

Please respond to the following questions:

a) Please discuss the issue of using the Mackenzie River acoustic results to predict the acoustic results in the Liard River. Please describe the similarities and differences

between the Mackenzie and Liard Rivers that allow WG to use the Mackenzie River results as a surrogate for completing a test program on the Liard River.

b) Was a model successfully constructed? If so, can the information gathered in the test program be extrapolated to the Liard River? Please explain.

Response

a) The acoustic program was designed to measure sound attenuation in a river environment. WesternGeco could not find any such data prior to the 2002 Test Program. The acoustic program was designed to measure the transmission loss and sound attenuation at distance in varying river conditions. (See all acoustic field study Appendix II). From the results of the test program it is expected than the loss coefficient for the Liard would be similar to the Southern Test Area. See acoustic report for discussion.

b) The acoustic model is the range of loss coefficient (A) in a river system, and was found to be between 21 and 27 (27 for the South section, 25 for the North section, and 21 for the Delta section)

The model for transmission loss used was:

$$RL = SL - A \text{ Log } 10\ r$$

RL = Transmission loss
SL = Source level
A = loss coefficient

1.2.18 Preamble

WG states that it will maintain a minimum 5 km separation between the WG and NRS seismic operations.

Request

Please describe the rationale for selecting the 5 km distance.

Response

The rationale in setting up a 5 km separation between WG and NRS is to ensure WG did not experience Seismic Interference from the NRS air gun arrays.

1.2.19 Preamble

In the 7th bullet on page iii it states that "If any injured or dead fish or wildlife are found, the survey will stop and will not start again until the situation has been discussed with the regulators." However, on page 144 it states that "Should 10 or more stunned fish be observed within one hour, or any dead fish or wildlife, or any injured wildlife, be observed in the wake of the Project, the Project will be suspended pending discussions with the DFO or RWED."

Request

As a stunned fish could actually be an injured fish these two statements seem to contradict each other regarding shut down protocol. Please clarify.

Response

Please be aware that during the 2002 Test Program that operated in 3 test areas, only 1 dead fish (death not attributable to airgun operation) was found, and that no dead wildlife were found. No fish or wildlife conditions that brought the operation in question were detected under vigilant monitoring conditions. We expect conditions in 2003 to be similar.

We agree that a stunned fish will evidence its behaviour as an injured fish. We also submit that the co-operation evident during the Test Program is expected to continue. The issue of the dead fish in 2002 was both quickly reported and quickly resolved. We suggest that quantifying the level of injury or death is of lesser importance than identifying and co-operatively resolving the situation.

1.2.20 Request

If fishing nets are noticed by the scout boats, is there a shut down protocol, and what is it?

Response

In 2002, no nets were observed by the scout boats, other small vessels or from the decks of the seismic survey vessels. WesternGeco suggests that, if nets are in place, they are likely to be placed in areas where current is less, simply because of logistics associated with keeping nets in place.

Travel of the seismic survey vessel in the river's thalweg, where nets would be a navigational hazard, will not encounter fishing nets directly. As a consequence, and because it is uncertain that catch rates will be affected, a shut down protocol does not appear to be required. However, if fishing nets are seen that interfere with safe navigation, appropriate procedures to avoid entanglement will be taken (i.e., change course or request net removal).

1.2.21 Request

In the original environmental impact assessment it stated that "Should a stop not be needed, WG will stop operations for one hour approximately every 6 hours, as an added precautionary mitigation with respect to fish." Is WG no longer planning on using this mitigation measure? Please clarify.

Response

There was no evidence of fish herding during the Fish Behaviuoral Program (see section 4 Results, Appendix III). The mandatory 1 hour every 6 hours shutdown period was mitigation against possible fish herding, and was therefore taken out of the 2003 EA. However, WesternGeco has added the additional precautionary mitigation and expects the operation to shutdown periodically for maintenance or cable reconfiguration. It is not expected that the program will run for more than 6 hours between shutdowns.

