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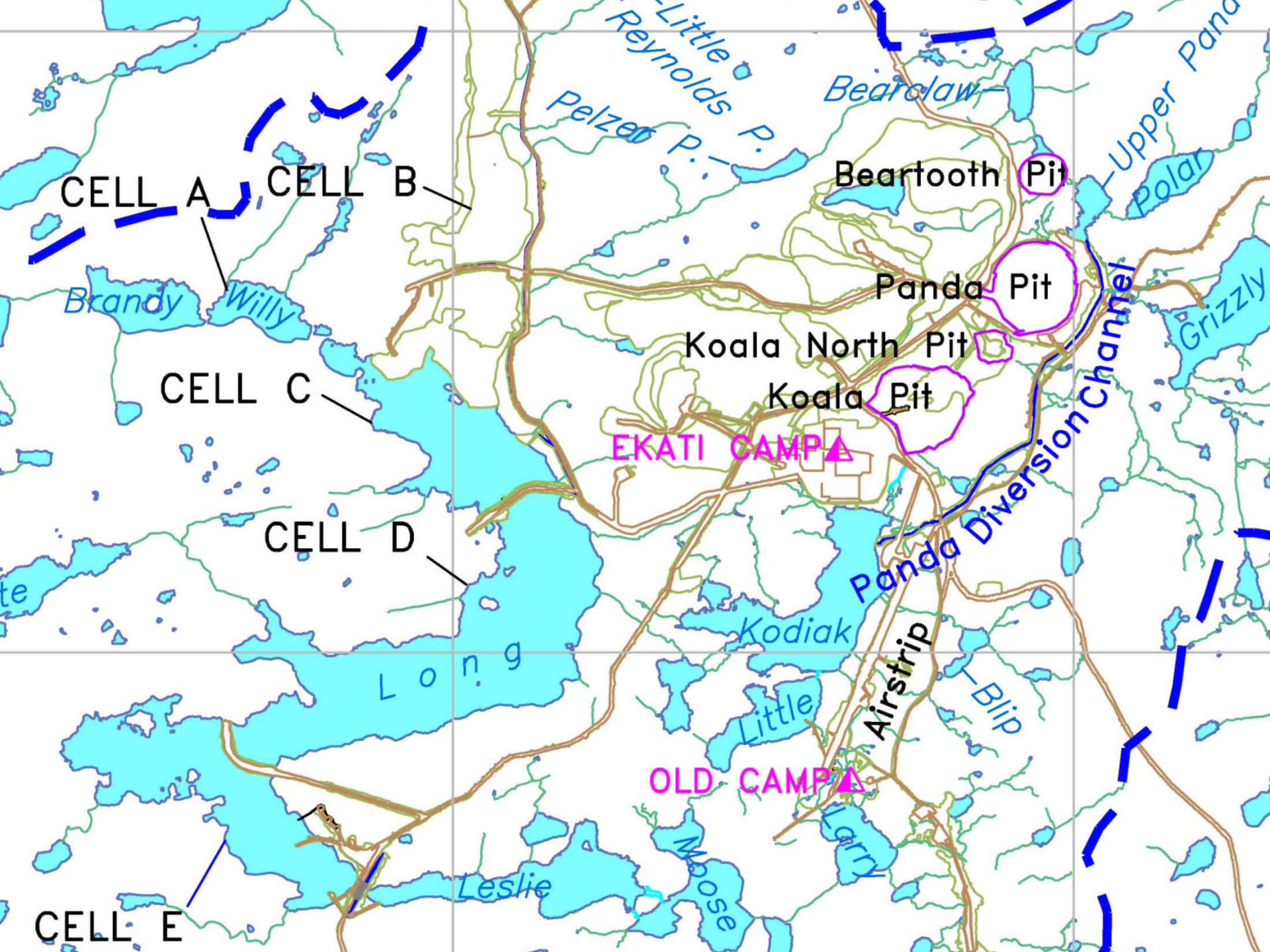
Studies in Long Lake - 2003

Review of Ekati's Environmental Monitoring And Management Programs Workshop
March 16th and 17th, 2004

Studies Include…

1. Update on water quality and ecology in Long Lake
2. Fish Survey in Cell E
3. Predictions of Water Quality in Cell E
4. Assessing Risk of Discharging Fox minewater into Cell D instead of Cell C


CELL A
CELL B
CELL C
CELL D
CELL E
Brandy
Willy
Little Reynolds P.
Pelzer P.
Beardaw
Upper Panda
Polar
Grizzly
Beartooth Pit
Panda Pit
Koala North Pit
Koala Pit
EKATI CAMP
Panda Diversion Channel
Kodiak
Airstrip
Blip
Long
Little
OLD CAMP
Larry
Moose
Leslie

