

IN THE MATTER OF

the Resource Management Act
1991

AND

IN THE MATTER OF

Resource consent applications by
various applicants from the Mid
Rivers New Applicants Group
(MRNAG)

STATEMENT OF EVIDENCE OF LYNN TORGERSON

BACKGROUND AND QUALIFICATIONS

- 1 My name is Lynn Torgerson and I am an Environmental Engineer with Pattle Delamore Partners Ltd. I have a Bachelor of Science in Civil and Environmental Engineering from the University of Wisconsin (Madison), USA (1988). From 1988 to 1998, I worked for the Wisconsin Department of Natural Resources as a Water Regulation Engineer. My duties involved the review, analysis and design of surface water resources projects. In 1999, I was an Investigating Officer for the Canterbury Regional Council. From 1999 to 2005, I was a Hydrology Lecturer for the Natural Resource Engineering Group at Lincoln University. My lecture topics included surface and groundwater behaviour and modelling. I have been employed with Pattle Delamore Partners (PDP) since 2006 working on surface and groundwater-related projects.
- 2 I have been involved in the preparation of numerous resource consent applications and assessment of environmental effects for groundwater and surface water projects in Canterbury.
- 3 The evidence I will present today is within my area of expertise, except where I state that I am relying on information provided by another party. I have not knowingly

omitted facts of information that might alter or detract from the opinions I express. I am familiar with the Code of Conduct for Expert Witnesses and I agree to comply with this code.

SCOPE OF EVIDENCE

- 4 The scope of my evidence includes the evaluation of
 - (a) The existing distribution of nitrate concentration in groundwater in the Lower Waitaki River catchment,
 - (b) The potential effects of the proposed consent applications on nitrate concentration in groundwater, and
 - (c) The future management of nitrate-nitrogen concentrations in groundwater in the Lower Waitaki River catchment.

- 5 My evidence is based on :
 - (a) Groundwater nitrate-nitrogen data collected by Environment Canterbury,
 - (b) Available hydro-geological information for the Lower Waitaki River catchment,
 - (c) Calculations provided by Irricon, GHD and Aqualinc with respect to nitrate impacts to groundwater,
 - (d) Available information on nitrate-nitrogen leaching and nitrate-nitrogen concentrations on groundwater in Canterbury and other similar regions of New Zealand, and
 - (e) Available information, including nitrate-nitrogen leaching models on farm management practices that affect nitrate-nitrogen leaching including irrigation, fertiliser application, stocking and cultivation.

INTRODUCTION

- 6 The Waitaki Catchment Water Allocation Regional Plan (WCWARP) recognises the importance of water quality considerations when allocating water to irrigation. Policy 13 of the WCWARP directs the consent authority to have regard to the extent to which the exercise of the consent may have on the water quality objectives in the Natural Resources Regional Plan.
- 7 In Canterbury, there is concern that increasing land intensification of agricultural lands may result in nitrate-nitrogen contamination of the groundwater. Nitrate-nitrogen in drinking water can pose a health risk to babies and pregnant women. The Ministry of Health (MoH 2005) has set guidelines for drinking water and the maximum acceptable value (MAV) for nitrate ion is 50 mg/L, which is equivalent to 11.3 mg/L nitrate-nitrogen.
- 8 In addition to health concerns, nitrate-nitrogen in groundwater can impact the quality of surface waters. In stream systems which are fed by groundwater, elevated nitrate-nitrogen concentrations can contribute to excessive algae and weed growth in the stream.
- 9 Objective WQL2 of the proposed Natural Resources Regional Plan (PNRRP) aims to provide water quality outcomes for groundwater. Objective WQL2(2)(b)(i) states that in unconfined aquifers, where the water quality is affected by human activities, the maximum concentration for nitrate-nitrogen shall not increase by more than two milligrams per litre above the maximum concentration as reported in 2002. It also goes on to state that the maximum nitrate-nitrogen concentration shall not exceed 11.3 mg/L.
- 10 Objective WQL2(c) states that on land, where the concentration of a contaminant exceeds the naturally occurring background level and this concentration poses an

unacceptable risk to human health or the environment, the land shall be managed in a way that reduces this risk and the risk from any discharge from the land to groundwater.

- 11 My evidence covers the impact of the proposed increased irrigation from the Middle River New Applicants Group (MRNAG) with respect to nitrate-nitrogen levels in the groundwater. Figure 1 shows the location of the proposed irrigation areas referred to in my evidence.