1.2.22 Request

In Section 3.3.4.3, please clarify what is meant by "The following tissues were examined for most fish when possible…". What tissues were not examined and why? Also, please clarify why in Table VIA (Appendix VI) certain tissues that were going to be looked at (indicated in Section 3.3.4.3) were not in the table (i.e., swimbladder).

Response

Each animal was not examined for every tissue listed in Appendix III, p. 18. Each fish was sectioned as described on p. 18 of Appendix III. All organs and tissues that appeared in sections were examined. The results of the histopathological examinations were provided in a summarized format and each organ/tissue that was examined for each specimen cannot be extrapolated from this.

1.2.23 Request

Will the Spill Response Flowchart and Oil Pollution Prevention Team information provided in question 2-3 of the above referenced NEB IR apply also to the Mackenzie and Liard Rivers portions of this program?

Response

WesternGeco will follow the same Spill Response Flow Charts and Oil Prevention Team information as provided in the WesternGeco Mackenzie Delta Marine 2D Seismic Program 2003, for the Mackenzie and Liard Rivers portion of this program.

1.2.24 Request

Please provide a consolidated summary of this information including, at a minimum, the following:

a) potential impacts;

b) proposed mitigation measures and other project commitments, with reference to location of additional detail provided in sections of the EIA or EA or other Project submissions, where appropriate. Where mitigation or commitments are location specific (i.e., Special Designated Area identified in Section 8.5.1 of Reference I), provide location information in the summary;
c) components of the proposed monitoring plans, where appropriate; and assignment of responsibility for ensuring compliance with proposed mitigation, project commitments and monitoring to specific job positions associated with the Project.

Response

The following table provides a consolidated summary of the information requested above, for potential residual impacts.

Table 2 - Summary of Potential Impacts, Proposed Mitigation and Monitoring

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
Effect of noise on traditional and commercial fishing	Use of environmental monitors[1]	Ship based monitors will work up to 2 km ahead of boat, to look out for people swimming, boats, nets, camps on shore, etc. Ensure no conflicts occur. Complete wildlife sighting form for each observation of wildlife in water while airguns are firing. Watch for debris in river. Communicate observations to Captain. Community based monitors will make daily boat trips before, during and after the seismic vessels pass, searching for sign of impacts that could be associated with the Project. They also liaise with local fishers and hunters to see if any concerns have been raised.	WesternGeco Project Manager is responsible for seeing that monitors are hired	8.1; 9.2.2; 9.2.9; 11.0
Terrestrial mammal disturbance	On-going discussions with RWED		WesternGeco Project Manager	8.5.1.1; Appendix IV
	Vessels will not operate near shore		NTCL Captain	3.3.1; 3.3.3; 9.1.1; Appendix IV
	Use of ramp up procedures		WesternGeco Marine Advisor	3.2.4; 9.2.3; Appendix IV
	Location and timing of Project		WesternGeco Project Manager	3.2.11; 4.0; 9.1.1; 9.2.4; Appendix IV
	Shutdown if wildlife observed in water within 1 km		NTCL Captain	9.2.3; 9.2.4; Appendix IV

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10; 10.3.2; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Nesting raptor disturbance	On-going discussions with RWED		WesternGeco Project Manager	8.5.1.1; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Nesting waterfowl disturbance	Project to occur after most sensitive nesting period		WesternGeco Project Manager	3.2.11; 3.3.3; 5.1.4
	Use of ramp up procedures		WesternGeco Marine Advisor	3.2.4
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Semi-aquatic mammal disturbance	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.4; 9.2.3; Appendix IV
	Shutdown if wildlife observed within 1 km		NTCL Captain	9.2.3; Appendix IV
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10; 10.3.2; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above, plus: On the vessel, monitors will check wildlife distances to vessels using laser range finder. Communicate to Captain if any semi aquatic mammals and marine mammals are within 1 km. Captain to halt operations if this threshold approached. Monitors 2 km behind boat will search for injured or dead wildlife. Report to RWED (or DFO for marine mammals) if any found, and Project to be suspended pending further discussion with RWED/DFO.	WesternGeco Project Manager	8.3; 9.2.3; 11.0; Appendix IV

