Government of the Northwest Territories

Technical Report for the Dominion Diamond Ekati Corporation

Jay Project

EA1314-01

Appendix

Jay Pipe Technical Report Review

Prepared by

Zajdlik and Associates, Inc.

for

Government of the Northwest Territories

Environment and Natural Resources

Jay Pipe Technical Report Review

Prepared for:

R. Walbourne, P. Green and N. Richea
Government of the Northwest Territories

Under contract SC445915

Prepared by:

Zajdlik & Associates Inc.

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Table 1: Acronym Definitions

Acronym	Definition
DDEC	Dominion Diamonds Ekati Corporation
GNWT	Government of the Northwest Territories
INAC	Indian and Northern Affairs Canada
IR(s)	information request(s)
MVLB	Mackenzie Valley Land and Water Board
TDS	total dissolved solids

1 Introduction

Zajdlik & Associates Inc was retained under contract SC447879 to review "specified sections of the Developers Assessment Report, identify any information or data gaps in the specified sections and develop information requests (IRs) based on the technical information and project description provided, participate in a teleconference, if and when requested, to discuss the IR's and any preliminary responses to IRs, and participate in 2 days of technical sessions for the Jay project in Yellowknife, tentatively scheduled for late February or March 2015".

2 Comment on Second Round of Information Request Responses

Many second round information requests (IRs) were not initiated by Zajdlik & Associates Inc. All second round IR responses were read to varying levels, but the level of comment herein varies as a function of completeness of response, overlaps with areas of competence and/or previous involvement and estimated level of concern given available timelines.

Table 2: Summary of Review Levels of Effort

IR	Topic	Comment
GNWT IR2-02	Project Mine Fleet and Equipment Procurement	Agree with GNWT request, IR response not read.
GNWT IR2-03	Assessment Boundaries	Added extensive discussion of spatial assessment scale for fish and fish habitat. Discussed in section 4. Comment on the water quality section is not provided at this time.
GNWT IR2-04	Effects Level Within Mixing Zones	No comment will be provided.
GNWT IR2-05	Contingencies	No comment will be provided.
GNWT IR2-06	Closure at Misery Pit	No comment will be provided.
GNWT IR2-07	Viability of Minewater Management Plan	Extensive discussion in section 3.
GNWT IR2-08	Stability of Meromixis Post-Closure	Extensive discussion in section 3.
GNWT IR2-09	Hydrogeologic Monitoring During Operations and Post-Closure	No comment will be provided.
GNWT IR2-10	Calibration of the 3-D Hydrogeologic Model	No comment will be provided.
GNWT IR2-11	Sediment and Water Quality	No comment will be provided.
GNWT IR2-12	Hydrocarbon Control	No comment will be provided.
GNWT IR2-13	Mercury	Inputs to Lac du Sauvage are

IR	Topic	Comment
		discussed.
GNWT IR2-14	Jay Pipe Dike Geotechnical Investigations	No comment will be provided.
GNWT IR2-15	Jay Pipe Dike Construction Technique and Turbidity Management	No comment will be provided.
GNWT IR2-16	Turbidity	No comment will be provided.
GNWT IR2-17	Jay Pipe Lake Bottom Sediment Management	No comment will be provided.
GNWT IR2-18	Hydrology Model Reliability	No comment will be provided.
GNWT IR2-19	Waste Incineration	No comment will be provided.

3 Hydrodynamic Modelling

The CE-QUAL W2 model (Cole and Wells, 2011) is used to predict pit stratification over time. The series of meetings, information request responses and dialogue with DDEC and DDEC consultants greatly facilitated the review process and effectively resolved many questions and concerns regarding use of this model and model inputs. However the following issues remain.

3.1 Bathymetry

The post-closure hydrodynamic model bathymetry does not include Lac du Sauvage (Figure 8G2.4-2). As fetch in Lac du Sauvage is much greater than the Jay Pit itself and wind induced mixing is one of the more important drivers of meromixis, the relevant post-closure bathymetry should be used to assess long term meromixis potential.

3.2 Calibration

Cole and Wells (2011) emphasize the requirement for adequate and appropriate calibration. I note that calibration is only approximate as the Jay Pit at least has not been constructed. It is not clear why data from Misery Pit has not been used to calibrate the Misery Pit model especially given the concerns noted by Coles and Wells (2011). Some comments and discrepancies between observed and predicted values for Lac du Sauvage calibration results are highlighted.

- Calibration scenario was Lac du Sauvage under pre-Project conditions which was applied to the future Jay Pit Lake. This is necessary but the implications of doing so are not clear.
- Limited depth data relative to depth of lake (Figure 8G2.3-4).
- Where data are available the calibrated model predicts temperatures at depth that diverge from observed values (Figure 8G2.3-4).
- Lack of calibration data for much of the year (Figure 8G2.3-5).
- Discrepancies between observed and predicted values surface water temperatures (Figure 8G2.3-5).
- Calibration based solely on temperature and not analytes of interest.

It is important to note that I am not an expert in hydrodynamic modelling or calibrating such models and cannot comment on the implications of these issues. Given the importance Coles and Wells (2011) ascribe to calibration and the importance of meromixis to the mine water management plan it is highly recommended that a third party independent expert in hydrodynamic modelling familiar with the CE-QUAL W2 model review the adequacy of the calibration conducted as this speaks directly to the utility of model output.

3.3 Parameterization

The maximum vertical eddy viscosity is set to 0.001 m^2/s which is 3 orders of magnitude lower than the default (1 m^2/s). This was discussed with DDEC in a meeting held July 6th, 2015 at Golder offices in Mississauga Ontario and the question was posed "Can this choice be contextualized using other applications of the same model?" The response was that the parameter was adjusted by calibration to available temperature data (See section 3.2 for a discussion of calibration). Comments in C-35 Appendix (Coles and Wells 2011) seem to indicate that choosing a maximum vertical eddy viscosity other than 1 m^2/s is for backwards compatibility[1].
Again given my inexperience with the CE-QUAL W2 model I recommend that a third party independent review be conducted for the reasons stated in section 3.2.

3.4 Inflows

"Groundwater inflows and losses to or from the pits were determined by the hydrogeological model (Appendix 8A) and were provided as inputs to the hydrodynamic model at several vertical points according to elevation, time-varying volumes, and TDS concentrations throughout the modeled time frame." (DDEC, 2014, Appendix 8G). The following graphic presents these TDS inputs to Jay Pit over time by depth for the environmental assessment scenario (DDEC, 2014, Appendix 8A) as provided to the GNWT. Depths represent distance from the surface in meters calculated using the formula maximum meters above sea level (373m) – midpoint of proposed CE-QUAL W2 layer.

[1] C-35 Appendix: To be backwards compatible with Version 2, set [AZC] to W2, [AZSLC] to EXP, and [AZMAX] to 1.0E-4 even though a value of 1.0E-3 is recommended as a minimum value of the maximum vertical eddy viscosity [AZ]. Note that for all model applications, we recommend using [AZC]=TKE, [AZSLC]=IMP and [AZMAX]= 1 m^2 s-1.

AZMAX = Maximum value for vertical eddy viscosity, m^2 s-1
AZC = Form of vertical turbulence closure algorithm, NICK, PARAB, RNG, W2, W2N, TKE, or TKE1
AZSLC= Specifies either implicit, IMP, or explicit, EXP, treatment of the vertical eddy viscosity in the longitudinal momentum equation

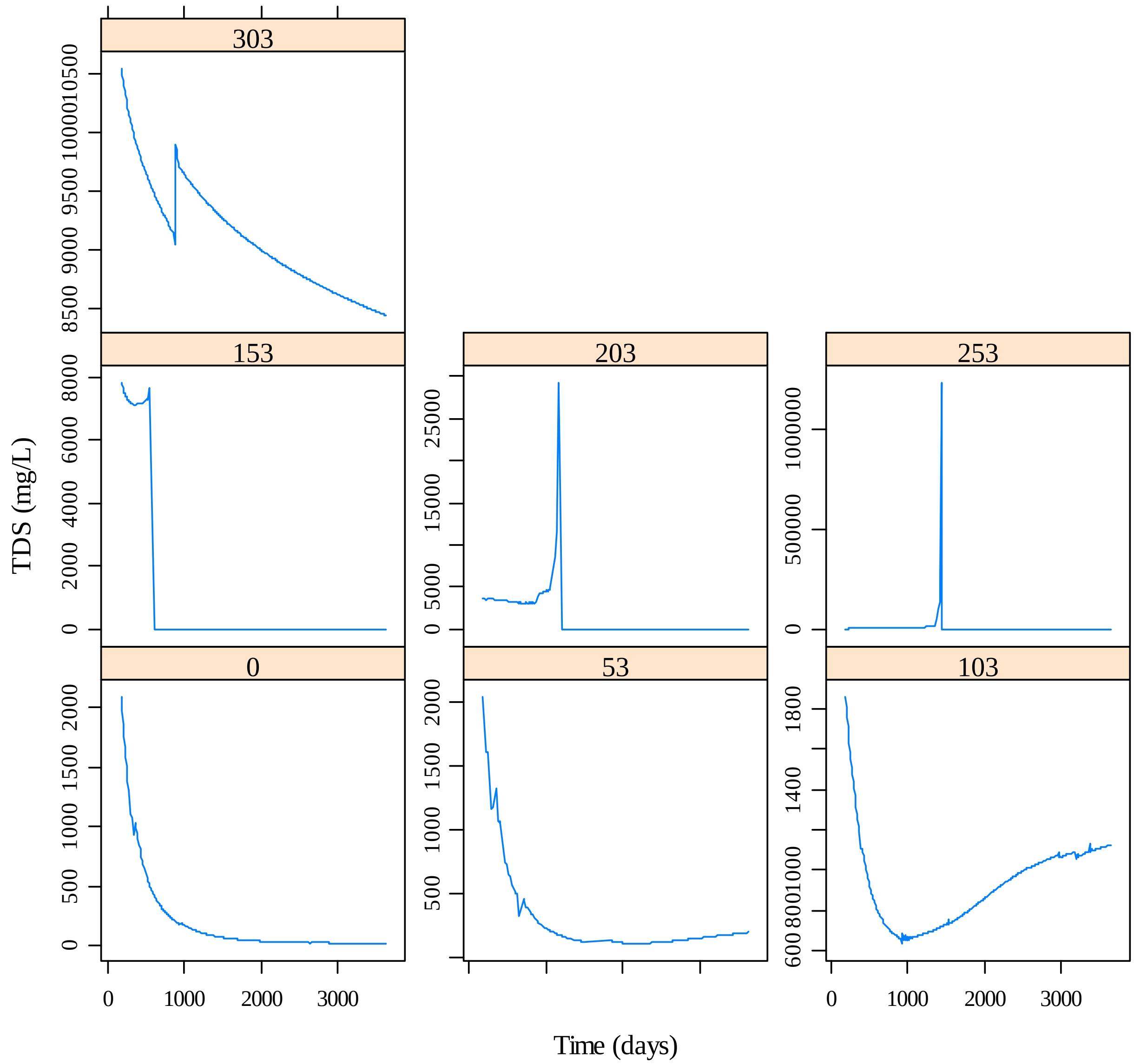

Figure 1: TDS Concentration Inputs to Jay Pit over Time by Depth Mid-Points, Assessment Scenario, 1st 10 Years