HYDROGEOLOGICAL SETTING

- 12 The geology of the Lower Waitaki river area is comprised of three main units of permeable strata where groundwater contributing to the Waitaki River flow. They are post-glacial deposits that occur in the lower surfaces in the centre of the valley, older Pleistocene gravels which occur on the elevated terrace surfaces above the Waitaki River floodplain and smaller and localised post-glacial alluvial fan deposits associated with each of the tributary streams that enter the Waitaki River from the north and south. These gravels overlay older, less permeable strata.
- 13 A report prepared for the Ministry of the Environment (SKM 2004) has described the thickness and lateral extent of the gravels in the valley. The variability in thickness and lateral extent of these gravels has a significant influence on groundwater gains and losses in the Lower Waitaki Valley. In general where the Post-Glacial alluvial gravels widen or thicken the river loses flow to groundwater and where these gravels become narrower or thinner the river gains flow from the groundwater.
- 14 The SKM report finds that the Waitaki River loses flow to the groundwater in the vicinity of Kurow and in the reach between Station Peak and Wainui Station. Between Wainui Station and Black Point the river gains flow from the groundwater due to the narrowing and reducing thickness of the permeable

Post-Glacial gravels. A few kilometres downstream of Black Point, the gravels widen and the river has a small loss of flow to the groundwater in this section of the river.

- 15 The SKM report looked at available groundwater information in the Waitaki Catchment and made some conclusions about the groundwater environment.
- 16 Most wells are located near the river and the plains areas itself and the well depths range from 1 m to 80 m. The piezometric contours indicate that the general direction of groundwater flow is parallel to the Waitaki River on the north side of the river, however it should be noted that there is some groundwater flow away from the river above Wainui Homestead and toward the river downstream of Wainui Homestead. On the south side of the Waitaki River, the piezometric contours indicate that the groundwater flow is toward the Waitaki River. Hydraulic conductivity in the lower Waitaki catchment ranges from 43 to 86 m/day in the Pleistocene gravels and 604 to 1,730 m/day for the postglacial gravels. The aquifer itself is recharged primarily by rainfall at a rate of about 540 mm per year. Storativity within the catchment is estimated to be about 0.2. The estimated average saturated thickness is about 10 m.

EXISTING NITRATE-NITROGEN CONCENTRATIONS IN GROUNDWATER

- 17 In 2002, Environment Canterbury published a report which reviewed nitrate-nitrogen data from over 2,300 wells in Canterbury (Hanson 2002). The purpose of the report was to provide a baseline understanding of the range of nitrate-nitrogen concentrations in the groundwater and to determine if there are any trends or patterns with the data. The report looked at data across Canterbury from as early as 1954 to the end of 2001, however the extent of the dataset varies with catchment. Nitrate-nitrogen data for the Lower Waitaki River

catchment area occurred more recently, with the most of the first measurements recorded after 1996.

- 18 The report found that nitrate-nitrogen concentration were low along the alluvial plain north of the Waitaki River. This was consistent with a large component of groundwater recharge coming from the river (essentially having a dilution effect). The median nitrate-nitrogen concentration for the area was generally in the range of about 1 – 3 mg/L.
- 19 The report comments that many of the median concentrations of nitrate-nitrogen in the alluvial plain north of the Waitaki River are on the order of 1 – 3 mg/L rather than less than 1 mg/L probably due to the heavy border strip irrigation that occurs in the area. It should be noted that the applications as presented will be using spray irrigation, rather than border strip irrigation, which uses less water.
- 20 With respect to trends the report found that along the lower Waitaki River, most wells did not show any discernable trend, although three wells near the mouth of the River showed an increasing trend.

EFFECTS OF PROPOSED IRRIGATION CONSENTS

- 21 The development of irrigation creates increased drainage of water and nutrients through the soil profile into the underlying groundwater. Depending on the types of land use, increased drainage can degrade water quality with respect to nitrate-nitrogen. This degradation of water quality may have adverse effects on other groundwater users and as a consequence of groundwater contamination, on surface water resources.

Effects of Individual Farms on Groundwater Nitrate-Nitrogen Concentrations

- 22 I have been provided with the results of mass balance analyses of individual farms for most of the farms in the

MRNAG. These analyses have been prepared by other consultants and they have stated that they have considered changes in land use as well as the change in irrigation conditions. I have not verified the work, but accept the conclusions generated from the results as part of the assessment of effects to groundwater.