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Study #1

Update on water quality and ecology in Long Lake

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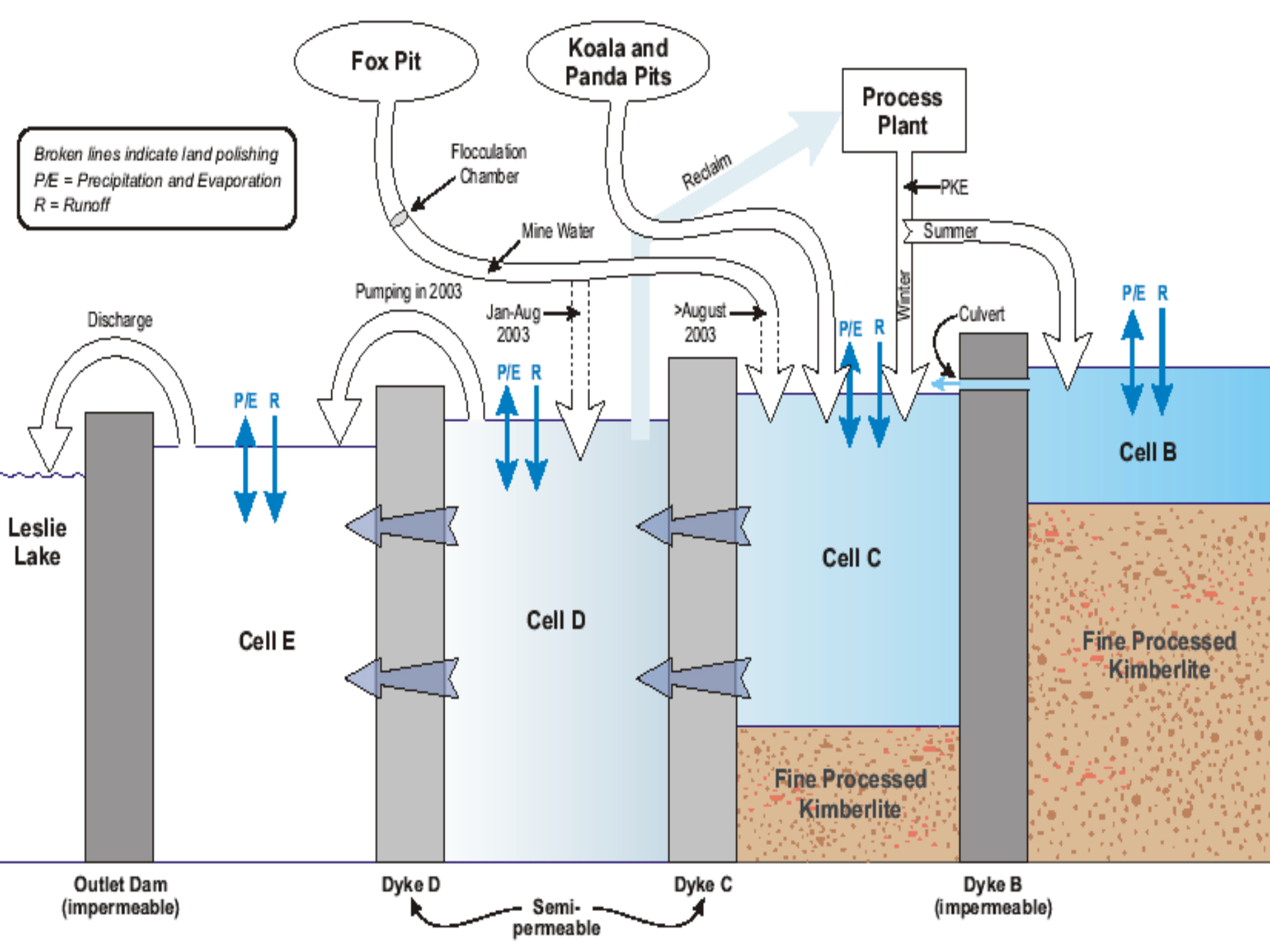
Purpose of Study

