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March 24, 2016

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Subject: Technical Memorandum
Hydrogeology modeling for the Howse deposit
Scenarios of wet and dry years
Howse Minerals Limited
Our file n°: 636981

Dear Madam:

SNC-Lavalin GEM[1] Québec inc. (further referred to as "SNC-Lavalin Environment and Geoscience") is pleased to provide you with the hydrogeology modeling update results for the Howse deposit regarding the open pit dewatering activities.

We trust that this technical report is to your satisfaction. Do not hesitate to communicate with the undersigned should you have further questions regarding the content of this report.

Regards,

<Original signed by>

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Senior Hydrogeologist

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[1] GEM: Géotechnique – Environnement – Matériaux

1 Introduction

A numerical model update for the Howse pit dewatering was conducted by SNC-Lavalin (2015) using complementary hydrogeological program conducted in the fall of 2015 by Geofor and on water balance calculation made for an average year.

To study the effect of wetter and dryer years on the water regime, two new modeling scenarios were conducted to represent these conditions. The following sections present the results of these new scenarios.

2 Modeling scenarios

Accurate values of recharge at the site requires a large amount of data of several complete years of stream flow, data infiltration and runoff volumes, and hydrological modeling of one or more representative watersheds in the Howse area. Therefore, estimated recharge may vary depending on the theoretical methods and hypothesis used.

The statistic results on precipitation and evapotranspiration summarized in Table 1 show that the evapotranspiration rate is relatively higher for a dry year in comparison to a wet year, and it represents 20% of the total precipitation. If the annual recharge rate is considered to be 20% of the net water depth available as was considered in previous modeling report, it would be estimated to 85 mm and 185 mm for a dry year and a wet year respectively. For a security factor, the annual recharge rate was decreased to 15% of net water depth available (equivalent to 60 mm) for a dry year, and increased to 27% (equivalent to 250 mm) for a wet year.

Table 1 Summary of statistic results on precipitation and evapotranspiration (from the Water Management Plan update report, SNC-Lavalin, 2016)

	Precipitation[1] (mm)	Evapotranspiration (mm)	Evapotranspiration (%)	Recharge[2] (mm)
Average year	782	111	14%	134
Dry year	532	106	20%	85
Wet year	1041	117	11%	185

[1] Precipitation includes rainfall and snowfall

[2] Recharge = 20% of net water depth available (Following the same method for recharge estimation in SNC-Lavalin report (2015) and Hydrogeology report of Geofor (2015))

Previous modeling of the Howse deposit included one base case scenario and sensitivity analyses by the modeling of three scenarios. The sensitivity analysis includes the increasing of the recharge and hydraulic conductivity of the hydrogeological units in the model. In case for the recharge, the scenarios were achieved by increasing the recharge from 100 to 200 mm/yr (case 2 of Table 2). For the hydraulic conductivity, it was multiplied by two for the overburden and Sokoman formation (case 5 of Table 2) and for all hydrogeological units (case 7 of Table 5).

Four new modeling scenarios are using the new recharge values for dry and wet years (Table 2). These scenarios are:

› Scenarios of cases 1 and 3 using the base case scenario and recharge values of 60 mm/yr and 250 mm/yr for a dry year and a wet year respectively;
› Scenarios of cases 4 and 6 using the base case scenario for which hydraulic conductivities for overburden and Sokoman were doubled, and recharge values of 60 mm/yr and 250 mm/yr for a dry year and a wet year respectively.

The scenarios of case 1 and 6 are considered respectively, minimal and maximal pumping scenarios for dry and wet years in the water management plan. The scenario 7 was not modeled with a recharge of 250 mm/y and was considered not representative due to the fact that the hydraulic conductivities are overestimated in this scenario.

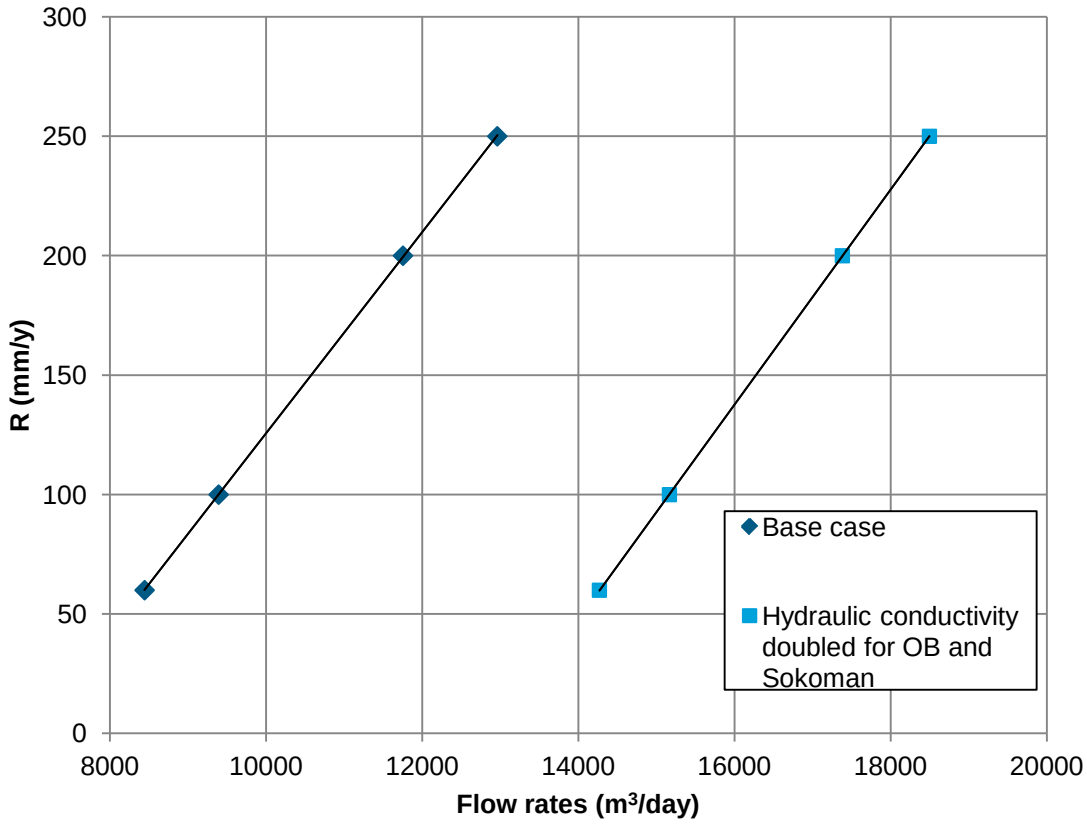
All the scenario results are summarized in Table 2. The new scenarios' results are presented in detail in Appendix A. A graph of the recharge versus the generated flow rate is presented in Figure 1, and shows a good correlation between these two parameters. In fact, the flow rate is proportional to the recharge, and the data follow a good straight line.