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
Physical effects to semi-aquatic mammals	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.3; 9.2.3
	Shutdown if wildlife observed within 1 km		NTCL Captain	9.2.3
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10; 10.3.2
	Use of environmental monitors	Environmental monitor duties as above, plus: On the vessel, monitors will check wildlife distances to vessels using laser range finder. Communicate to Captain if any semi aquatic mammals and marine mammals are within 1 km. Captain to halt operations if this threshold approached. Monitors 2 km behind boat will search for injured or dead wildlife. Report to RWED (or DFO for marine mammals) if any found, and Project to be suspended pending further discussion with RWED/DFO.	WesternGeco Project Manager	8.3; 9.2.3; 11.0; Appendix IV
Important species involvement (listed species)	Covered in other sections of this table. See Question 2-6 for more details.			8.3; 9.2.4
Grounding of equipment on the river bed	Vessels will stay in deepest part of river channels	Following scout boat will monitor position of end of cable.	NTCL Captain	3.3.1; 3.2.5.2; 5.1.2
Physical effect to eggs and larvae	Project routed in deepest part of river channel, thereby avoiding typical spawning and rearing habitat		NTCL Captain	5.1.2; 8.2; 9.2.2.1; 10.3.1; Appendix III
Physical effect to young of year and adult fish	Scheduling the Project so that most dispersal predicted to occur before Project starts		WesternGeco Project Manager	3.2.11; 3.3.4; 8.2; 10.3.1
	Scheduling Project to avoid most fish migration		WesternGeco Project Manager	3.2.11; 3.3.4; 5.1.4; 8.2; 9.2.2.1; 10.3.1
	Limit exposure; sounds will be pulsed, not continuous; array size to be used has been shown not to kill fish		WesternGeco Marine Advisor	9.2.2; Appendix III

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
	Use of optimum array depth to minimize exposure	Depth monitored by WesternGeco.	WesternGeco Marine Advisor	5.1.2
	Use of environmental monitors	Environmental monitor duties as above plus: Monitors 2 km behind boat will search for and collect any dead fish. Stunned fish will be reported to DFO. If more than 10 stunned fish observed within 1 hr, or any dead fish, Project will be suspended pending further discussion with DFO.	WesternGeco Project Manager	10.3.1; 11.0; Appendix III
Behavioral response by fish	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.4; 8.2.1.1; 10.3.1; Appendix III
	Periodic shutdown of airguns		WesternGeco Marine Advisor	9.2.2.2
Disturbance to invertebrates and their habitat from grounded equipment	Vessels will stay in deepest part of river channels	Following scout boat will monitor position of end of cable.	NTCL Captain	3.2.2; 4.0; 8.11.2; 9.2.5; 9.2.6.2
Conflicts with fish harvesting	Ongoing community consultation		WesternGeco Project Manager	7.2; 10.3.3
	Use of community based monitors	Community based monitors will discuss with local HTCs to advise of Project schedule and check for any issues before and after boat passes.	WesternGeco Project Manager	8.5; 9.2.2.2; 9.2.9; 10.3.3; 11.0; Appendix III; Appendix V
Conflict with local river traffic	Communication between Project vessels and ferry captains		NTCL Captain	6.6.2; 9.2.10
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	9.2.9; 10.2; 10.3; 11.0, Appendix V
Increased employment	n/a			9.2.11; 10.3.5
Reduction in water quality	Use of community monitors	Environmental monitor duties as above.	WesternGeco Project Manager	9.2.8; 11.0
	Vessels will stay in deepest part of river channel; avoid disturbance of river bed	Following scout boat will monitor position of end of cable.	NTCL Captain	4.0; 5.1.2

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
Conflicts with regular barge traffic	Use of NTCL push-boats and crew facilitates integration		NTCL Captain	8.6.1; 9.2.10.1; 10.3.4
	Communication between Project vessel and ferry captains		NTCL Captain	9.2.10
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	10.3; 11.0; Appendix V

[1] Both ship-based and community-based environmental monitors will be employed.