Figure 1shows that the hydrogeological model inputs to the hydrodynamic model are quite detailed over the first 10 years. Initially, it was not clear what the drivers of the small detailed changes are. Note at depth mid-point 253 m (120 MASL), TDS input is predicted to be 1,233,572 mg/L or approximately 1.2 kg/L after 1430.395 days. Assuming that TDS is comprised primarily of NaCl with K_{sp} = 359,000 mg/L at standard temperature and pressure, the solubility of NaCl is exceeded. At this point in time, the solubility of the expected TDS composition was not assessed against the predicted input TDS concentration but it is doubtful that 1.2 kg of solids could be dissolved in 1 kg of water especially if common ions are present. Furthermore the input TDS concentration abruptly changes to zero on the next day which defies any reasonable hydrogeological explanation. Similar abrupt changes are noted in panels 153 and 203. This was discussed with DDEC in a meeting held July 6th, 2015 at Golder offices in Mississauga Ontario. The response was that the high TDS concentrations were an artifact of the time step difference between volumes and concentrations. If volume predictions precede concentration predictions and volume predictions approach zero then concentrations will approach infinity. In the next time step volume goes to zero as does TDS concentration. Thus abrupt discontinuities should be obviated by plotting depth specific loads over times.

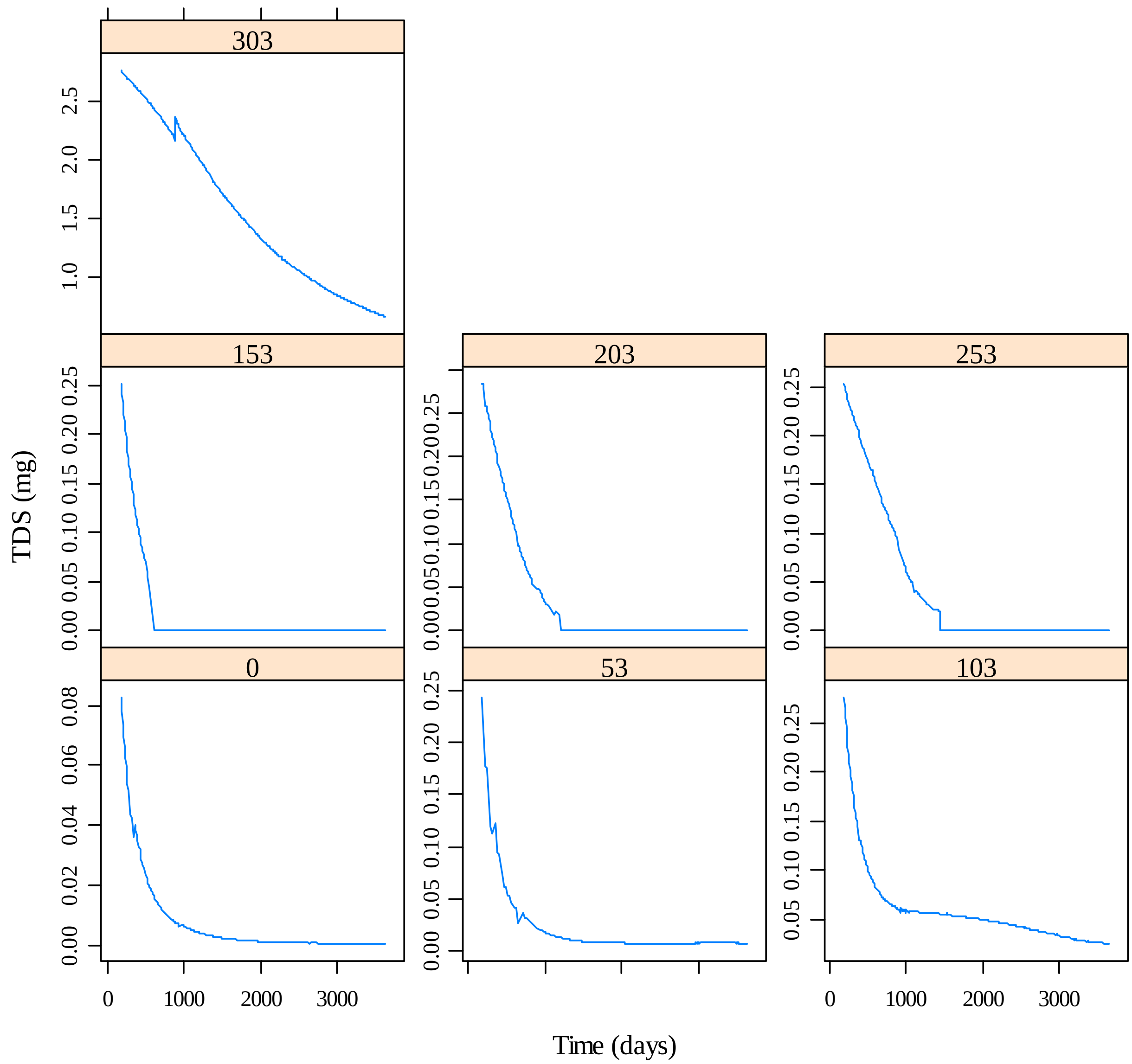

Figure 2: TDS Loads to Jay Pit over Time by Depth Mid-Points, Assessment Scenario, 1st 10 Years

The preceding figure shows that by and large, abrupt discontinuities are obviated when examining loads. This examination led to the further question of the influence of artificially high TDS concentrations (shown in Figure 1) in the hydrodynamic model output. The statement was made that as loads are summed over the 6 hydrodynamic model depth increments, there is no effect of artificially high TDS concentrations which makes sense.

The following series of graphics present TDS concentrations by pit depth for approximate mid-month dates to understand the output of the hydrogeological model. The dates are approximately mid-month because no correction was made for leap years and the assumption was made that one month contains 30 days. Neither of these assumptions affects the conclusion made.