Table 2 Dewatering Simulation Results

Scenario	Flow rates (m^3/day)		Note (see Appendix A on sensitivity analysis for more details)	Pumping rate increase
	Model	Safety factor of 1.25		
Base case: Calibrated model	9393	11741	Kx, Ky, Kz; Recharge : 100 mm/y	
Sensitivity analysis Case 1	**8445**	-	Kx, Ky, Kz; Recharge decreased to 60 mm/y	0.9
Sensitivity analysis Case 2	11754	14693	Kx, Ky, Kz; Recharge increased to 200 mm/y	1.3
Sensitivity analysis Case 3	12962	16203	Kx, Ky, Kz; Recharge increased to 250 mm/y	1.4
Sensitivity analysis Case 4	14270	17838	Kx, Ky and Kz multiplied by 2 for OB and Sokoman, Recharge decreased to 60 mm/y	1.5
Sensitivity analysis Case 5	17382	**21728**	Kx, Ky and Kz multiplied by 2 for OB and Sokoman, Recharge increased to 200 mm/y	1.9
Sensitivity analysis Case 6	18497	**23121**	Kx, Ky and Kz multiplied by 2 for OB and Sokoman, Recharge increased to 250 mm/y	2.0
Sensitivity analysis Case 7	18752	23440	Kx, Ky and Kz multiplied by 2 for all five units (OB, Sokoman, Wishart, Shale and Fault zones), Recharge increased to 200 mm/y	2.0

- Base case scenario and scenarios of cases 2, 5 and 7 are conducted in previous model (SNL-Lavalin, 2015).
- Scenarios of cases 1, 3, 4 and 6 are new scenarios for which the results are presented in details in Appendix A
- Highlighted in bold are flow rates considered for dry, average and wet years for the Water Management Plan.

Figure 1 Simulated Recharge and Dewatering Rate Results (Kx, Ky and Kz of base case scenario are maintained constant)



3 Conclusions

The current groundwater flow modeling has allowed for the evaluation of dewatering flow rates of the Howse deposit for a dry year and a wet year. The main conclusions from the modeling results are:

For a dry year scenario with a recharge of 60 mm, the estimated dewatering rate is about 8,500 m³/day;

For a wet year scenario with a recharge of 250 mm and conductivity hydraulic multiplied by 2 for overburden and Sokoman units, the estimated dewatering rate is about 23,200 m³/day.

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References

Geofor Environnement, November 2015. 2015's Hydrogeological Campaign results on Howse deposit. Hydrogeology chapter of the EIA Howse property project report.

SNC-Lavalin (2015). Hydrogeology Numerical Modeling for the Howse Deposit – Update. Howse Property Project. Howse Minerals Limited. Preliminary Report.

SNC-Lavalin (2014) Conceptual Engineering for Howse Water Management Plan. Technical Note. 622834-4000-40ER-0005. November 2014.

Notice to Reader

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The findings, conclusions and recommendations in this report (i) have been developed in a manner consistent with the level of skill normally exercised by professionals currently practicing under similar conditions in the area, and (ii) reflect SNC-Lavalin GEM's best judgment based on information available at the time of preparation of this report. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our original contract and included in this report. The findings and conclusions contained in this report are valid only as of the date of this report and may be based, in part, upon information provided by others. If any of the information is inaccurate, new information is discovered, site conditions change or applicable standards are amended, modifications to this report may be necessary. The results of this assessment should in no way be construed as a warranty that the subject site is free from any and all contamination.

Any soil and rock descriptions in this report and associated logs have been made with the intent of providing general information on the subsurface conditions of the site. This information should not be used as geotechnical data for any purpose unless specifically addressed in the text of this report. Groundwater conditions described in this report refer only to those observed at the location and time of observation noted in the report.

This report must be read as a whole, as sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final version of this report, it is the final version that takes precedence. Nothing in this report is intended to constitute or provide a legal opinion.