To update water quality and biological data for Long Lake

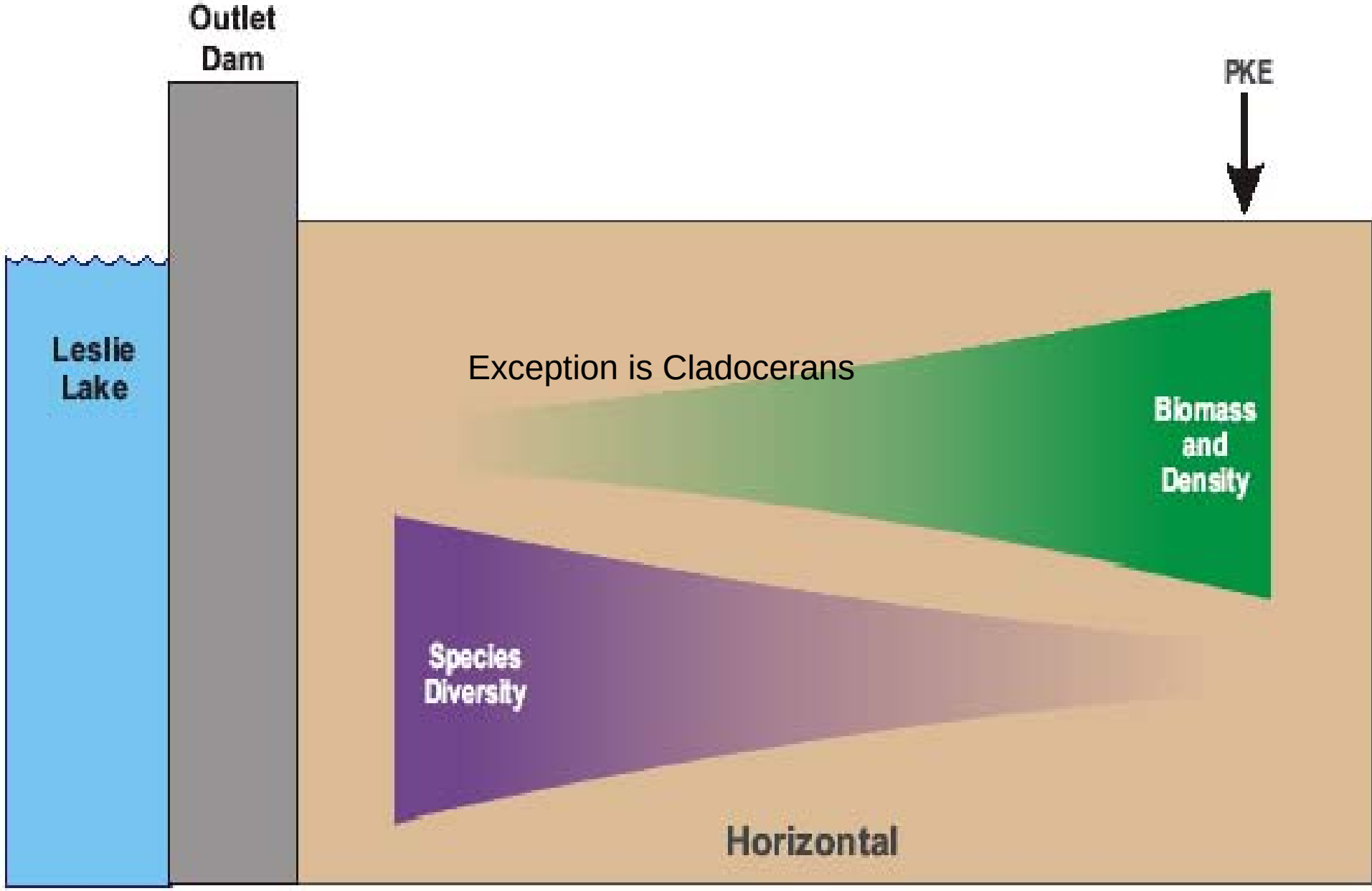
Study Approach

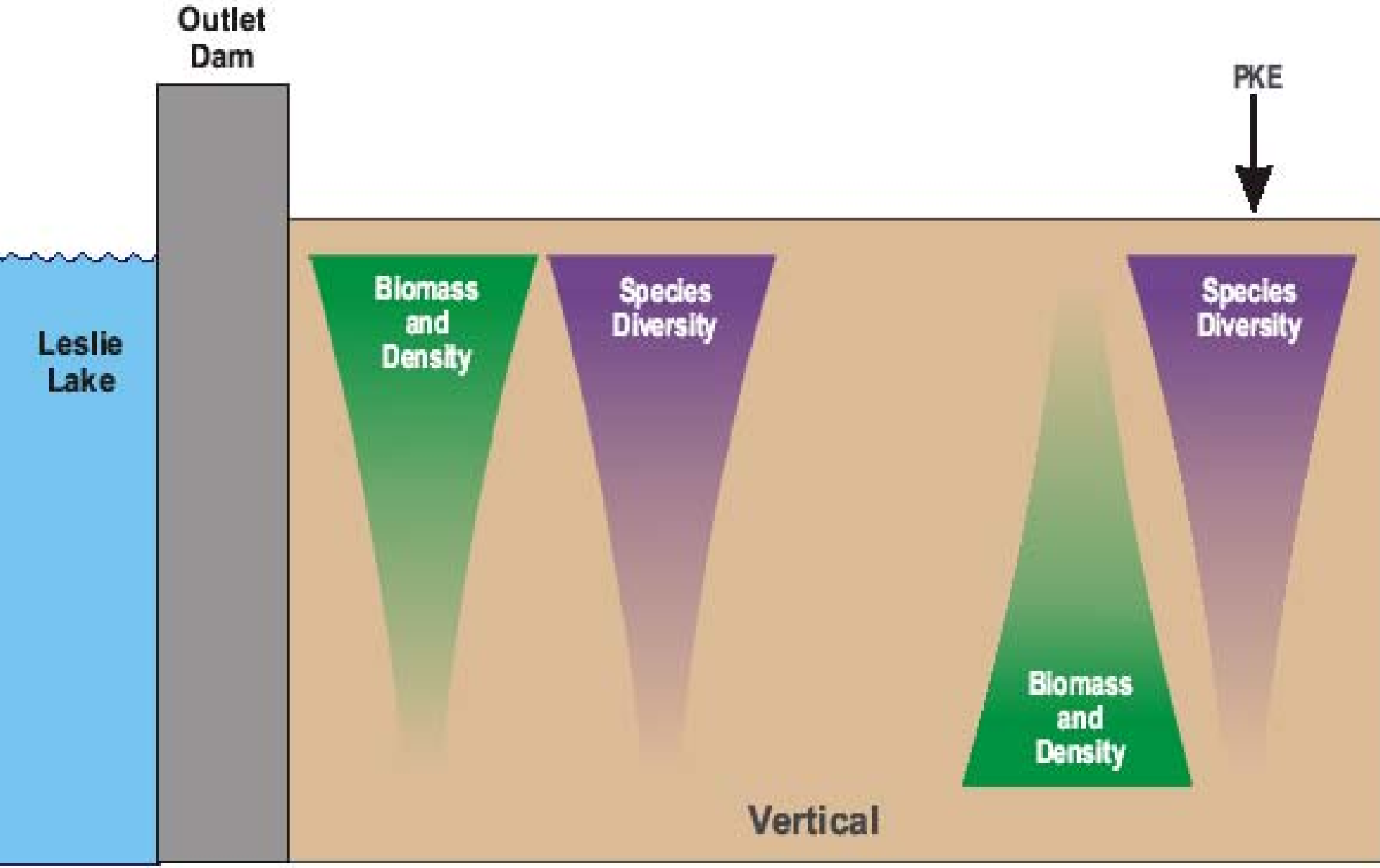
- Sample shallow and deep water in cells C, D, and E during open water
- Use AEMP sample methods
- Sample water quality for both dissolved and total metals to determine what proportion could be trapped by dyke filters
- Use above data to develop understanding of how water quality and aquatic life changes from cell to cell, and from shallow to deep water.
- Use this information to guide Fox risk assessment