- 23 In several instances (Westmere Estates, Cameron) no analysis was completed as the application was for a consent replacement with no significant change in land use, and therefore there it is inferred that there is no increase in the nitrate-nitrogen concentration to groundwater as a result of the consent. Further there was a consent (Chalmers) which was changing to spray irrigation and would be contributing less to the drainage, so no analysis was completed for this property either. Finally, given the small irrigated area of Waitaki Orchards and Miekle, no analyses were completed for these consents.
- 24 Based on this information provided by Irricon, GHD and Aqualinc, I found that for most of the MRNAG properties the concentrations of nitrate-nitrogen in the groundwater increased under the proposed irrigation scenario. Background nitrate-nitrogen concentrations were based on information from off-site bores, and varied for each property. Using the background concentrations, the predicted groundwater nitrate-nitrogen concentrations as a result of irrigation ranged from 0.24 mg/L to 3.89 mg/L. The increase in groundwater nitrate-nitrogen concentrations ranged from 0.04 mg/L to 1.9 mg/L.
- 25 In general the predicted increases in the groundwater nitrate-nitrogen concentrations are small, with no properties having an increase in the groundwater water nitrogen concentration of more than 2.0 mg/L. It should also be noted that none of the predicted concentrations exceeded the MAV of 11.3 mg/L.

- 26 The results from this modelling should be seen as indicative rather than absolute. While an effort has been made to ensure that the inputs to the models reflect the actual conditions, numerous assumptions have had to be made, especially with respect to the aquifer properties.
- 27 In this light, it is recommended that improved land management practices be employed which would reduce nutrient entry into the groundwater.

Cumulative Effects on Groundwater Nitrate-Nitrogen Concentrations

- 28 I have considered the possible cumulative effects of the proposed irrigation consents on groundwater nitrate-nitrogen. While there are areas that may experience an increase in the nitrate-nitrogen in the groundwater as a result of the increased irrigation, these areas can be mitigated using specific on-farm management practices to reduce the amount of nitrate-nitrogen in the leachate. Specific measures are discussed later in my evidence.
- 29 Based on the modelling and the mitigation measures proposed, I conclude that overall it is unlikely that the groundwater nitrate-nitrogen will increase significantly across the Lower Waitaki River catchment.

Impact of Groundwater Nitrate-Nitrogen Concentrations on the Lower Waitaki River Water Quality

- 30 Groundwater often provides a significant portion of flow for surface water. In the Lower Waitaki River, there are both gaining and losing reaches. Where groundwater provides flow for the river, there is the potential for the surface water quality to be affected as a result of the groundwater contribution.

- 31 In the gaining reaches of the Lower Waitaki River, primarily from Wainui Station to Black Point, groundwater flow contributes to the flow of the river. There is also general seepage from the terraces bordering the valley. The interchange between the groundwater and surface water will be of most significance when the river flows are low.
- 32 In the losing reaches of the Lower Waitaki River, where the surface flows is lost to groundwater, the surface water will essentially have a dilution effect on the groundwater nitrate-nitrogen concentrations.
- 33 As part of the Northbank Tunnel Concept and Project Aqua assessments. A Waitaki River water balance model was constructed to determine the contributions of the groundwater in the Lower Waitaki River downstream of the Waitaki Dam. The model approach and findings was peer reviewed by PDP. The review (PDP 2008) found that the losses to or gains from groundwater are relatively small, in the order of -2 to +2 m³/s.
- 34 A simple relationship can be set up which considers the effect of groundwater nitrate-nitrogen concentration on the river when the groundwater and river water are completely mixed. Under low flow conditions, say around 30 m³/s as occurred historically during 1964, and using the highest background nitrate-nitrogen concentration in the Lower Waitaki River as reported at surface water quality monitoring station SQ20505 in 2002, the concentration of the river water once mixed can be estimated. Based on the highest groundwater concentration and flow expected and the lowest historic river flows, the expected nitrate-nitrogen concentration in the river would be on the order of 0.4 mg/L.
- 35 This scenario used historic low flows, rather than more typical flows. For higher river flows, it would be expected that the effect of groundwater nitrate-nitrogen would be further reduce. For a minimum flow of 100 m³/s with all other components the same, the expected nitrate-nitrogen

concentration in the river water would be more on the order of 0.11 mg/L.