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Appendix A

Modeling Results

Case 1 Kxyz of initial calibration + Recharged reduced to 60 mm/yr

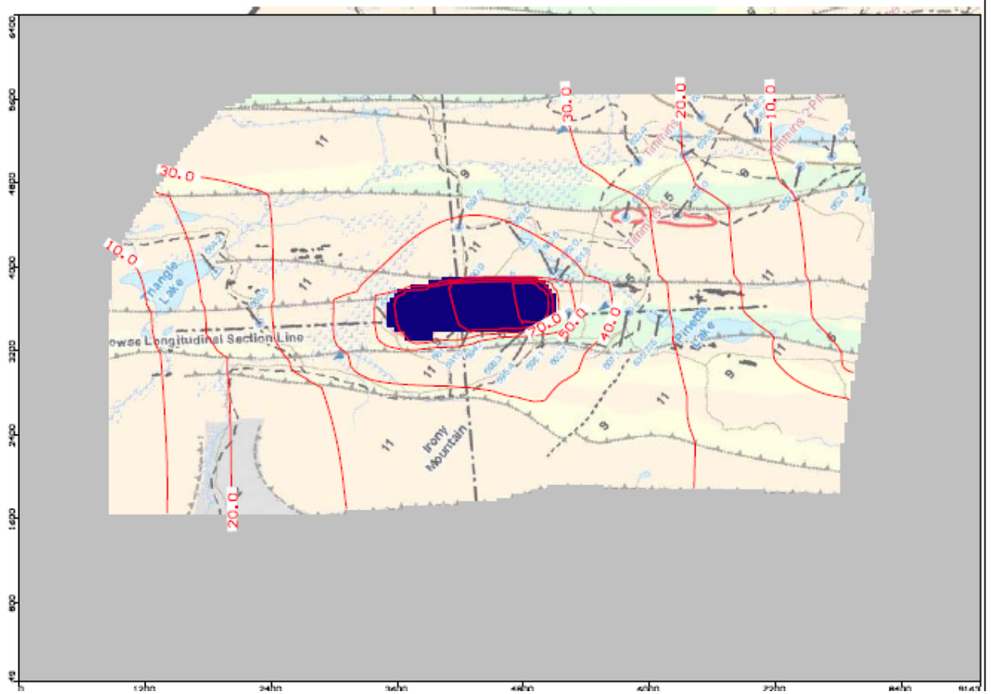
Table Sensitivity analysis – Case 1

Zone	Kx (m/s)		Ky (m/s)		Kz (m/s)	
	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis
Overburden	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
Sokoman	9,40E-06	9,40E-06	9,40E-06	9,40E-06	9,40E-06	9,40E-06
Wishart	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07
Shale	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07
Faults zones	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07

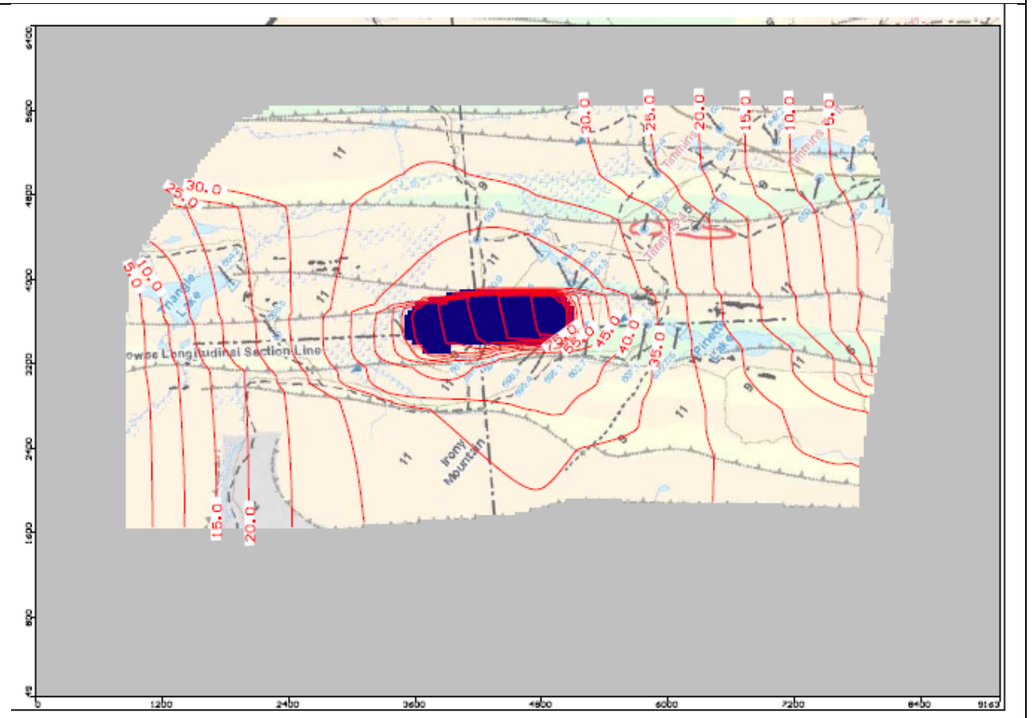
Recharge (mm/year)	Calibrated	Sensitivity analysis
R(1)	100	60

Highlighted values were modified)

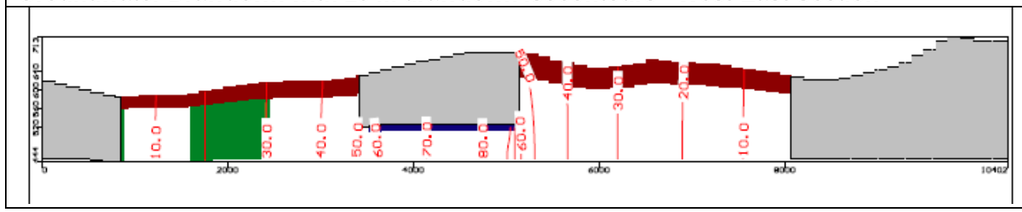
Groundwater Drawdown – 10 m drawdown isocontours