Fox Pit
Koala and Panda Pits
Process Plant
Broken lines indicate land polishing
P/E = Precipitation and Evaporation
R = Runoff
Flocculation Chamber
Reclaim
PKE
Summer
Winter
Mine Water
Pumping in 2003
Jan-Aug 2003
>August 2003
Culvert
Discharge
P/E
R
Cell B
Leslie Lake
Cell E
Cell D
Cell C
Fine Processed Kimberlite
Fine Processed Kimberlite
Outlet Dam (impermeable)
Dyke D
Dyke C
Semi-permeable
Dyke B (impermeable)

Results - Water

- 19 water quality variables decreased significantly from upper end to cell E
- Generally concentrations in variables increased with depth


Outlet
Dam
PKE
Leslie
Lake
Exception is Cladocerans
Biomass
and
Density
Species
Diversity
Horizontal


Outlet
Dam
PKE
Leslie
Lake
Biomass
and
Density
Species
Diversity
Species
Diversity
Biomass
and
Density
Vertical

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Study #2

Survey of Fish Populations in Cell E

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Purpose of Study

- To describe present fish community in cell E
- To compare this with pre-development situation
- To refine expectations about the kinds of changes that could happen downstream in the future.

Background

2002 AEMP study of 3 downstream lakes (Moose, Nema, Slipper) found

“no significant alterations in the relative abundance and biological characteristics of lake trout and round whitefish that could be linked to mine development.”

Approach

- Caught fish in cell E and measured 22 characteristics
- Compared measurements to data from 1994 baseline and 1997 fish-out study
- Used AEMP control lakes for reference where no baseline data available for Long Lake

Results

- 7 of 22 variables showed significant change
- General finding - “little evidence to indicate that changes in water quality affected fish health and population status”
- Uncertainty of findings is “high” because of low fishing effort and sample size of the 2003 survey

Significant Changes

- Only lake trout & round whitefish caught; no burbot or grayling
- Average catch-per-unit-effort of roundfish was twice as great as 1994, and 3 to 10 times greater than in 1997. BHPB calls this “unambiguously positive”
- Average lengths of both species increased
- Age frequency distributions were narrower; “weak” recruitment of juveniles

BHPB's Explanation for "Weak Recruitment"

- "primary effect" of converting Long Lake to tailings facility was the loss of spawning habitat leading to reduced recruitment of juveniles

- Additionally, annual lowering of water level in late summer may further reduce amount of spawning habitat

IEMA Concerns

- Sampling effort in 2003 was greatly reduced from 1994 and 1997; uncertainty increased about results

	1994	1997	2003
Total hours of fishing	126	7809	17
Total fish captured	236	3702	46
Average CPUE for all fish	25	9	49

Increase in CPUE?

CPUE results not “unabiguously positive”, for at least 2 reasons:

1. 2 different mesh sizes used in 1994
2. 1997 data are from “fish-out” program

IEMA's Concerns cont'd

- Recruitment is not just "weak" but is non-existent. Data show fish are not reproducing
- 2 additional causes are possible:
  - Sedimentation from construction has reduced egg-to-fry survival
  - Some characteristic in water is causing large mortalities to early life stages of fish (eg. nitrates?)
- Report provides no information on early life stages, which would be expected to be more sensitive to water quality changes

IEMA's Recommendations

- Experimental studies should be done to determine whether cell E water is having toxic effects on developing young
- Survey fish populations in Leslie Lake to determine if they are successfully reproducing.
- If CPUE data are to be used, then use only data for smaller mesh size, restrict 1997 data to first few days of fishing before population size was depressed, and use only data from cell E portion of Long Lake.