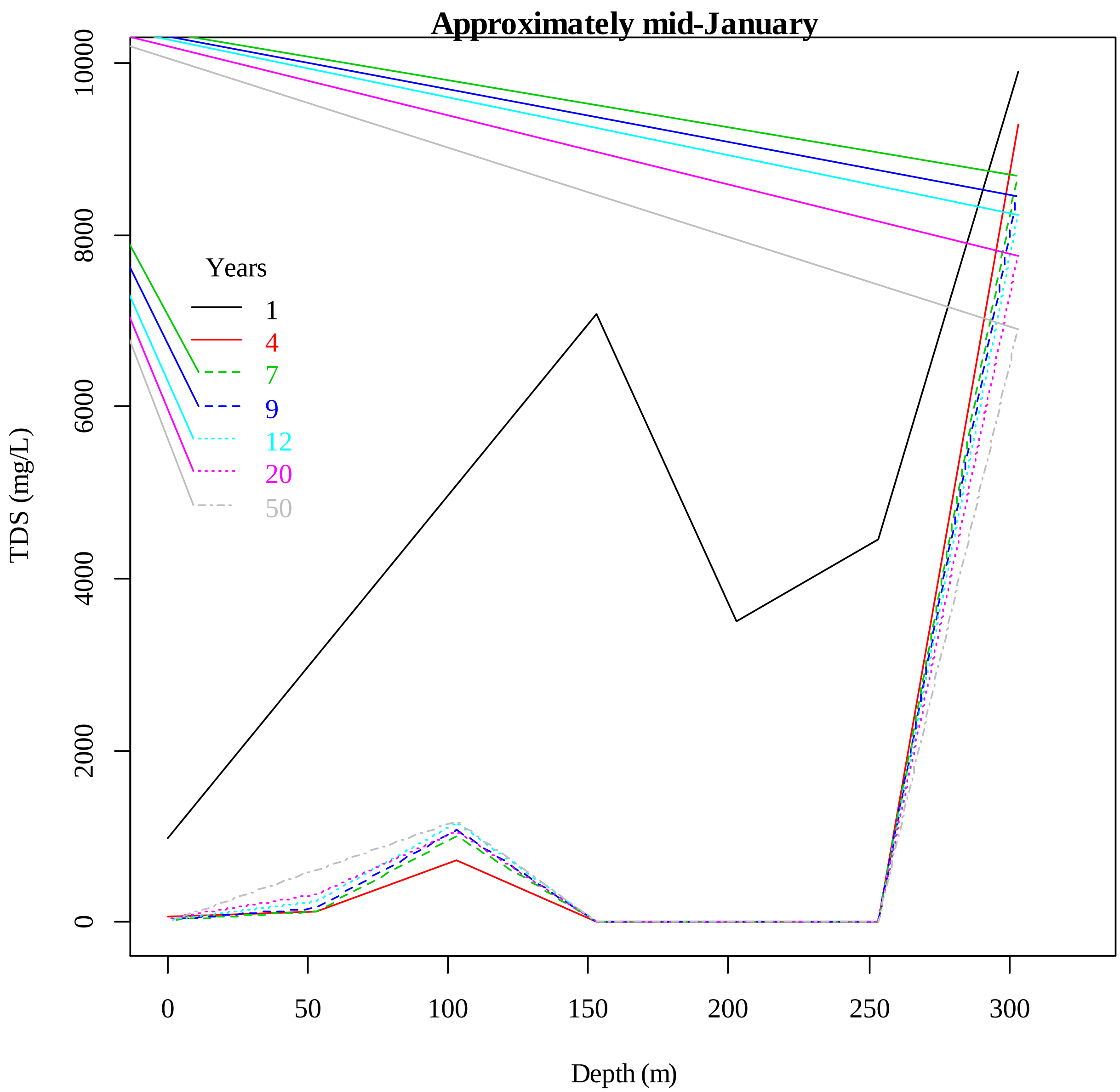

Figure 3: TDS by Depth over Time; Approximately Mid-January

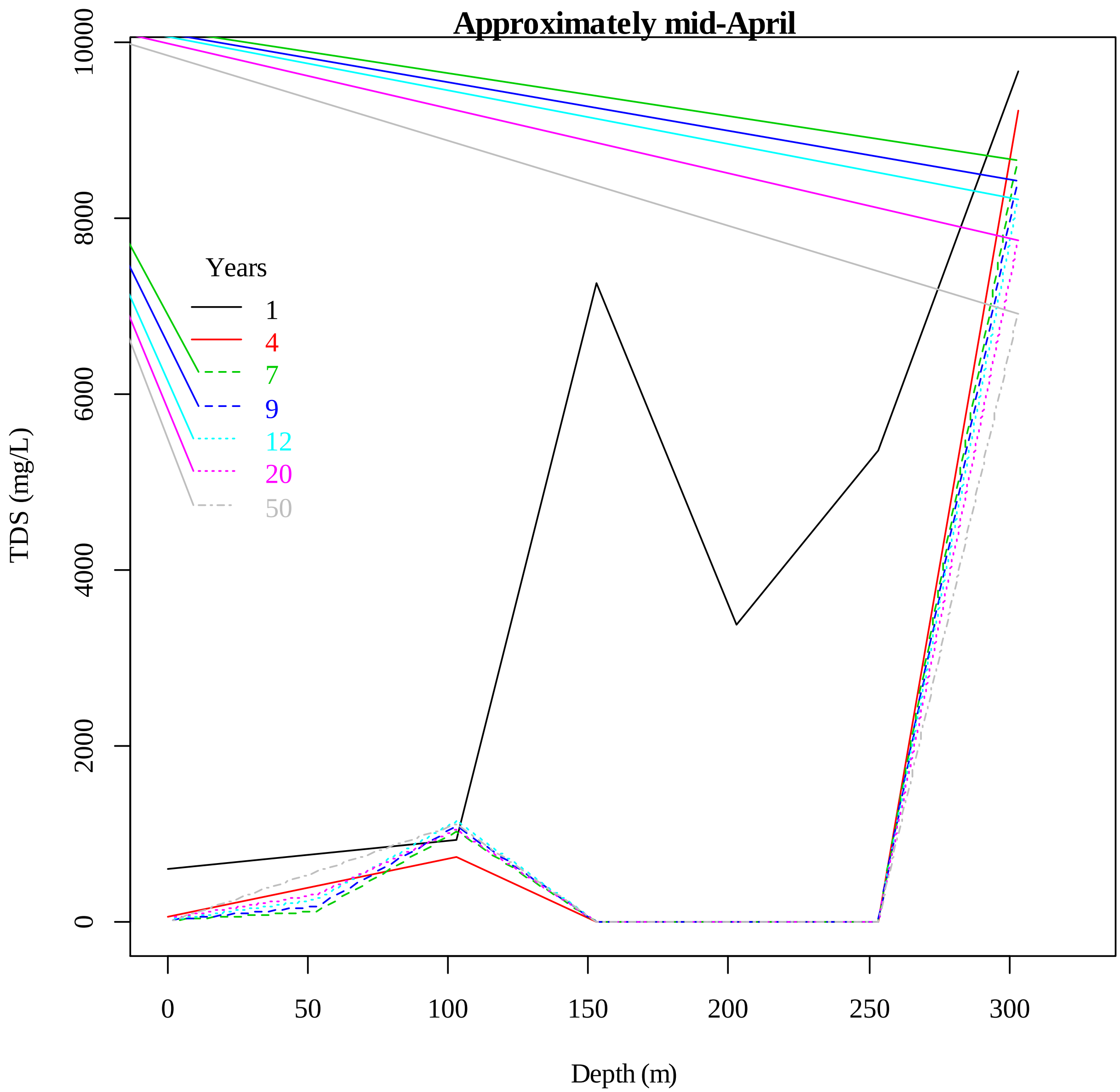

Figure 4: TDS by Depth over Time; Approximately Mid-April

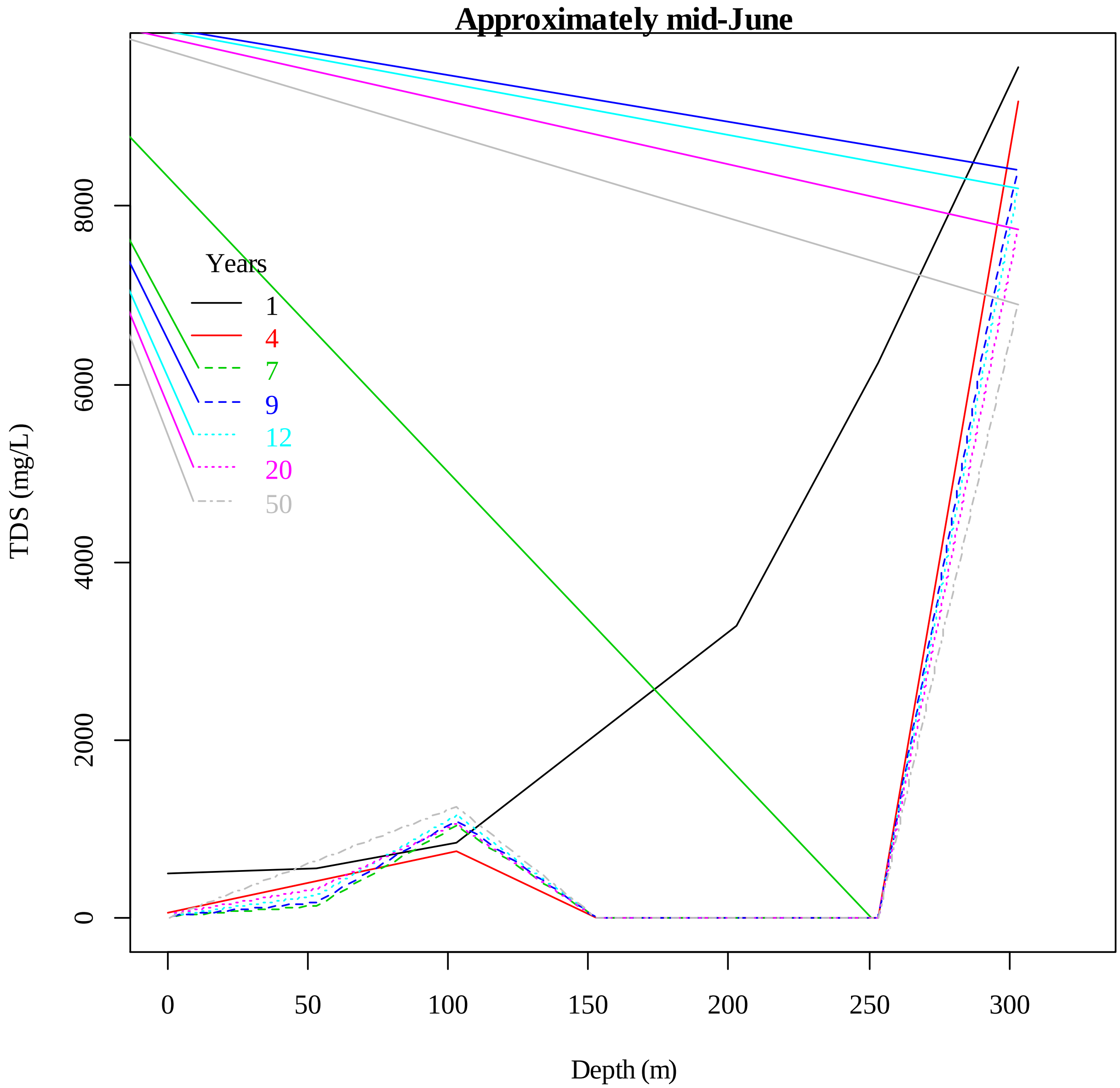

Figure 5: TDS by Depth over Time; Approximately Mid-June

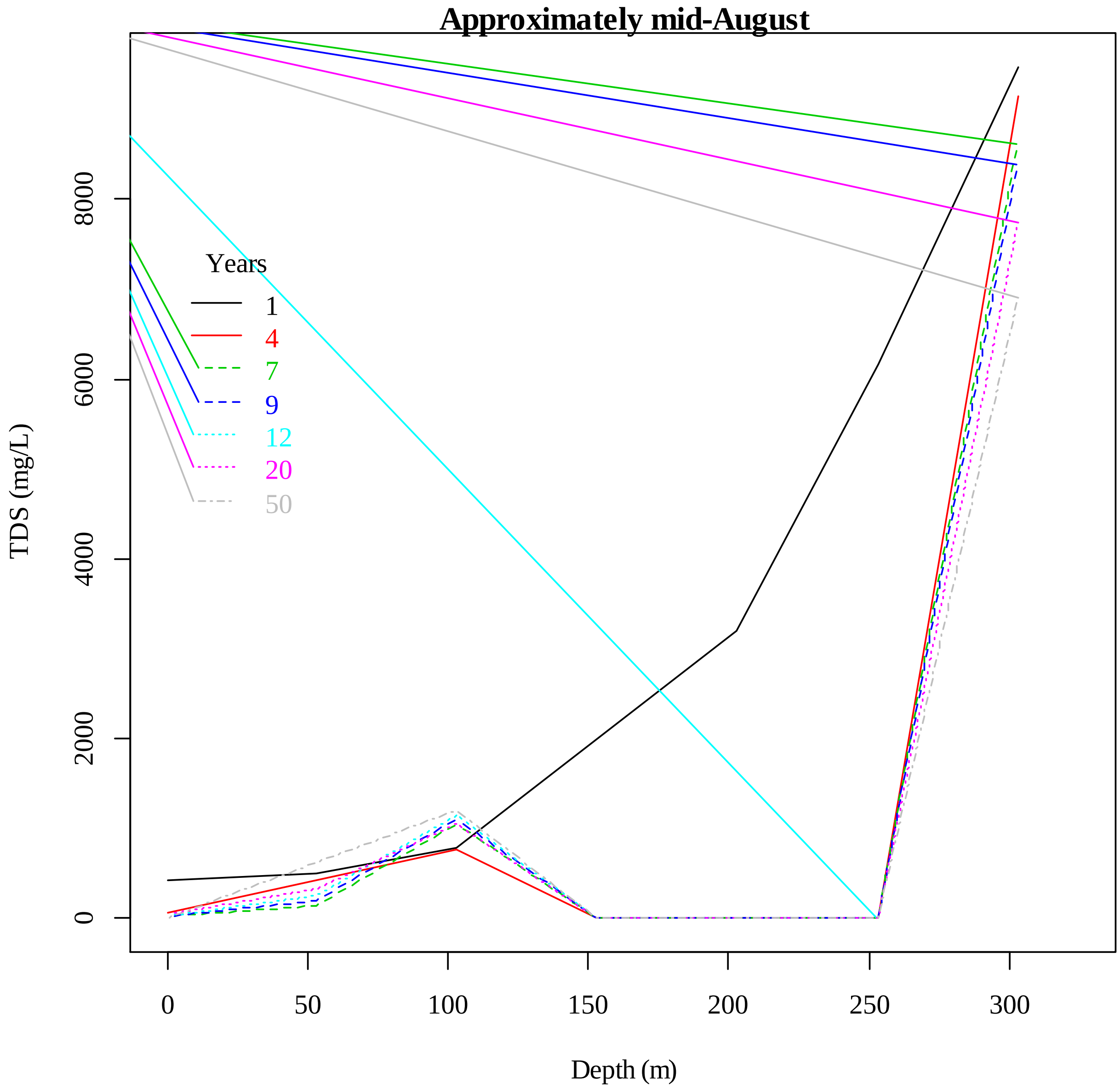

Figure 6: TDS by Depth over Time; Approximately Mid-August

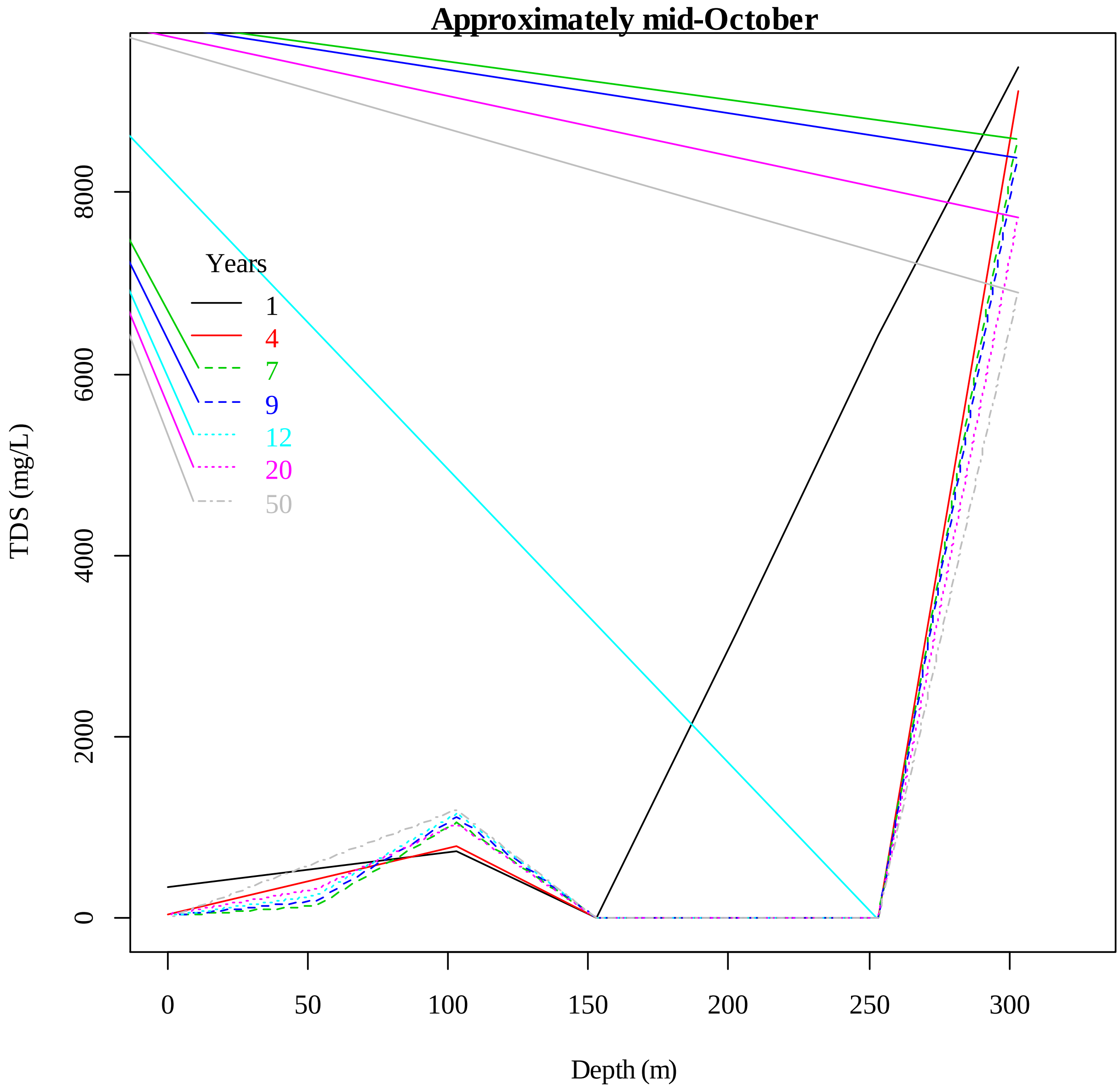

Figure 7: TDS by Depth over Time; Approximately Mid-October

TDS profiled by depth of the Jay pit lake in Figure 3- Figure 7 are not monotonically increasing as stated in DDEC(2014, §8.2.1.2.3). This was discussed with DDEC in a meeting held July 6th, 2015 at Golder offices in Mississauga Ontario. DDEC stated that TDS pit influent concentrations are not monotonically increasing because inflow at a specific depth may be recruited from other depths due to the local drawdown effect due to pit pumping during operations. This was verified in a teleconference (July 20th, 2015) by D. Chorley, Golder Associates. Figure 3 through Figure 7 show that the drawdown effect is short lived and that TDS concentrations are non monotonic with depth. As this may again be due to a flow effect, loads are assessed below.