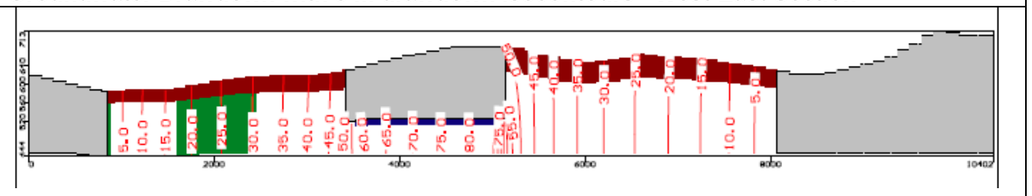
Groundwater Drawdown – 5 m drawdown isocontours



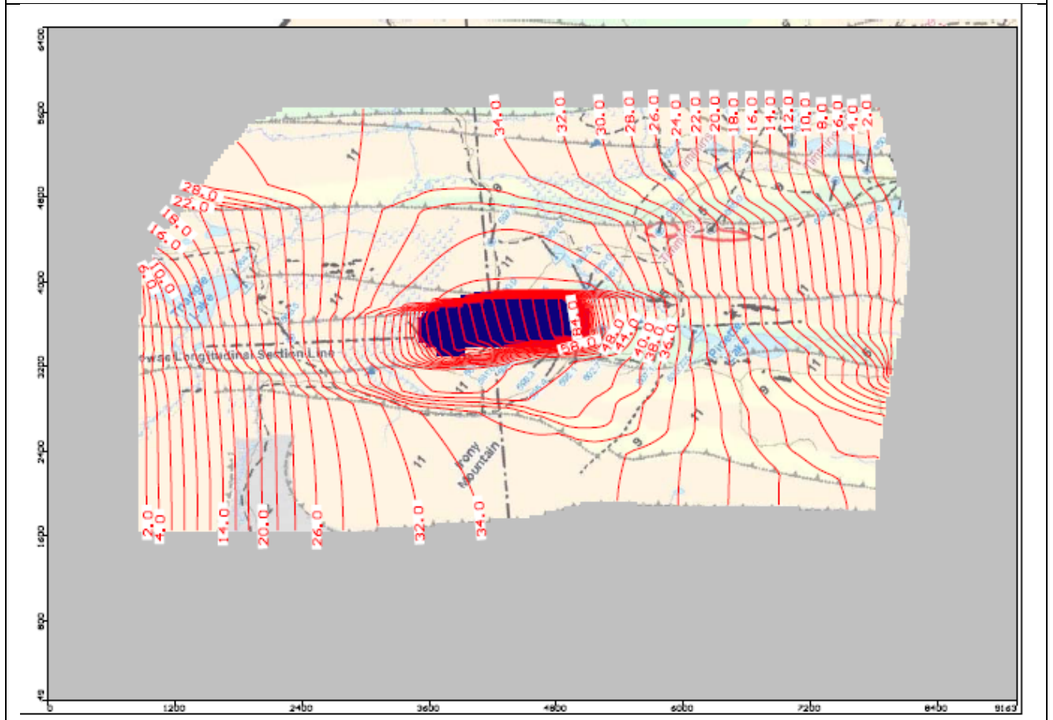
Groundwater Drawdown with 10 m drawdown isocontours - West-East Section



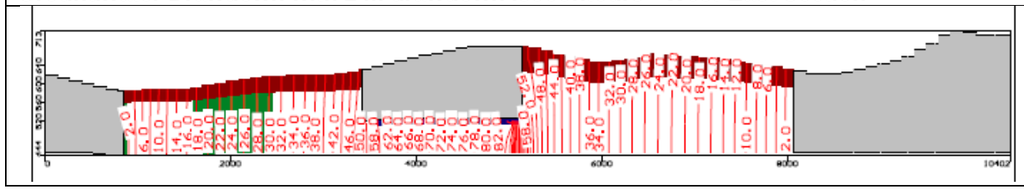
Groundwater Drawdown with 5 m drawdown isocontours - West-East Section