Study #3
Predictions of Long Lake Water Quality

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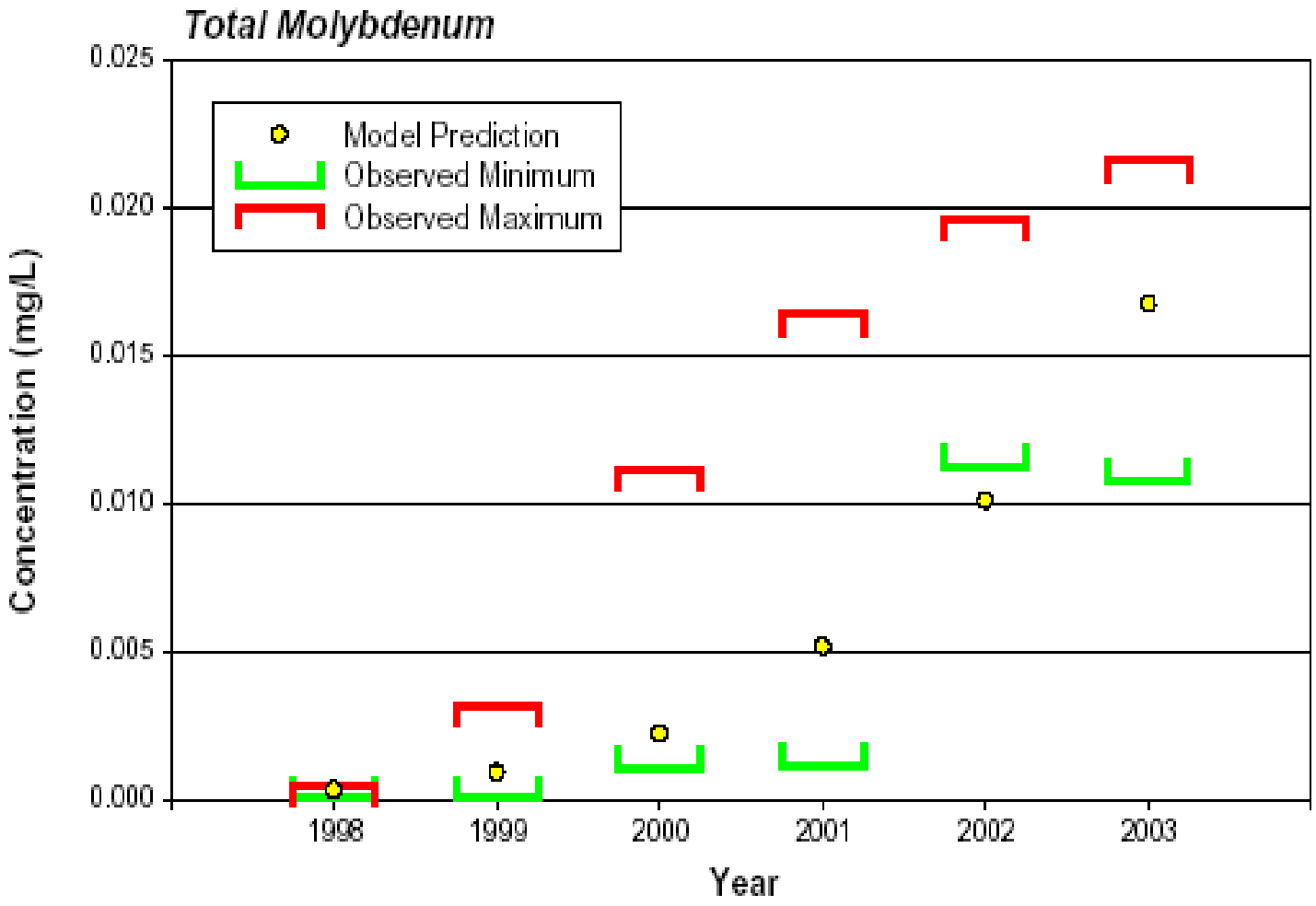
Purpose of Study

- To update water quality prediction model for LLCF discharge
- Update required because of change in mine plan & proposed water mgt alternatives
- Updated model used for Fox Risk Assessment

2 Scenarios Modeled

- Scenario 1 – current mine plan with treated mine water from Panda, Koala, Fox, Beartooth and Pigeon reporting to cell C
- Scenario 2 – as above except Fox mine water reporting to cell D

MOLYBDENUM, 1998 - 2003



Results

- Model results compared closely to actual measured SNP data 1998-2003
- Model results for non-SNP parameters was less reliable
- Future predictions for LLCF discharge were slightly higher for Scenario 2 than Scenario 1
- All predicted maximums for regulated parameters were “well below” licence limits

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Study #4
Fox Mine Water Risk Assessment