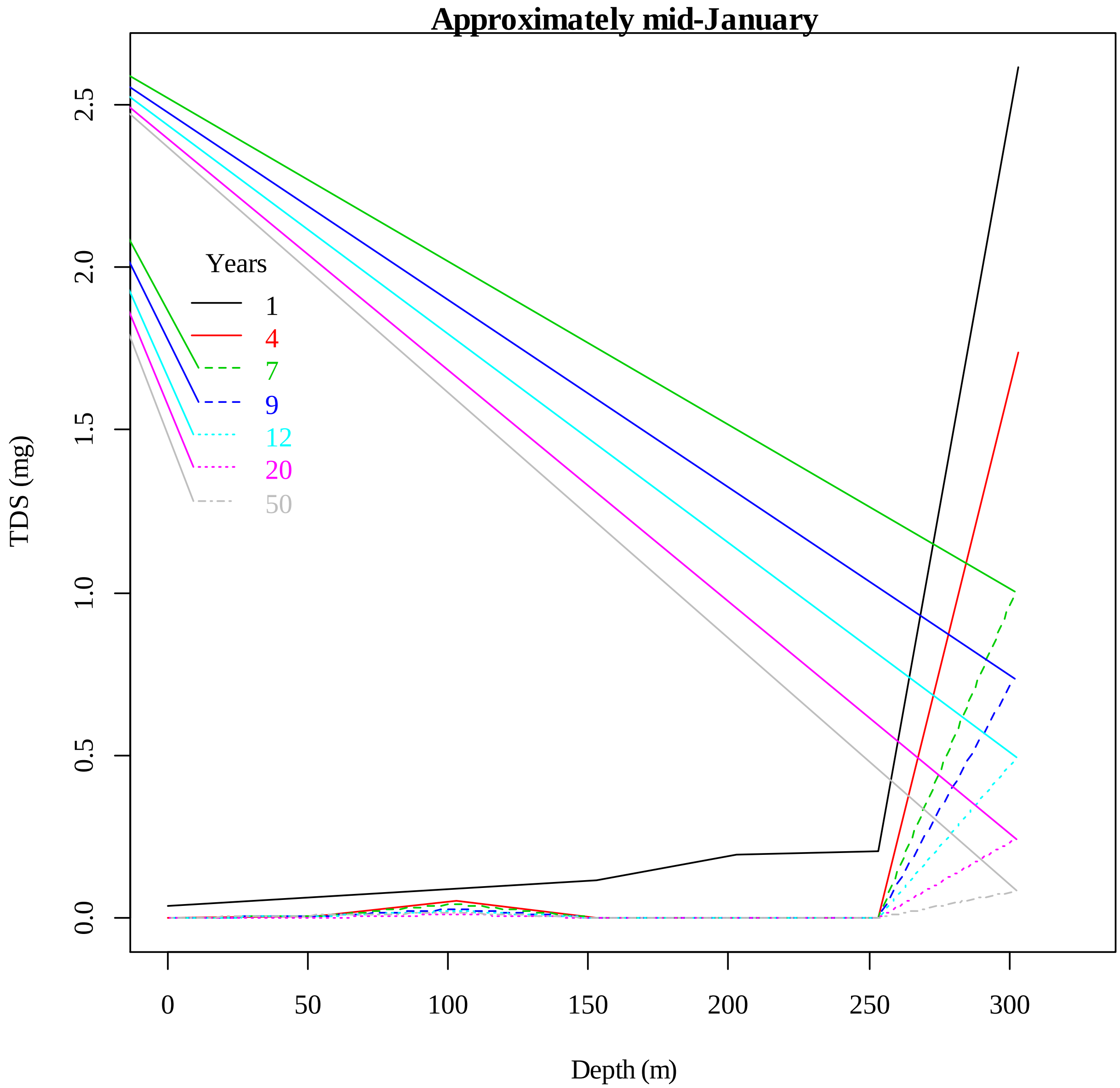

Figure 8: TDS Load by Depth over Time; Approximately Mid-January

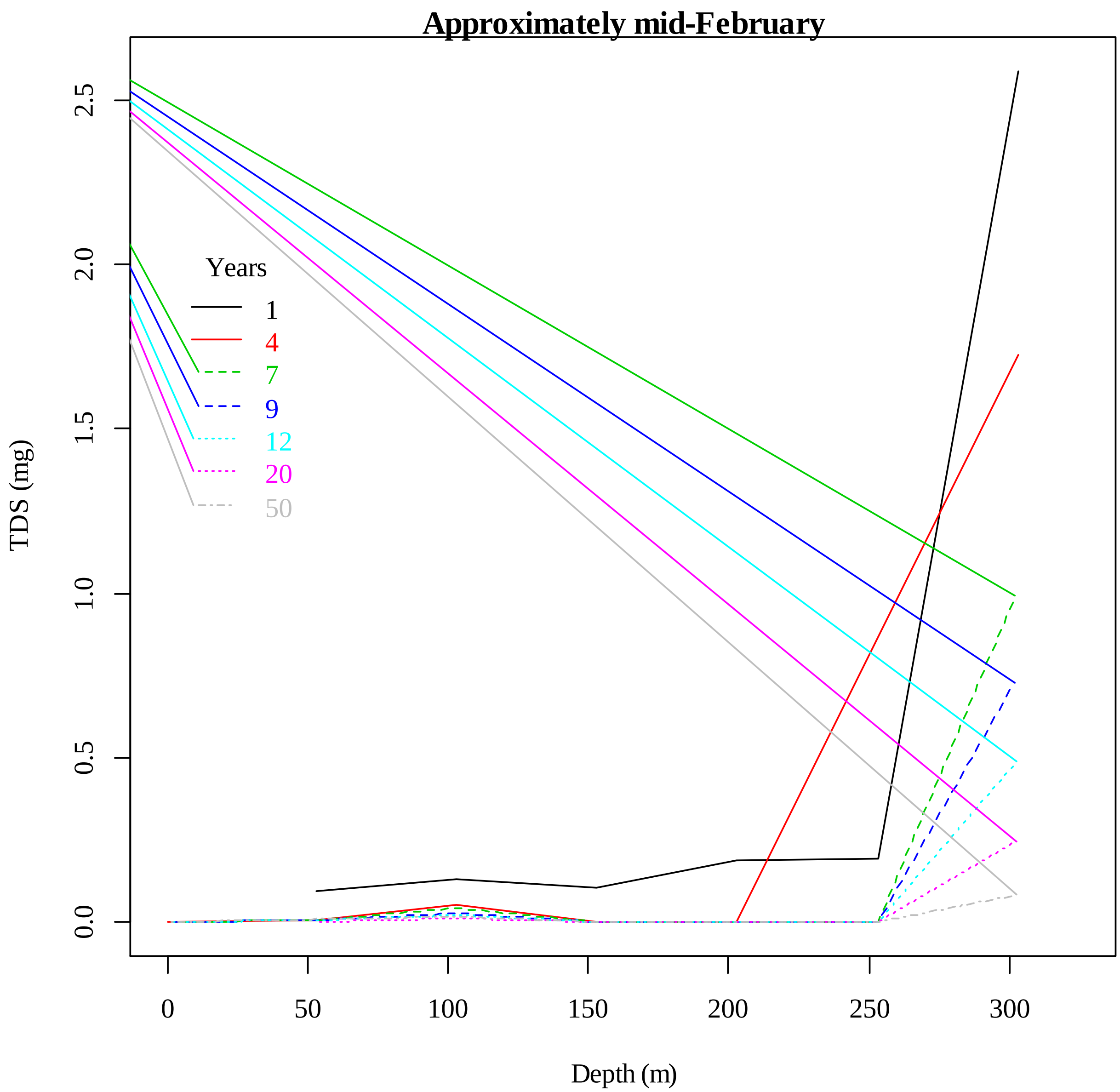

Figure 9: TDS Load by Depth over Time; Approximately Mid-February

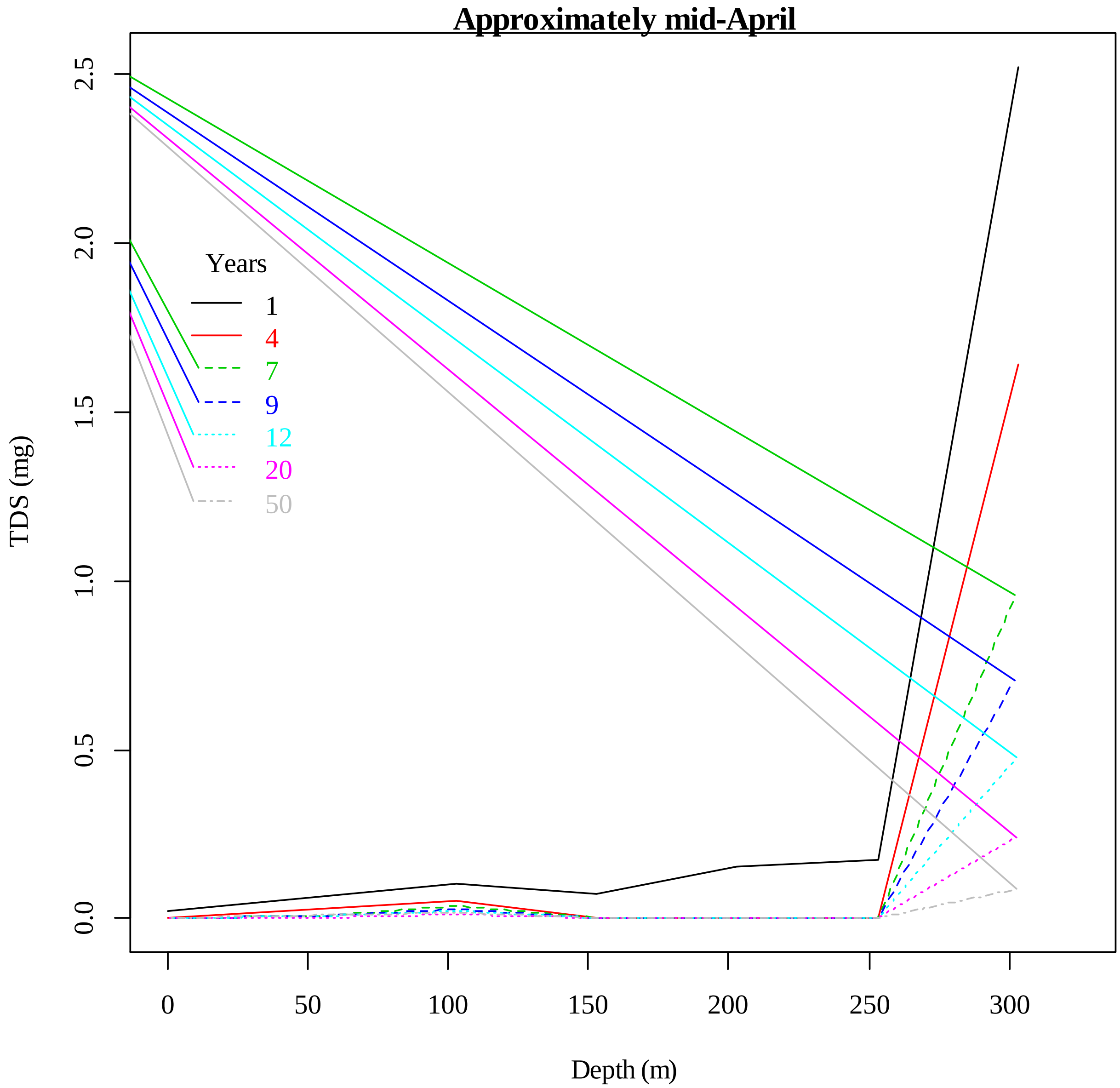

Figure 10: TDS Load by Depth over Time; Approximately Mid-April

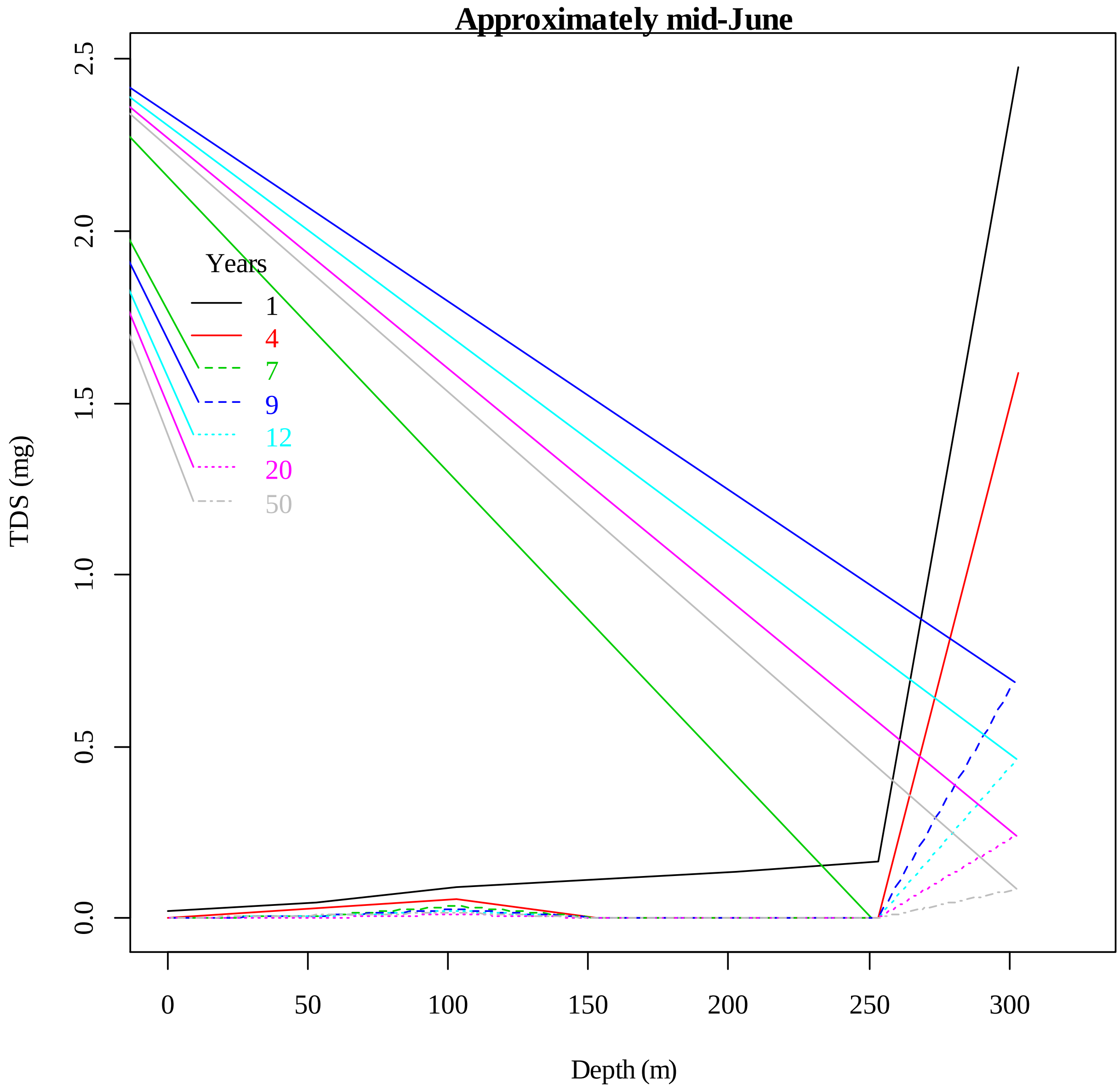

Figure 11: TDS Load by Depth over Time; Approximately Mid-June

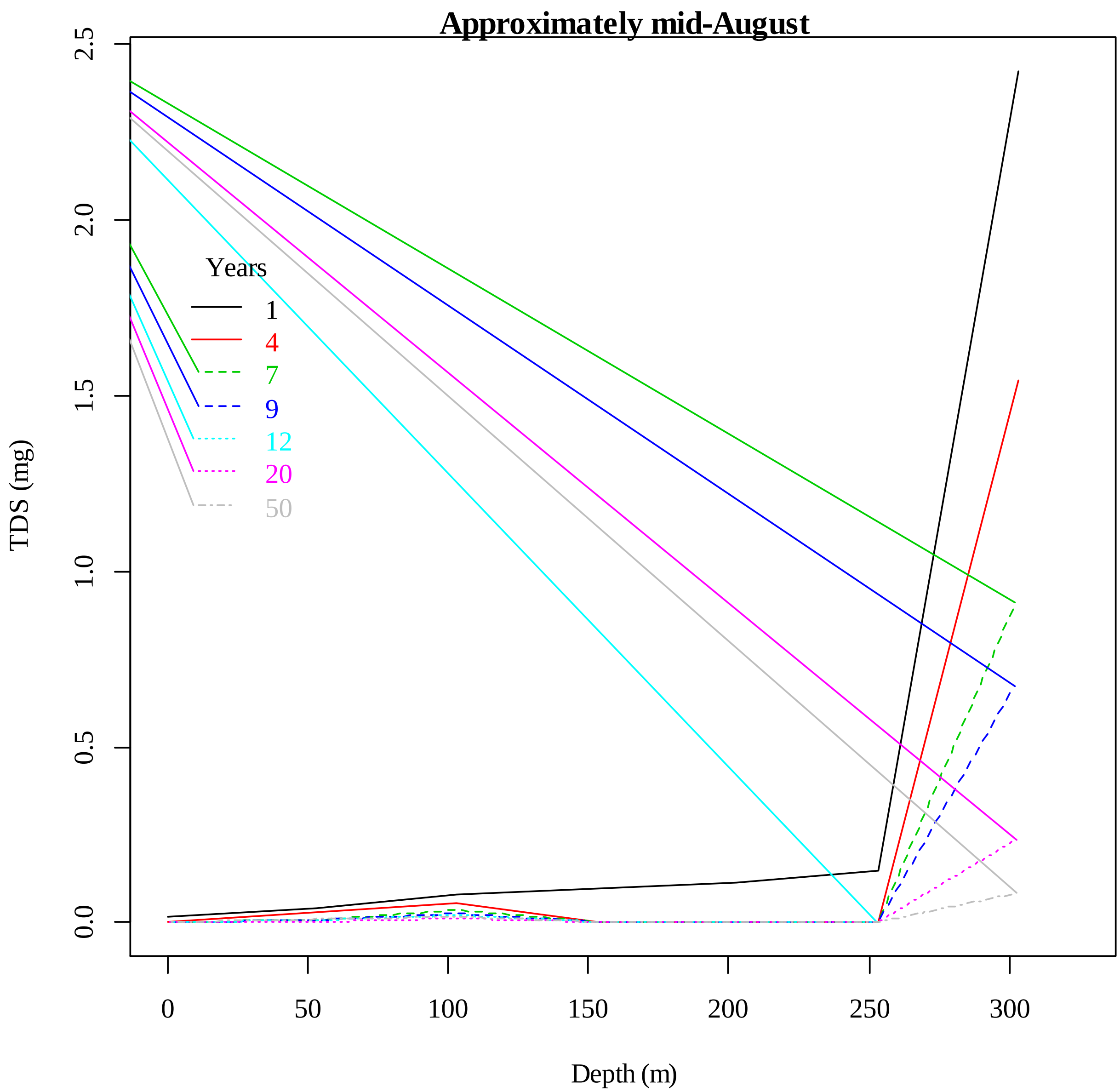

Figure 12: TDS Load by Depth over Time; Approximately Mid-August

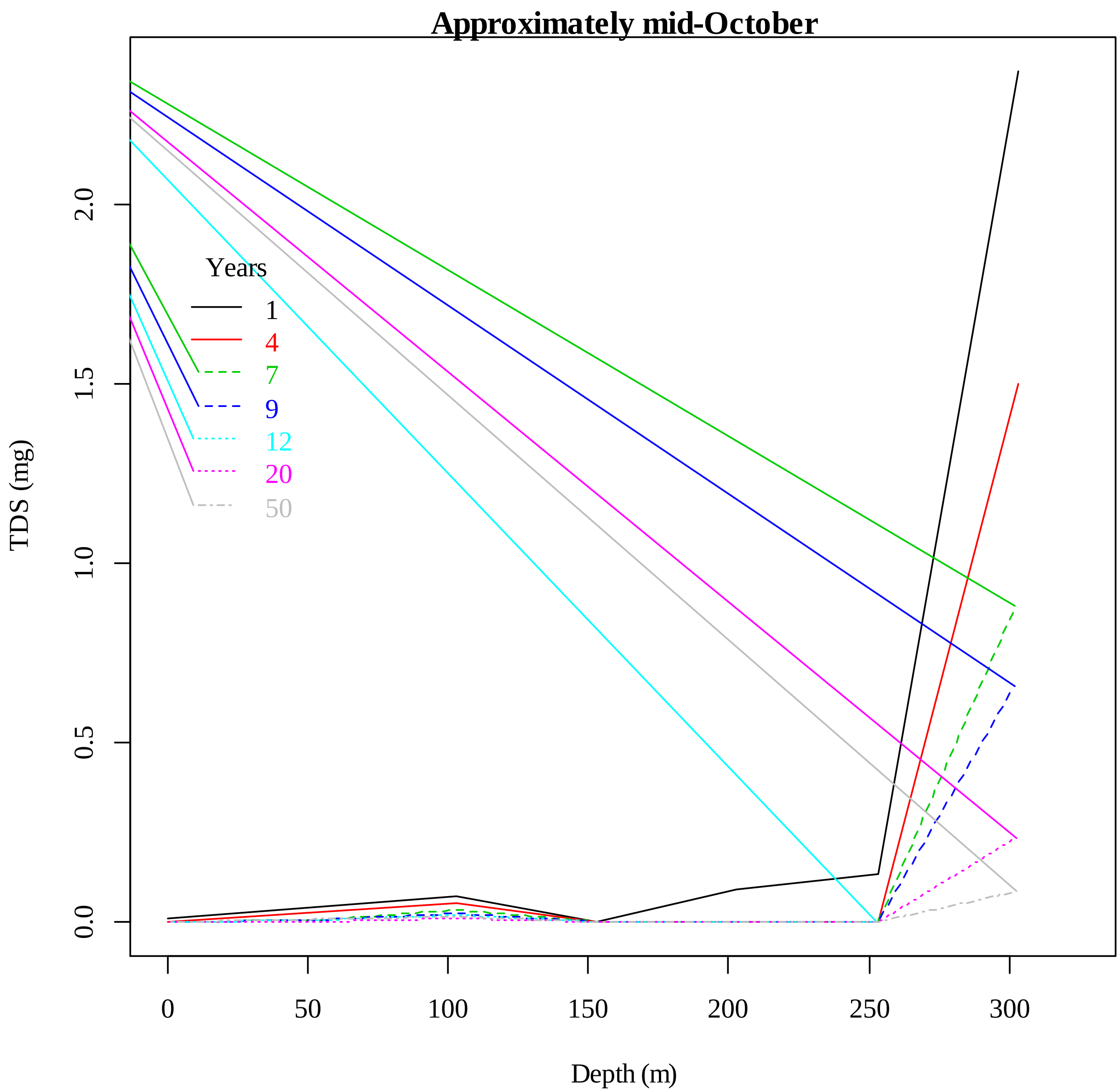

Figure 13: TDS Load by Depth over Time; Approximately Mid-October

TDS loads are very low over most of the depth range likely due to low flows following pit flooding. The higher loads at depth reflect higher flows.

3.5 Recommendation

An independent third party review of the CE-QUAL-W2 is recommended as the viability of the minewater management plan rests on the requirement for permanent meromixis in the Jay and Misery Pits. Some of the issues of concern are the limits of the calibration data (discussed in section 3.2), use of bathymetry that does not reflect the closure scenario (discussed in section 3.1) and uncertainty regarding parameterization (discussed in section 3.3).

3.6 References

Cole T.M. and S. Wells. 2011. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.7; User Manual. Prepared for US Army Corps of Engineers Waterways Experiment Station. Washington, DC, USA.

DDEC (Dominion Diamond Ekati Corporation). 2014. Dominion Diamond Ekati Developer's Assessment Report Jay Project.

4 Scope of Fisheries Valued Component Assessment Scale

GNWT expressed concerns regarding assessment scales of the fisheries Valued Component in both rounds of information requests (49 and 3 for the first and second rounds respectively). DDEC asserts that "For fish *Valued Components*, the most relevant factor in defining the assessment boundary is the spatial scale of the population or fisheries unit under examination (Randall et al. 2013), with the goal of providing an ecologically relevant classification of impacts."

The concern for the fish Valued Component was, and still is, based on possible effects on the limited suitable spawning habitat in Lac du Sauvage due to proximity of the effluent plume and construction activities and other effects not directly related to habitat loss, within Lac du Sauvage indexed over an environmental study area that includes both Lac de Gras and Lac du Sauvage. GNWT requested a discussion of the scale over which fish Valued Component effects are assessed and the superposition of dike and effluent plumes on various maps. The DDEC response was presented in DAR-GNWT-IR-49 (DDEC, 2015a).