Groundwater Drawdown – 2 m drawdown isocontours



Groundwater Drawdown with 2 m drawdown isocontours - West-East Section



Case 3 Kxyz of initial calibration + Recharged increased to 250 mm/yr

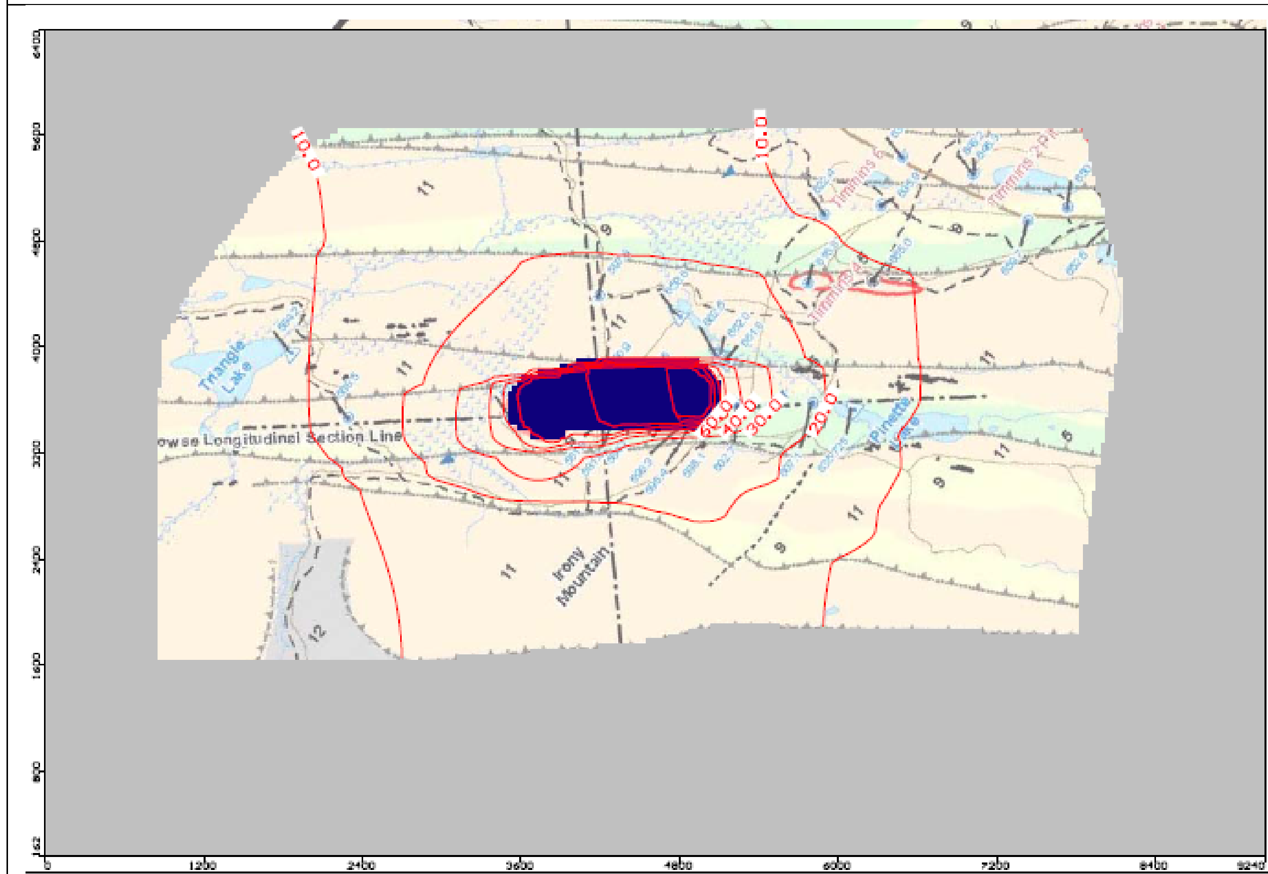
Table Sensitivity analysis – Case 3

Zone	Kx (m/s)		Ky (m/s)		Kz (m/s)	
	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis
Overburden	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
Sokoman	9,40E-06	9,40E-06	9,40E-06	9,40E-06	9,40E-06	9,40E-06
Wishart	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07
Shale	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07
Faults zones	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07

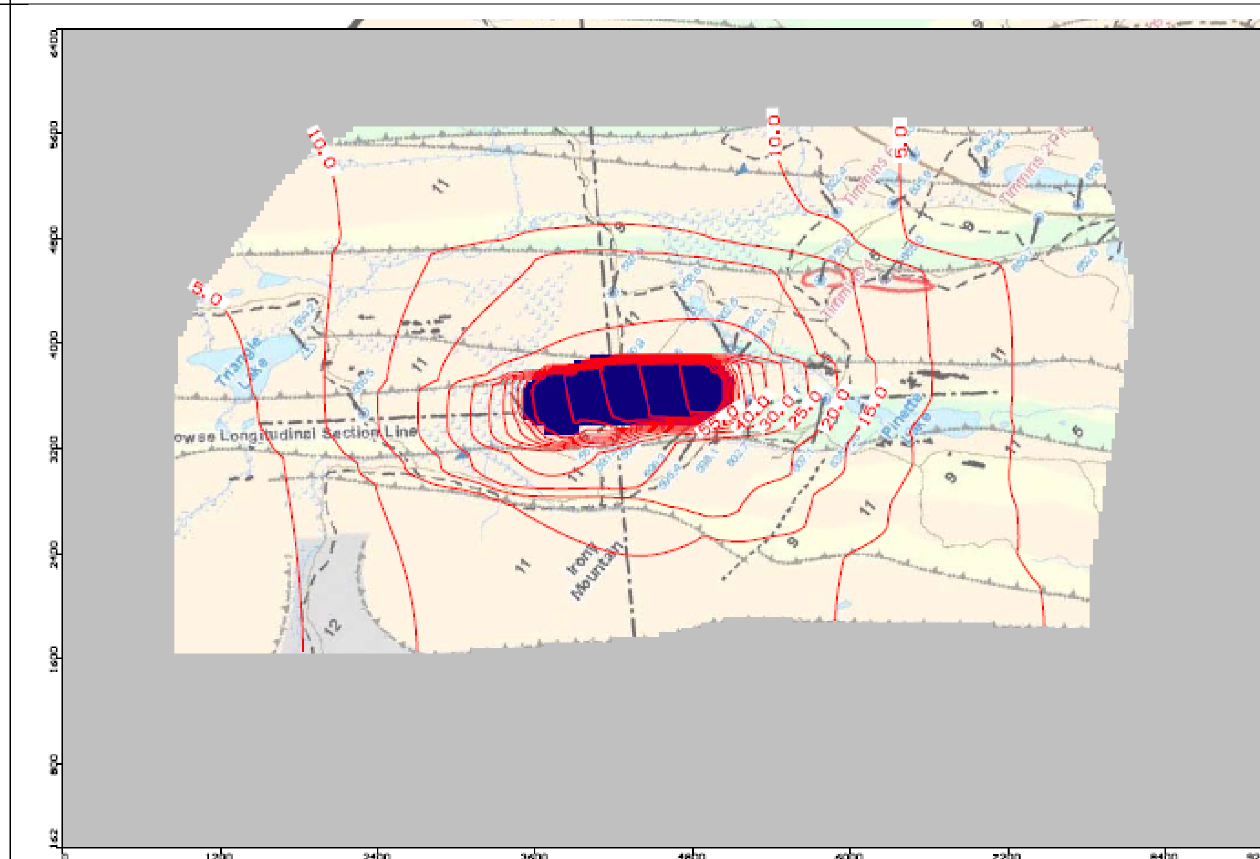
Recharge (mm/year)	Calibrated	Sensitivity analysis
R(1)	100	250