- 36 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) provide trigger values for the protection of riverine eco-systems. The trigger values for the protection of 95 % freshwater species suggest that nitrate-nitrogen concentration in rivers should be 7.2 mg/L. Looking at the worse-case scenario presented above (ie historic low river flows, highest nitrate-nitrogen concentration, the concentration of nitrate-nitrogen after mixing with groundwater is less than the trigger value. Therefore, I conclude that while nitrate-nitrogen in groundwater may be mixed with the surface water, the effect is insignificantly small compared to concentrations which affect freshwater species.
- 37 The New Zealand Periphyton Guidelines (MfE 2000) define thresholds for conditions that may promote excessive periphyton growth in an effort to ensure that these values in rivers and stream are protected. Total nitrogen concentrations of greater than 0.5 mg/L are considered to promote the growth of periphyton (Harding 2004). If it is assumed that Total nitrogen is comprised of only nitrate-nitrogen species, and, comparing to the worse case scenario presented above, it can be seen that the contribution of groundwater will not result in the surface water exceeding this trigger concentration. Therefore, I conclude that nitrate-nitrogen in groundwater from the proposed irrigation is unlikely to promote periphyton growth in the Lower Waitaki River, and the effect to surface water from the groundwater is no more than minor.

MANAGEMENT OF NITRATE AND WATER ON THE FARM

- 38 The use of irrigation provides the potential for more intensive land use than if the land was not irrigated. This includes carrying more stock on the land for longer periods than previously. A consequence of this would be an increase in

the nitrogen returned to the land in dung, urine and fertiliser. The additional water from irrigation provides a means of more easily mobilising the nitrates so that more reach groundwater. Balancing this to some extent is the dilution afforded to the nitrogen by the additional drainage water. However, one means of ensuring that the amount of nitrate-nitrogen leached to the groundwater is minimised is through the proper management of nitrate-nitrogen on the farm.

- 39 Farm management practices can be used to reduce potential nitrate-nitrogen leaching and minimise the impacts of irrigation on the groundwater quality. A farm management programme (FMP) can be developed to manage the nitrate-nitrogen on farm in effort to reduce nitrogen losses to groundwater. Each farm should have its own FMP which considers the specific farm site and receiving environment.
- 40 A FMP identifies key sources of nitrate-nitrogen, and then develops practices in which to reduce or mitigate the loss of nitrate-nitrogen. An auditing regime should be put in place to ensure that the recommended practices are occurring are effective. Strategies should also be incorporated in an FMP to address any deficiencies found during the auditing process. Finally, provisions should be made to periodically update the FMP with respect to changes in farm status or improving technology.
- 41 An individual FMP prepared for the MRNAG farms should include specific practices to reduce the potential impact to groundwater water.
- 42 One component in a FMP would include the consideration of timing and rate of irrigation application. Soil properties should be considered when planning the rates of irrigation. In addition, the timing and rate of irrigation should be compatible with the soil moisture levels, so that the irrigation does not cause surface runoff or raise the water table too near the surface. The timing of the irrigation should be considered

with respect to any proposed fertiliser application, which leads to the next component in the FMP.

- 43 Appropriate timing and rate of nitrogen fertiliser applications can be used to effectively manage nitrogen losses from the pasture. Application of nitrogen fertiliser should not occur when the water table is high (no closer than 2 m below ground level) or when heavy rainfall is expected. Application of nitrogen fertiliser should occur when grass growth is active, and ideally in split dressings to give plants more opportunity to use what is applied.
- 44 Nitrogen fertilisers should only be applied in quantities necessary to support the plants' needs. A nitrogen budget should be created to consider the likely available on-pasture nitrogen, including that derived from livestock, plant fixation and if applicable, any land-based effluent application. Nitrogen fertilisers shall only be applied to meet any nitrogen deficit determined by the budget.
- 45 In summary, a FMP assists the consent holder in effectively reducing the nitrate-nitrogen concentrations that may be leached to groundwater. A successful FMP includes monitoring which can determine the efficacy of the practices, and allows the FMP to be modified to address any deficiencies in the practices.
- 46 In addition to the FMP, where tributaries to the Waitaki River cross irrigated areas, it is further recommended that the consent holders establish a riparian margin adjacent to the tributaries. Well vegetated riparian margins can intercept a significant amount of nutrients in shallow groundwater before it reaches a waterway. It is recommended that a margin of at least 12 m be established to ensure that the margin is effective.

PROPOSED CONSENT CONDITIONS

- 47 A consent condition to manage nitrate-nitrogen has been offered by the majority of the applicants within MRNAG. This condition has been included in the evidence of Mrs Johnston, Ms Anthony and Mr McIndoe. I have reviewed the wording of the condition and find that the condition is appropriate for ensuring that on-farm nitrate management practices are effective.
- 48 I would like to note that two applicants, Miekle and Waitaki Orchards, do not offer this condition as the irrigated areas are very small and the impact to water quality as a result of their consents is not considered to be an issue.
- 49 Furthermore, the MRNAG applicants have also offered a Farm Management Programme condition. I find that the condition as worded addresses the components necessary to ensure that nitrate loss to ground from on-farm practices is mitigated so that the effect to groundwater is no more than minor.