The maps provided show the chemical plume in Lac du Sauvage using Cl as a surrogate unexpectedly makes it more important to assess fish Valued Component changes at the scale of Lac du Sauvage because the gradient in concentrations in the main body of Lac du Sauvage is shallow. For example using Map 49-1c (DDEC, 2015a) there is roughly only a 20% reduction in Cl concentrations in the cells proximal to the diffuser and shoal S16, the most distant shoal labelled as "fair" or better for lake trout spawning habitat, within the main body of Lac du Sauvage. Within Lac du Sauvage, 100% of "good" lake trout habitat and 75% of "fair" lake trout habitat will be exposed to concentrations that are roughly within 20% of concentrations just outside the mixing zone. Note that these exposures pertain to all conservative elements of the effluent plume so exposure in these spawning areas represents the simultaneous exposure of sensitive, early life stages to multiple contaminants.

The DAR (DDEC, 2014) measures effects to fish exposures, a Valued Component, by measuring changes in fish population metrics against the combined fish populations of Lac du Sauvage and Lac de Gras. This basis for comparison is rationalized in DDEC (2015a) using Randall et al (2013) and Dillon (2002). Additional rationalization regarding fish movement is provided in DDEC (2015b) however those studies do not pertain to Lac de Gras or Lac du Sauvage. The single study conducted in these water bodies was by Dillon (2002). DDEC (2015a) cites Dillon (2002) as stating "There are no physical barriers to prevent fish from moving between Lac du Sauvage and Lac de Gras, with evidence of lake trout movements from Lac de Gras to the Lac du Sauvage Narrows and likely into the waters of Lac du Sauvage (Dillon 2002), and therefore, including Lac de Gras as part of the ESA to assess fish populations and fish habitat changes is appropriate." Dillon (2002), Figure 1.0 shows the extent of sampling zones in Lac de Gras and Lac du Sauvage. Telemetry surveys were conducted as follows:

- "Autumn 2000 – boat, helicopter (45+ hrs of tracking)
- Winter 2001 – snowmobile, helicopter (50+ hrs of tracking)
- Spring/Summer 2001 – boat, helicopter (25+ hrs of tracking), and;
- Autumn 2001 – boat, helicopter (30+ hrs of tracking)" Dillon (2002).

The level of tracking effort comprised approximately 150 continuous hours over two years and three seasons. Dillon (2002) states that the Narrows are a highly productive area with at least one tagged fish being detected in every survey in the immediate vicinity of the Narrows. Fitzsimmons (2013) restates this and adds that lake trout were caught in the Narrows which may or may not be the correct interpretation (See 6th bullet, below). Figure 7.0 (Dillon, 2002) shows that all the fish detected were detected in Lac de Gras. Not one lake trout tagged during 2000 or 2001 was detected in zone 9 which is the only zone falling within Lac du Sauvage. Dillon (2002) does not describe the movement of fish into Lac du Sauvage and does not state that fish movement into Lac du Sauvage is likely but they do hypothesize that a failure to detect tagged fish could be due to movement into Lac du Sauvage (further discussed below). It is not clear how DDEC (2015a) makes the conclusion that fish movement into Lac du Sauvage is "likely" or "suspected" (DDEC 2015b) based on the findings of Dillon (2002) especially as the Dillon report pertains to lake trout only and as previously stated, not one tagged lake trout was detected in Lac du Sauvage. DDEC (2015b) states that "Dillon (2002) could not relocate all of the tagged fish in their limited sampling area (which included Lac de Gras but excluded most of Lac du Sauvage) and contend that tagged Lake Trout may have migrated out of Lac de Gras to inhabit the waters of Lac du Sauvage." Dillon (2002) discusses reasons that all tagged fish could not be relocated. The following is extracted from Dillon (2002).

"*Apart from Lac de Gras' large area, there are numerous possibilities for not locating all of the 26 tagged lake trout during all sampling periods.*

Some of these include:

- *The radio tags are capable of transmitting for approximately one year, therefore the fourteen tags from September, 2000 may not have transmitted a strong enough signal that could be detected during the 2001 late summer or autumn assessments (especially if the fish were deeper than 30m);*

- *Lake trout typically inhabit deep water areas throughout the year; therefore, many fish may have been out of receiver range for extended periods of time. Unfortunately due to the size of Lac de Gras, adverse weather conditions, as well as time and budgetary constraints, it was not always possible to cover all 20 sampling zones using boat support and the hydrophone, which locates fish at depths greater than 10+m. Radio telemetry assessments using helicopter support were therefore limited to the upper 10 m of the water column;*

- *Receiver range for the hydro-acoustic (hydrophone) and radio telemetry (H-Antenna) surveys were approximately 1 and 3 km's respectively. When compared to the size of Lac de Gras (636.4 km^2), the success of the study may have been jeopardized somewhat by inadequacies in existing tracking technologies;*

- *Although lake trout move into shallow water habitats during the spring and autumn, the level of effort performed was not sufficient to locate all tagged fish during each tracking session. Simply put, 2000-2001 telemetry assessments represented a "snap-shot" in time. To accurately assess/locate tagged lake trout, telemetry methodologies would require daily monitoring for extended periods of time, as fish move into and out of habitats based on water temperatures, time of day, weather and light conditions. Continual tracking for 15-20 days would be required at each sampling session to adequately assess habitat usage throughout the year;*

- *Tagged lake trout may have migrated out of Lac de Gras to inhabit the waters of Lac du Sauvage or habitats downstream of Lac de Gras;*

- *Angling pressure at the narrows may have resulted in the capture/mortality of tagged fish. John Andre, camp manager of a sports fishing camp located southeast of the Lac de Gras/Lac du Sauvage narrows, reported that anglers caught several fish with radio transmitter tags in 2001.*

While Dillon (2002) does make the statement that tagged lake trout may have migrated to Lac du Sauvage it is only one of 6 possible reasons and again note that no tagged fish were detected in Lac du Sauvage. Finally, discussions with Dr. P. Cott (GNWT) formerly with Fisheries and Oceans Canada (Yellowknife) suggests that lake trout will not migrate from Lac du Sauvage to Lac de Gras to spawn. Other species were not discussed.

DDEC (2015a) cites Randall et al (2013) as stating that assessment endpoints be "aligned to the scales of the changes in habitat relative to the full area contributing to the fishery." Randall et al (2013) discuss spatial assessment scales stating that scales have changed since 1986. The 1986 scale used the smallest relevant spatial scale because a lack of change at that scale precludes changes at larger scales. Since 2012, fisheries assessments are made from the perspective of change that allows for sustainable use. The premise is that because recruitment and utilization occurs at various scales, protection at the smallest spatial scales may not be necessary. The three scales described by Randall et al (2013) are landscapes, biological populations, and fisheries. Randall et al (2013) state that "From a landscape-level perspective, the most likely scale that would be considered is matched to physical features that roughly support ecosystems. In freshwater these could be watersheds (likely mid-order), small and medium sized lakes, and basins or arms of larger lakes." The next larger scale is a biological population with an obvious definition and the broadest scale is the fisheries scale. The only rationalization provided by DDEC (2015a) for using the broadest possible scale is that aboriginal harvesters use the Narrows as a fishery[2]. As a fishery, recruitment would occur from Lac de Gras and "likely" from Lac du Sauvage. Therefore both lakes could be combined for the assessment of this fishery. The Narrows has been shown to contain lake trout (but not other species) from Lac de Gras that have moved from as far as the tagging areas near East Island, there is movement of fish (lake trout)

[2] DDEC (2015b) provides another rationalization based on the Project category following Randall et al (2013) that is discussed later in this section.

within Lac de Gras to the area. However movement into Lac de Gras from Lac du Sauvage has not been demonstrated. As noted by Dr. P. Cott (GNWT) such movement of lake trout is unlikely. It is not clear that the fishery scale is appropriate because the fishery may be comprised only of fish from Lac de Gras. The intermediate scale of assessment was not chosen by DDEC (2015a) despite the fact that populations of small bodied fish are likely distinct between the two lakes due to limited home ranges. Note that small bodied fish are the main food source for larger bodied fish in both lakes. An impact to small bodied fish could result in an impact to large bodied fish in either lake.

Assuming for the moment that the broadest fisheries scale assessment is appropriate, the implications of doing so should be evaluated. Under the assumption that fish densities are the same in Lac du Sauvage and Lac de Gras (no fish density estimates are available for Lac de Gras) the degree of change in Lac du Sauvage can be assessed against the change in total fish density in Lac de Gras and Lac du Sauvage combined. These assessments use Table 9.2-7 of DDEC (2014) and a table of waterbody physical characteristics compiled from DDEC (2014).

Table 3: Table 9.2-7 (DDEC, 2014)

	Internal Basin Aa/b (Lac du Sauvage East)			Internal Basin Ac/d/e (Lac du Sauvage West)			
	Fish / 100,000 m^3			Fish / 100,000 m^3			
Percentile Statistics	>5 m	0 to 5 m	Abundance	>5 m	0 to 5 m	Abundance	Total Abundance
50%	80.63	27.40	104,106	31.69	21.16	93,316	197,422
75%	213.30	281.03	516,164	71.72	100.89	311,988	828,153

Table 4: Waterbody Physical Characteristics (from DDEC, 2014)

Waterbody	Volume (m^{3})	Surface Area (km^2)	Maximum Depth (m)	Mean Depth (m)
Lac du Sauvage	631,400,000	86.38	40.4	7.3
Lac de Gras	6,155,800,000	572.23	50	10.8

Under the assumption of similar fish density the total abundance of fish in Lac de Gras and the combined baseline study area (BSA) can be estimated. These estimates are presented below.

Table 5: Total Fish Abundance in Lac de Gras, Lac du Sauvage and the Proposed Baseline Study Area

Percentile Statistics	LdS Total Abundance	LdG Total Abundance - Volumetric Estimate	BSA Total Abundance
50%	197,422	1,924,755	2,122,177
75%	828,153	8,074,033	8,902,186

Using the results of Table 5, an x% reduction can be applied to fish density in Lac du Sauvage and the proportion reduction in the baseline study area can be estimated. These are presented below.

Table 6: Assessing Reduction in Fish Abundance in Lac du Sauvage using Proposed Baseline Study Area

Percentile Statistics	Total Abundance with a 10% Reduction in LdS	%Effect using Baseline Study Area	Total Abundance with a 50% Reduction in LdS	%Effect using Baseline Study Area	Total Abundance with a 100% Reduction in LdS	%Effect using Baseline Study Area
50%	177,680	0.991	98,711	0.95	0	0.91
75%	745,338	0.991	414,077	0.95	0	0.91

Table 6 shows that a 10% reduction in fish abundance in Lac du Sauvage corresponds to less than a 1% reduction in (the 50th and 75th percentiles) of fish abundance over the baseline study area. Even if fish abundance is reduced by a drastic 50%, there is only a 5% reduction in (the 50th and 75th percentiles) fish abundance in the baseline study area. If all fish were removed from Lac du Sauvage (50th and 75th percentiles set to zero) there would be only a 9% reduction in fish abundance in the baseline study area. These results are the inevitable consequence of using a large scale fishery to assess change on a local scale. Based on experience with aquatic effects monitoring programs a difference of 10% in total abundance is not detectable given typical sampling efforts. Thus extirpation of fish in Lac du Sauvage would not be detected[3] in the typical AEMP.