Highlighted values were modified)

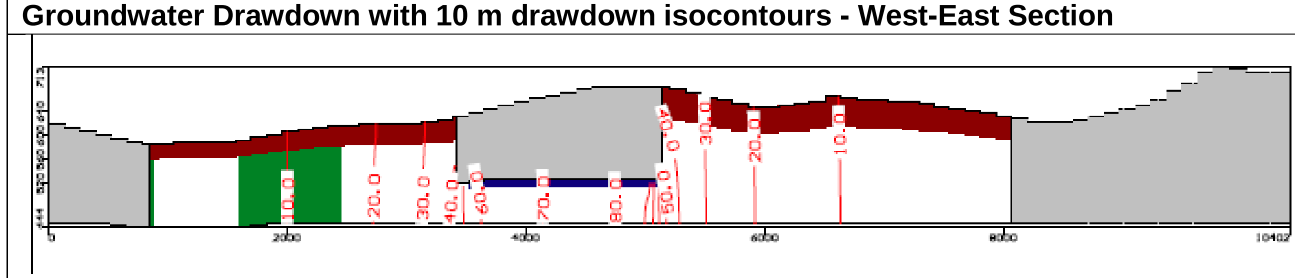
Groundwater Drawdown – 10 m drawdown isocontours



Groundwater Drawdown – 5 m drawdown isocontours



Groundwater Drawdown with 10 m drawdown isocontours - West-East Section



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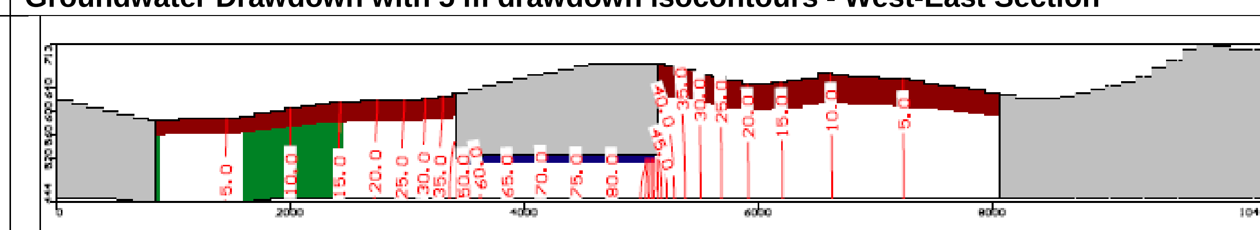

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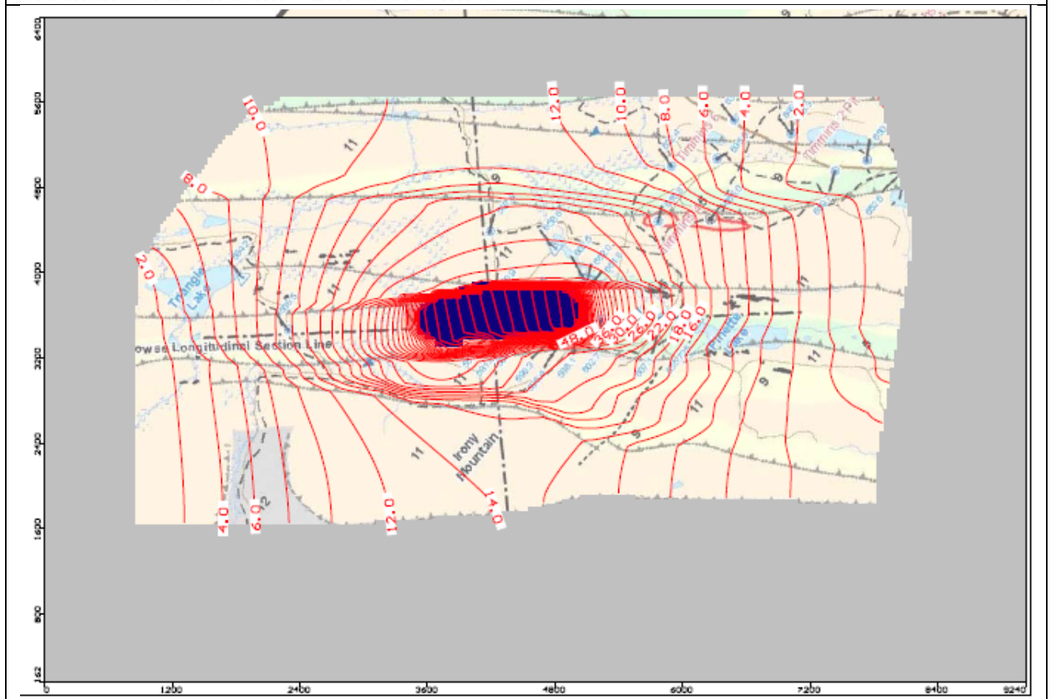
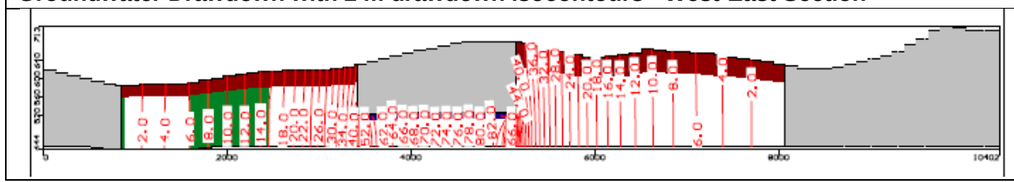