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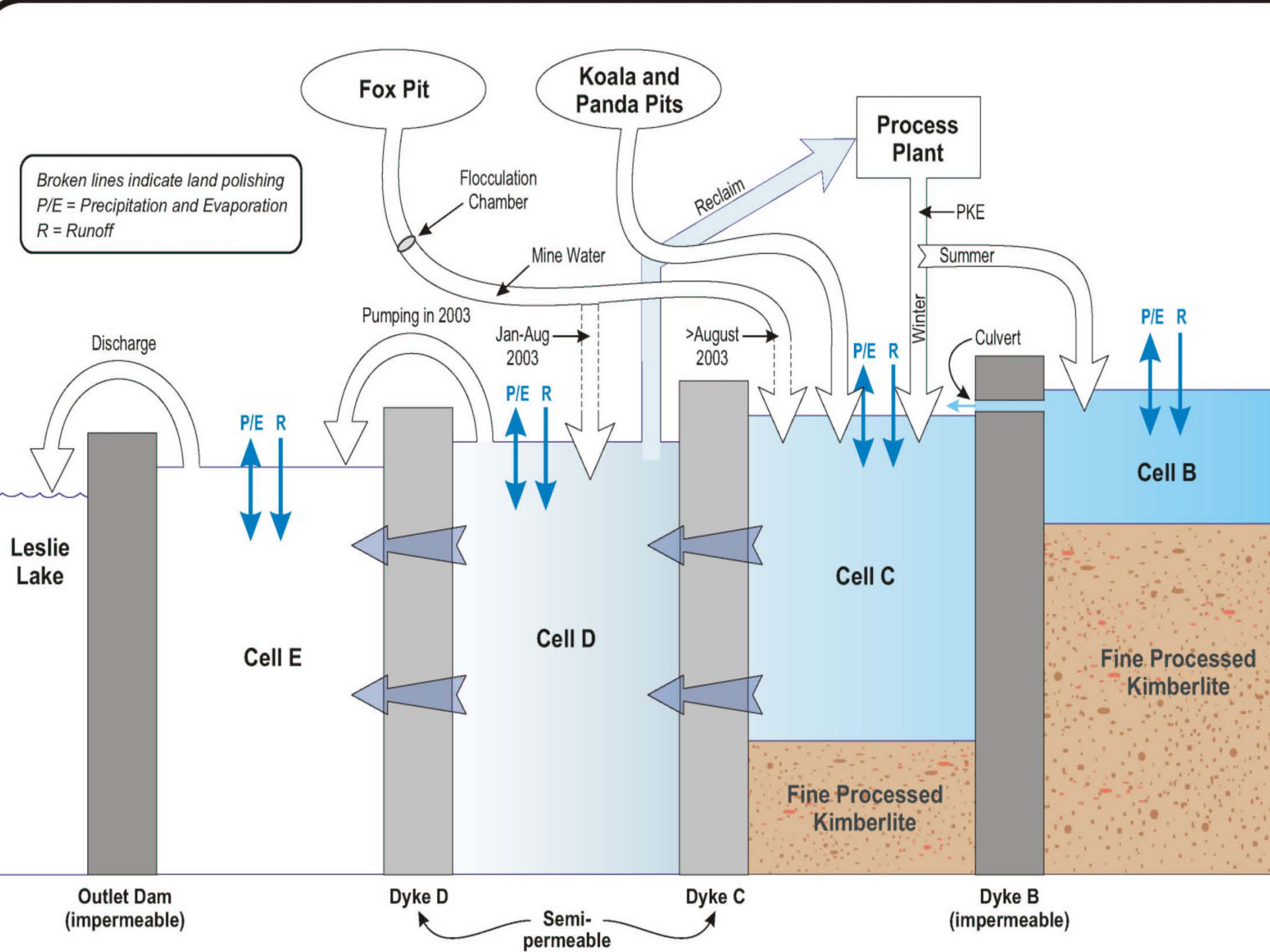
Purpose of Study

- To determine whether there would be a significant difference to cell E water quality if Fox pit water is discharged into cell D instead of cell C.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Outlet Dam (impermeable)
Dyke D
Dyke C
Dyke B (impermeable)
Semi-permeable

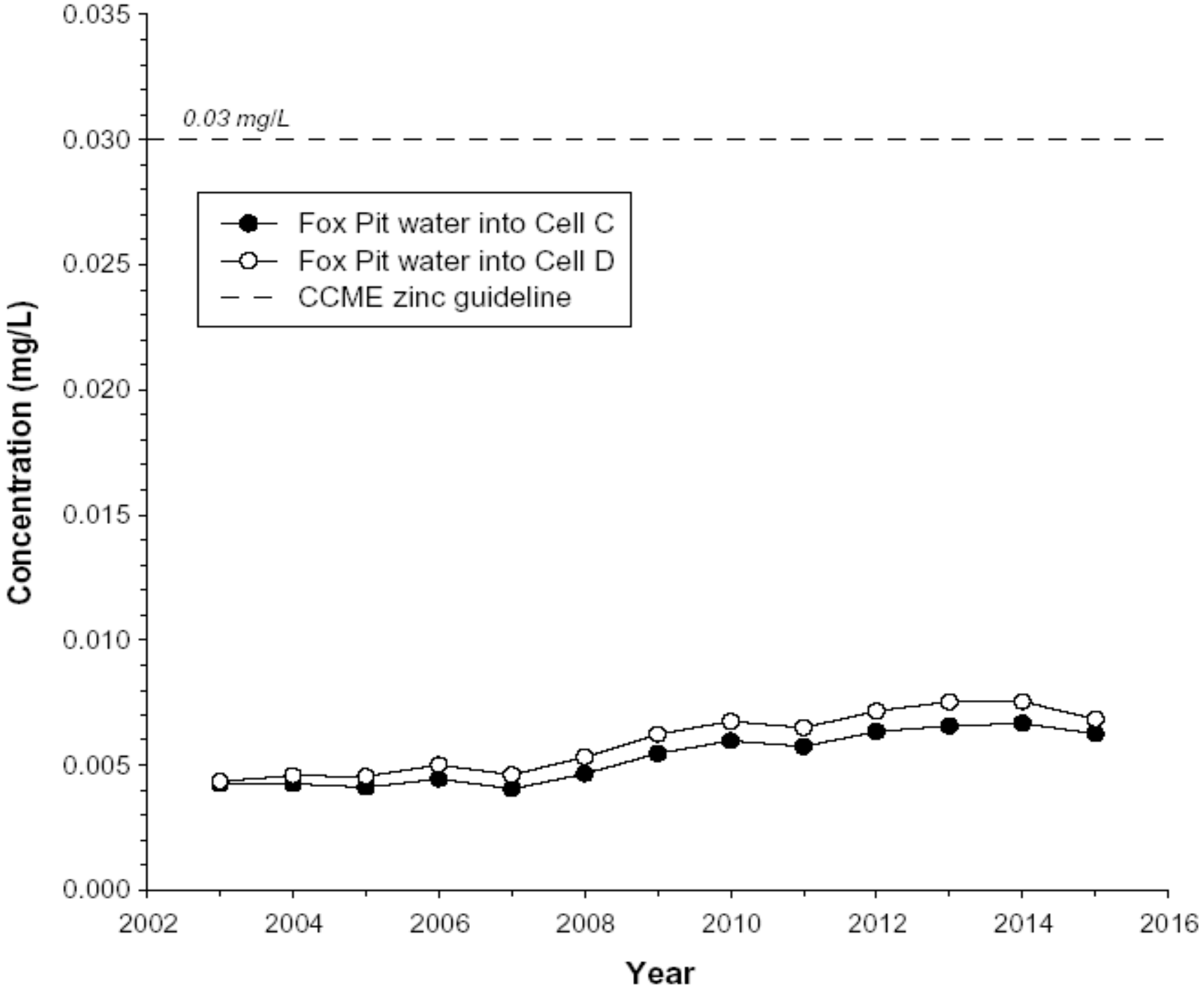
Assessment based on..