Using the proposed baseline study area assessment scale allows for extirpation at the landscape level. If fish populations in Lac du Sauvage are distinct from fish populations in Lac de Gras (and no evidence has been offered to suggest otherwise, particularly for small bodied fish) the proposed large scale also allows for extirpation at the population level.

The lack of demonstrable movement of lake trout between Lac du Sauvage and Lac de Gras, the small home range of at least small bodied fish suggest that a reasonable assessment scale is no larger than the landscape level. Clearly assessment at the proposed baseline study area scale is inappropriate as extirpation of all fish within Lac du Sauvage registers as less than a 10% change.

Randall et al (2013) discuss categories of projects that can affect fish which is a Valued Component (VC) of this environmental assessment. The Jay Pipe project falls into the first or second categories. In the first category there is direct loss of habitat with a concomitant loss in yield – the key metric of fisheries utilization which is the focus of the 2012 Federal Fisheries Act. The second category refers to diffuse projects that arise from flow alterations, non-lethal sediment discharges, nutrient inputs, temperature changes, riparian clearing etc. These changes are manifested through changing the productivity of individuals. The third category is defined as

[3] Hopefully data analysts would comment that no fish could be captured in Lac du Sauvage!

“Major projects that result in significant ecosystem transformation (e.g., hydropower resulting in river to reservoir transformation), or removal of the ecosystem from use (e.g., lake infills, other, large infills).” Randall et al 2013). This level of change is not expected as a result of the Jay Project although DDEC (2015b) states that “According to Randall et al. (2013), the Jay Project would be defined as a major project with the potential to affect the ecosystem”.

Despite the emphasis on measuring productive capacity of a fishery in the context of the Fisheries Protective Provisions (Randall et al, 2013), Minns et al (2013) acknowledge that “most fish habitat management in Canada is based on the use of productive capacity purely as an abstract implicit concept and not a concrete measurable quantity”. This is especially true of changes associated with the first project category (Randall et al, 2013). With respect to the second project category, a Pathway of Effects (PoE) analysis is advocated following (*loc. Cit.* Jones et al. 1996; Clarke et al. 2008). This attempts to link changes in habitat to fish population metrics. The qualitative PoE approach can indicate direction of expected change and qualify whether the habitat change is meaningful. AEMP guidance (INAC, 2009) recommends that quantitative measurement endpoints be used to assess change. Randall et al (2013) states that measuring changes in productivity (yield) is difficult for projects falling into the second project category and that project effects can be indirectly assessed using yield surrogates “either at the landscape or population scale” but not fisheries scale. Some of the yield surrogates mentioned are abundance measured as density or catch per unit effort, rates such as survival, growth and recruitment, biomass, production to biomass ratios etc. Minns et al (2011) discuss the relative strengths and weaknesses of these indirect measures of productive capacity.

Acknowledging that productive capacity is difficult to measure at the scale relevant to the Jay Pipe development, it is recommended that indirect quantitative measurement endpoints be used within Lac du Sauvage as the maximum scale. Given the juxtaposition of the effluent plume with limited dilution outside the mixing zone and the large fraction of suitable lake trout spawning habitat within Lac du Sauvage indirect measures of production capacity should be indexed to baseline or pre-development measures. This recommendation is consistent with the precautionary approach discussed by Randall et al (2013) due to uncertainty in the productive capacity of Lac du Sauvage.

DDEC (2015b) expresses concern that “consideration of an *Experimental Study Area* using only Lac du Sauvage for fish that may be affected by the Project would fail to capture cumulative effects from existing and reasonably foreseeable developments in the Lac de Gras watershed, and inadequately predict impacts at the population scale”. I agree with this statement as it speaks to cumulative effects. The GNWT CIMP uses the Canadian Council of Ministers of the Environment cumulative impact definition: “a change in the environment caused by multiple interactions among human activities and natural processes that accumulate across space and time.” By definition, cumulative impacts cannot be assessed using data (fish in this case) from Lac du Sauvage, alone. However the assessment of cumulative impacts is distinct from the assessment of project related effects at lesser scales. Finally, note that even if fish populations in Lac du Sauvage are sub-populations of an overall Lac de Gras – Lac du Sauvage “meta-population” use of metrics such as maximum sustainable yield (which is conceptually linked to production capacity) can lead to local depletion (Ying et al 2011).

4.1 References

Dillon (Dillon Consulting Ltd.). 2002. Lake Trout Habitat Utilization Study, 2001. Technical Report – Final. Prepared for Diavik Diamond Mines Inc., Yellowknife, NWT, Canada.

DDEC (Dominion Diamond Ekati Corporation). 2014. Dominion Diamond Ekati Developer’s Assessment Report Jay Project.

DDEC (Dominion Diamond Ekati Corporation). 2015a. Jay Project Developer's Assessment Report Information Request Responses DAR-GNWT-IR-49, April 2015

DDEC (Dominion Diamond Ekati Corporation). 2015b. Jay Project Developer's Assessment Report Information Request Responses DAR-GNWT-IR2-03, July 2015.

Fitzsimmons, J.D. 2013. Assessment of the use of dikes at Diavik Diamond Mine Lac de Gras for Lake Trout Spawning 2011. Unpublished Report. Available http:// www.mvlwb.ca/ Boards/WLWB/; accessed July 9, 2015. 24 pages.

Golder. 2014a. Dominion Diamond Ekati Corporation, Lac Du Sauvage Northwest Territories Canada. Jay Project Mine Water Management Plan. Submitted to Dominion Diamond Ekati Corporation. October 2014.

Golder. 2014b. Dominion Diamond Ekati Corporation, Lac Du Sauvage Northwest Territories Canada. Jay Project Fish and Fish Habitat Baseline Report. Prepared for Dominion Diamond Ekati Corporation. September 2014.

INAC (Indian and Northern Affairs Canada). 2009. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the Northwest Territories: Overview Report and Technical Guidance Documents Volumes 1 to 6. Prepared by MacDonald Environmental Sciences Ltd. and Zajdlik and Associates Inc., in association with the Water Resources Division. Yellowknife, NT.

Minns, C.K., R.G. Randall, K.E. Smokorowski, K.D. Clarke, A. Velez-Espino, R.S. Gregory, S. Courtney and P. LeBlanc. 2011. Direct and indirect estimates of the productive capacity of fish habitat under Canada’s Policy for the Management of Fish Habitat: Where have we been, where are we now, and where are we going? Can. J. Fish. Aquat. Sci. 68:2204-2227.

Randall R.G., M.J. Bradford MJ, K.D. Clarke and J.C. Rice. 2013. A science-based interpretation of ongoing productivity of commercial, recreational or Aboriginal fisheries. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/112 iv + 26 p.

Ying, Y., Y. Chen, L. Lin, and T.Gao. 2011. Risks of ignoring fish population spatial structure in fisheries management. Can. J. Fish. Aquat. Sci. 68:2101–2120.

5 Screening Values

Some screening values (i.e. chloride) are “hardness adjusted”. While adjusting for toxicity modifying factors is an accepted practice the intent is to adjust by naturally occurring levels of the toxicity modifying factors. DDEC (2014) uses a hardness of 50 mg/L to derive a hardness adjusted chloride screening level. The correct hardness is approximately 5 mg/L (Table 8.2-49 median hardness is 5.3 and 4.5 mg/L under ice and during open water season; respectively).

The intent of CCME guidance is not to use anthropogenically elevated concentrations of toxicity modifying factors. The fundamental scientific argument is that a calcium or magnesium ion (both contribute to the measurement of hardness) is a calcium or magnesium ion regardless of source and will exert its toxicity modifying effect, regardless of source. That argument is correct. What this argument ignores is the intent of CCME guidance and regulatory policies that include pollution prevention as an objective (MVLWB, 2011).

5.1 References

MVLB (Mackenzie Valley Land and Water Board). 2011. Water and Effluent Quality Management Policy.

6 Mercury

The response to GNWT IR2-13 (DDEC, 2015) is assessed herein. DDEC (2014, Appendix 8E) states: “During operations, water reporting to the diked area and the Jay Pit will be pumped to the Misery Pit. Water balance modeling indicates the total volume of water (87.1 million m^3) that needs to be managed through the Misery Pit during the life of mine is approximately double the design capacity of the pit (41.3 million m^3). Excess water stored in the Misery Pit will be discharged to Lac du Sauvage to accommodate additional storage from inflows to the Jay Pit and the diked area.” Without accounting for the 60 m freshwater cap on Misery Pit, conservatively, 87.1- 41.3 = 45.83 million m^3 of water will be discharged to Lac du Sauvage. During 2023-2030 (Operations - Post-Diavik Shutdown) the lower of two values of the maximum of mean daily predicted concentrations in the Misery Pit discharge to Lac du Sauvage (open water season) from 2023 to 2030 is 0.000105 mg/L total Hg (DDEC, 2014, Appendix 8E, Table 8E4.1-1[4]). The product of the conservative volume (45.83 million m^3 of water discharged to Lac du Sauvage) and maximum mean concentration (using lower of two seasons) is 4.8 kg Hg discharged over a period of 7 years. Bioaccumulation factors and deposition rates were not estimated but it isn’t obvious that this loading level poses a threat due to bioaccumulation and/or biomagnification. Given the current level of Hg in sediments even modest increases should be avoided. Tissue methyl Hg should be monitored in sentinel species within Lac du Sauvage to assess temporal trends. Methyl Hg should also be monitored in edible tissues of Lake trout due to their high trophic position, long life span and importance to aboriginal consumers.

[4] The IR Response Table 13-2 incorrectly points to Appendix 8E Table 7-1. The correct table is Appendix 8E, Table 8E4.1-1.

6.1 References

DDEC (Dominion Diamond Ekati Corporation). 2014. Dominion Diamond Ekati Developer’s Assessment Report Jay Project.

DDEC (Dominion Diamond Ekati Corporation). 2015. Jay Project Developer's Assessment Report Information Request Responses DAR-GNWT-IR2-13, July 2015.