Groundwater Drawdown with 2 m drawdown isocontours - West-East Section



Case 4: Increase Kxyz for the Sokoman and Overburden (x2) + Recharged decreased to 60 mm/yr

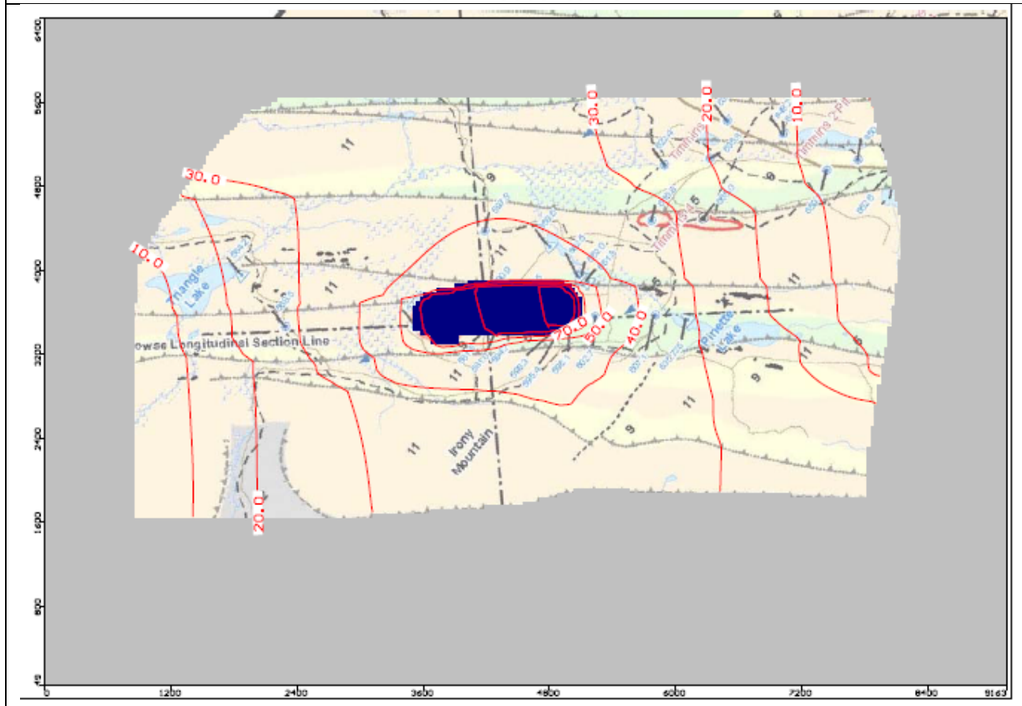
Table Sensitivity analysis – Case 4

Zone	Kx (m/s)		Ky (m/s)		Kz (m/s)	
	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis
Overburden	1,00E-05	2,00E-05	1,00E-05	2,00E-05	1,00E-05	2,00E-05
Sokoman	9,40E-06	1,88E-05	9,40E-06	1,88E-05	9,40E-06	1,88E-05
Wishart	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07
Shale	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07
Faults zones	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07

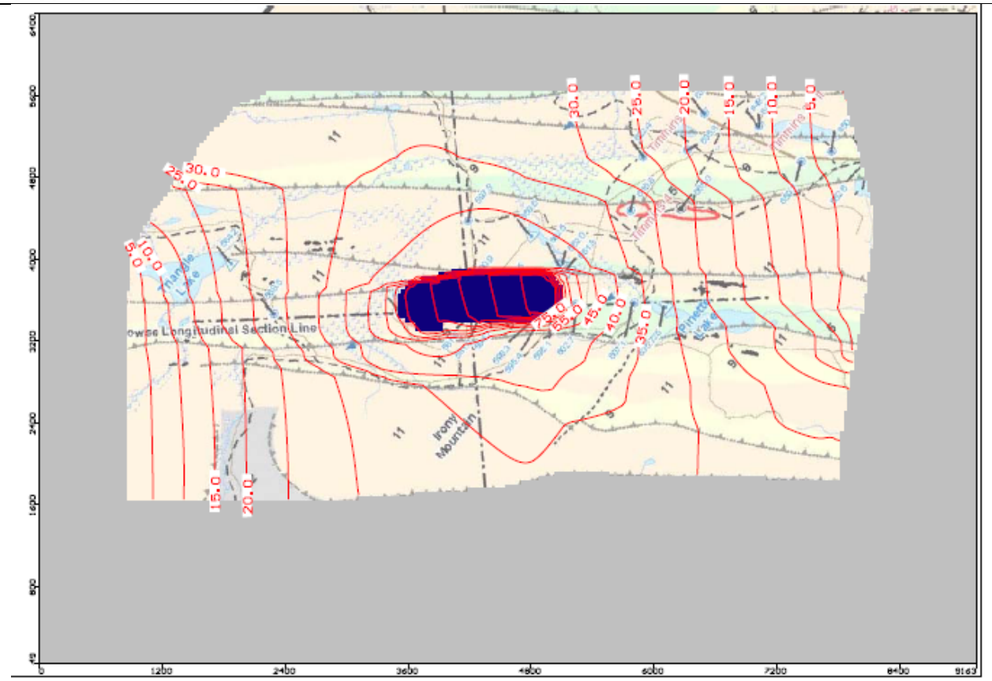
Recharge (mm/year)	Calibrated	Sensitivity analysis
R(1)	100	60