CONCLUSIONS

- 50 Increased irrigation in the Lower Waitaki River catchment may cause an increase in nitrate-nitrogen in groundwater, however on-farm mitigation measures can be used to reduce the nitrate losses to groundwater, and thereby ensure that the effect to the groundwater from the additional irrigation is no more than minor.

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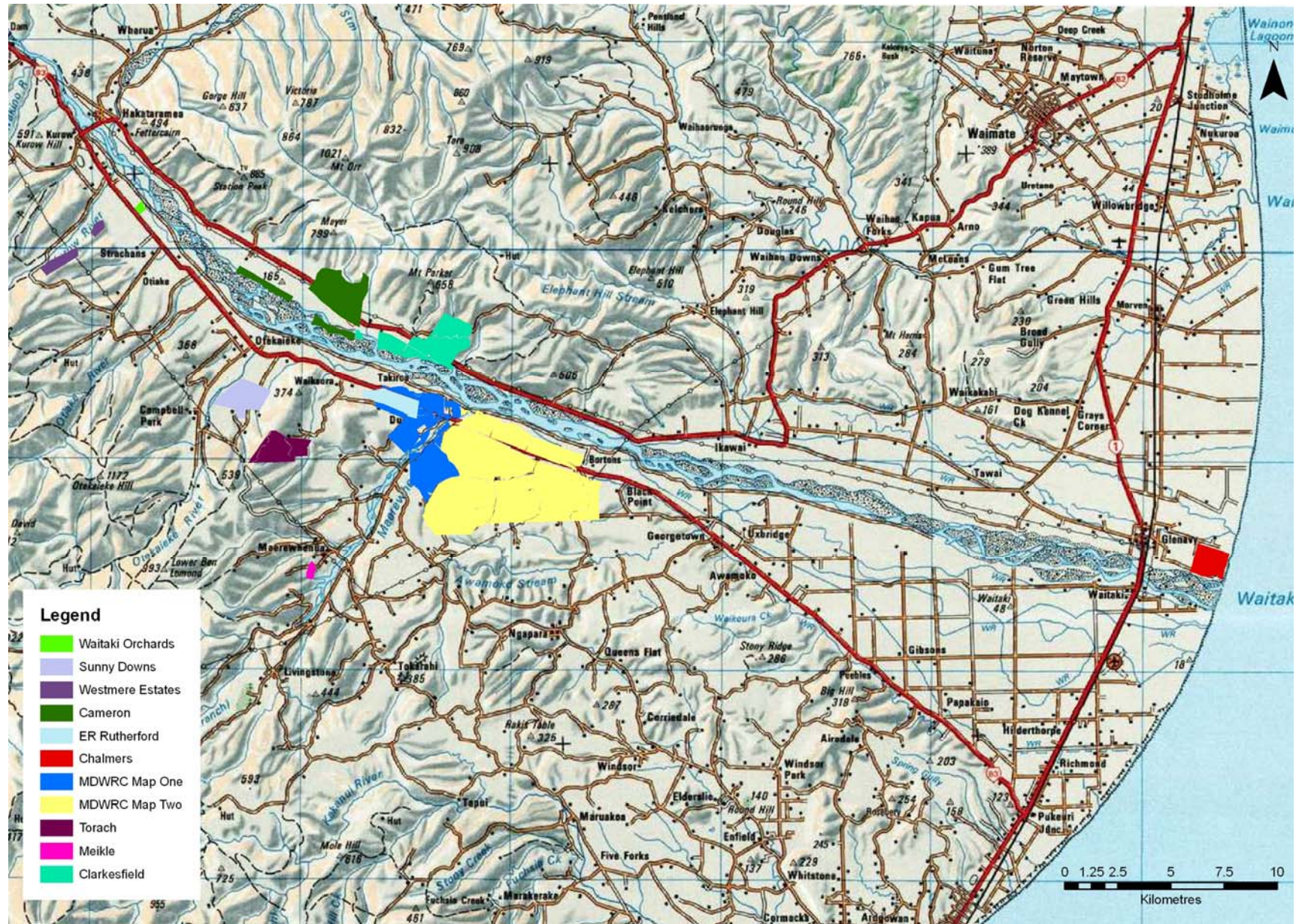


Figure 1: Mid River New Applicants Group