- Both
  - Water licence effluent limits
  - CCME guidelines

- Cell E water quality would have to meet or exceed both of the above (conservative approach)

26 Measured Variables

- Nutrients (nitrogen and phosphorus compounds)
- Total metals
- Mixed variables: alkalinity, hardness, major ions, dissolved solids, conductivity
- 5 of the above are controlled by water licence (ammonia, aluminum, arsenic, copper, nickel)
- 11 have CCME guidelines (ammonia, nitrate, nitrite, aluminum, arsenic, cadmium, chromium, copper, molybdenum, nickel, zinc)

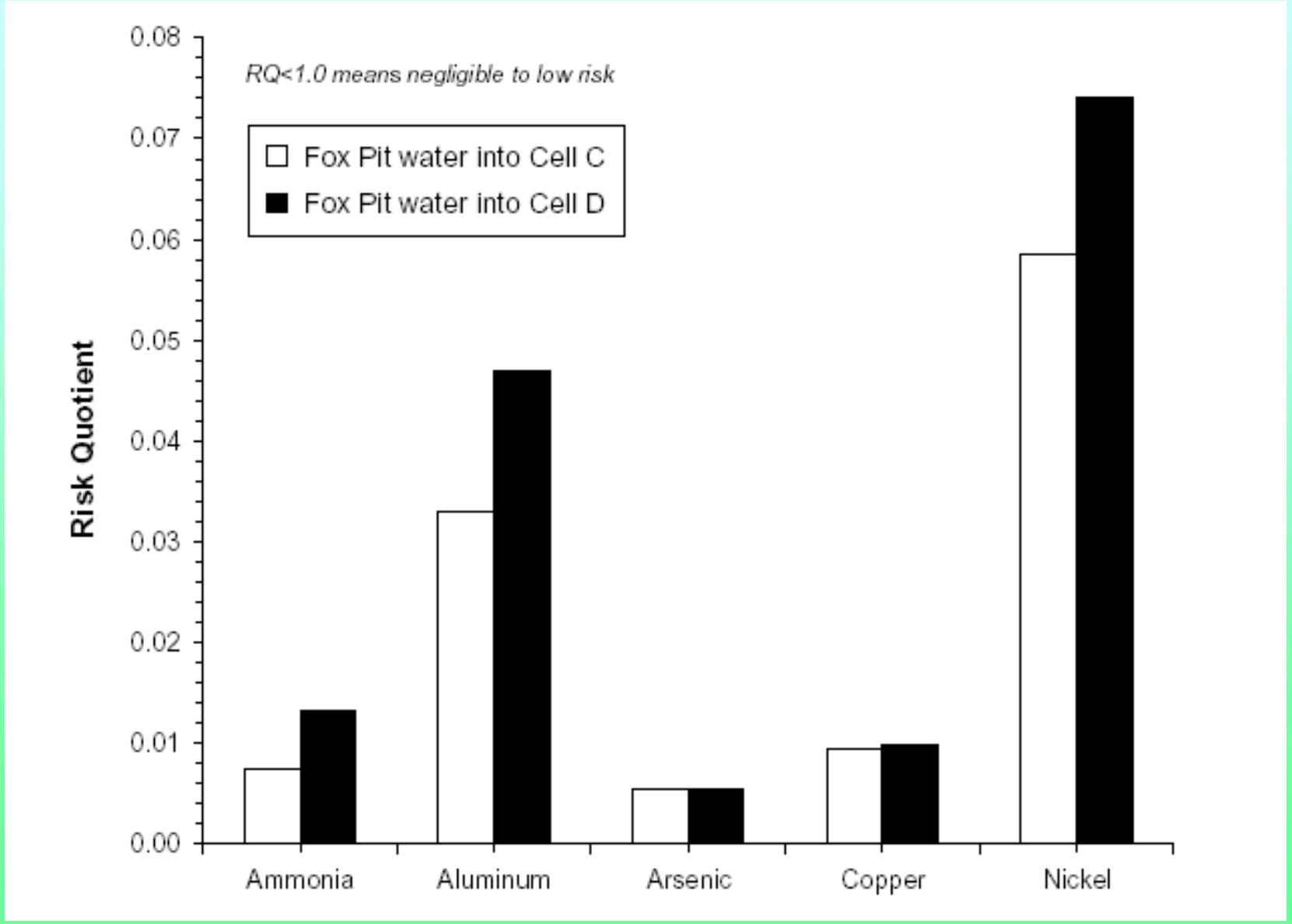

0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.03 mg/L
Fox Pit water into Cell C
Fox Pit water into Cell D
CCME zinc guideline
Concentration (mg/L)
2002
2004
2006
2008
2010
2012
2014
2016
Year

How BHPB Rated the Risk

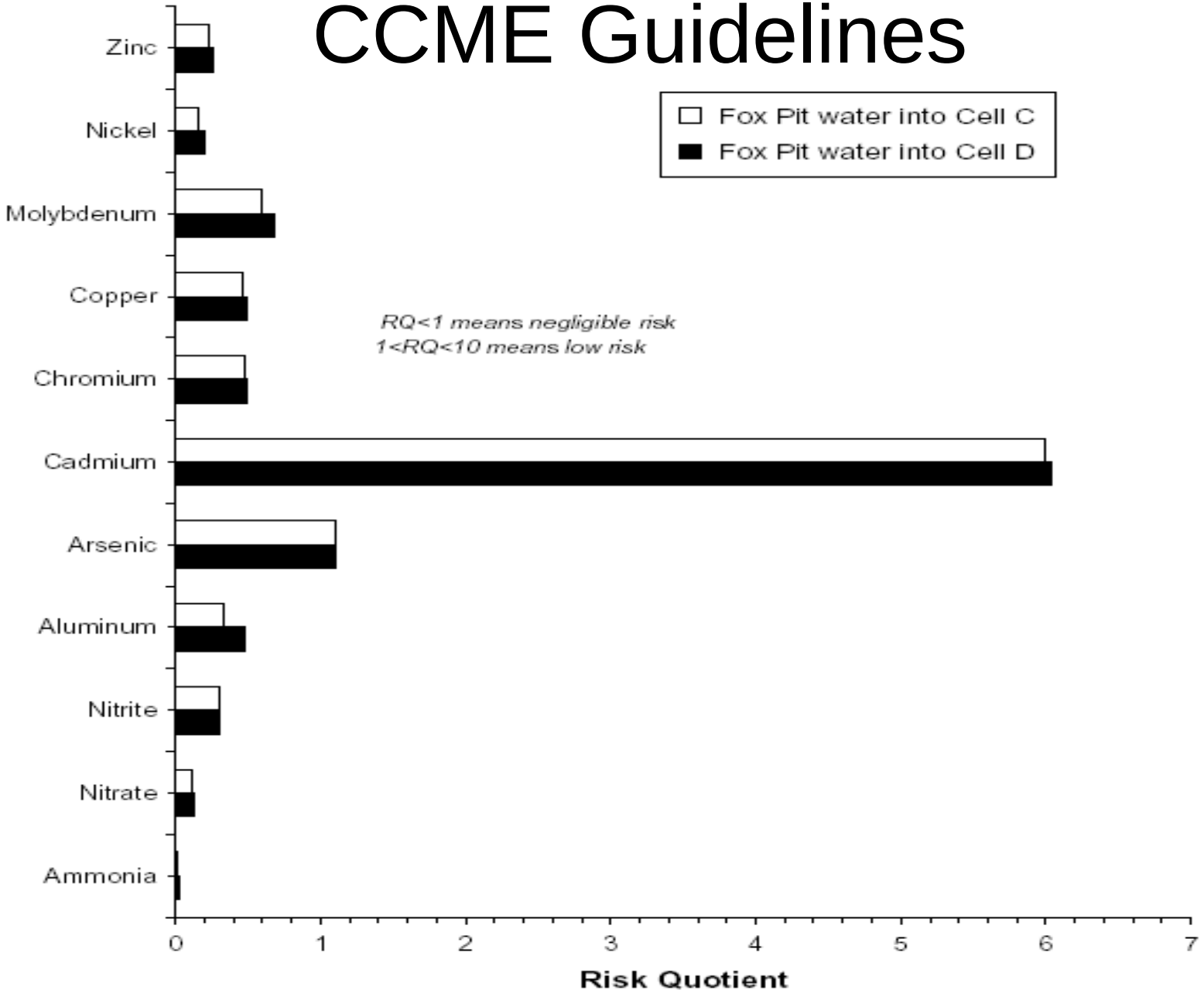
- Risk described as ratio of predicted concentration in cell E to the licence limit or the CCME guidelines
- For water licence – two ratings:
  - *Negligible to Low* (ratio less than or equal to 1.0)
  - *Moderate to High* (ration greater than 1.0)

- For CCME – 4 ratings:
  - *Negligible* (ratio less than or equal to 1.0)
  - *Low* (ratio between 1 and 10)
  - *Moderate* (ratio between 10 and 100)
  - *High* (ratio greater than 100)

Results for Water Licence Variables



CCME Guidelines



BHPB's Conclusion

- Overall conclusion: Some variables met CCME guidelines while others exceeded them by amounts that were less than the 10-fold safety factor typically used to set the guidelines.

- Given dilution downstream in Koala drainage, all concentrations are "unlikely to produce significant downstream ecological changes regardless of whether Fox pit water is discharged into cell C or D.

IEMA's Conclusions

- Cell D is OK for discharging Fox minewater without significant risk to environment
- Suspended solids were not modeled, so don't know what the study means for these (and this may be important)
- Continued surveillance is recommended for the two substances (arsenic and cadmium) which show predicted concentrations greater than CCME guidelines