Highlighted values were modified)

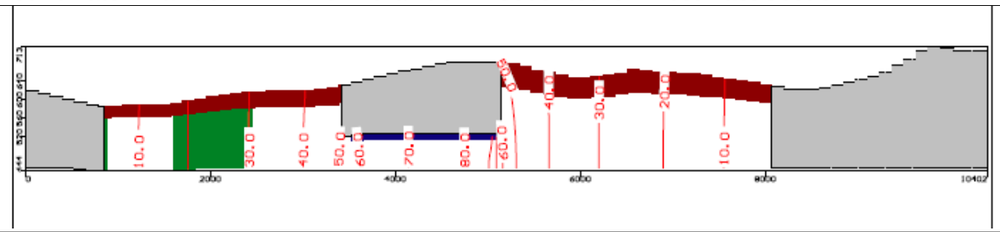
Groundwater Drawdown – 10 m drawdown isocontours



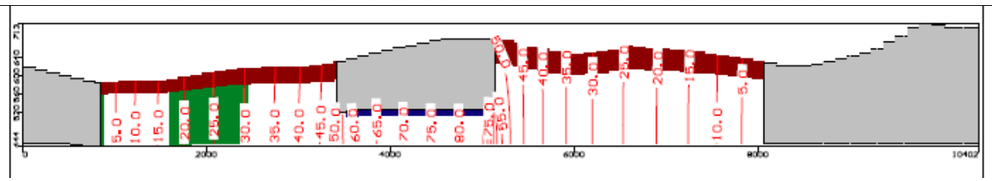
Groundwater Drawdown – 5 m drawdown isocontours



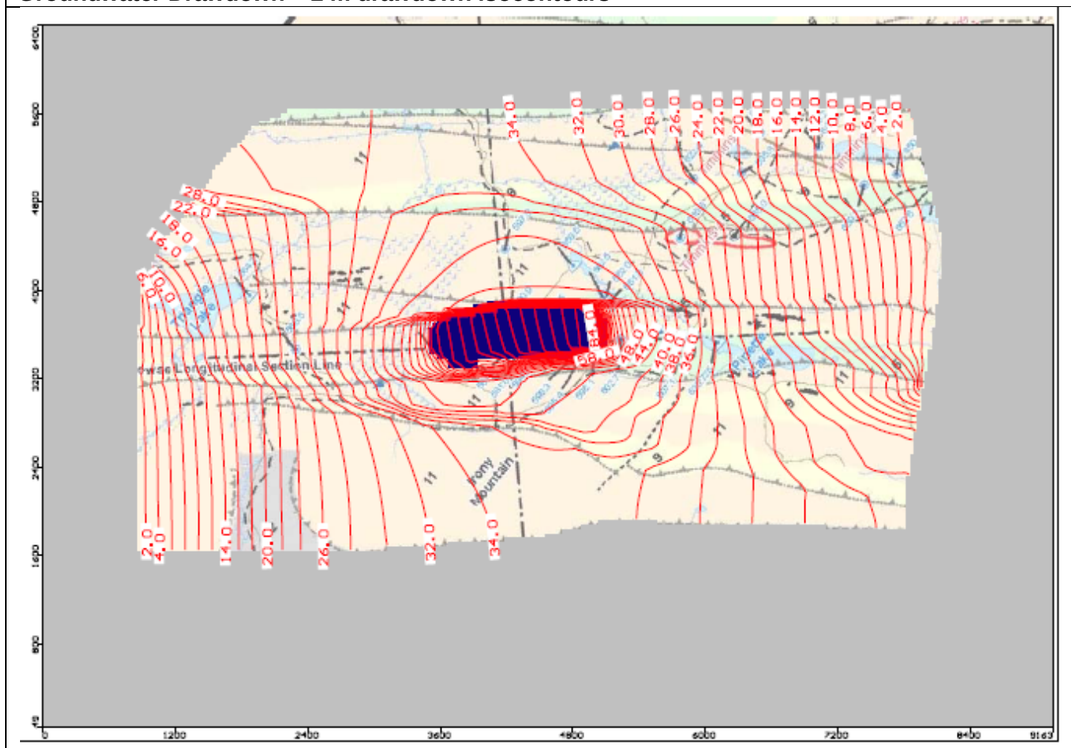
Groundwater Drawdown with 10 m drawdown isocontours - West-East Section



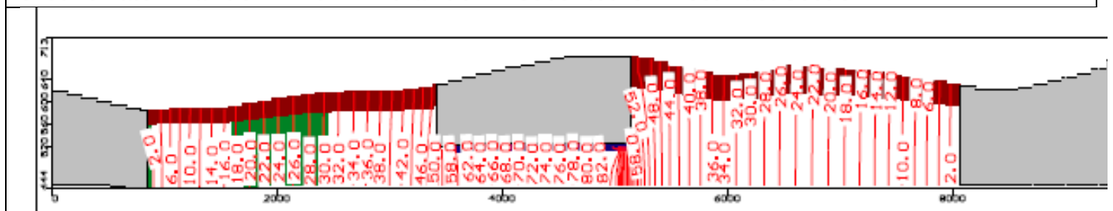
Groundwater Drawdown with 5 m drawdown isocontours - West-East Section



Groundwater Drawdown – 2 m drawdown isocontours



Groundwater Drawdown with 2 m drawdown isocontours - West-East Section



Case 6: Increase Kxyz for the Sokoman and Overburden (x2) + Recharged increased to 250 mm/yr

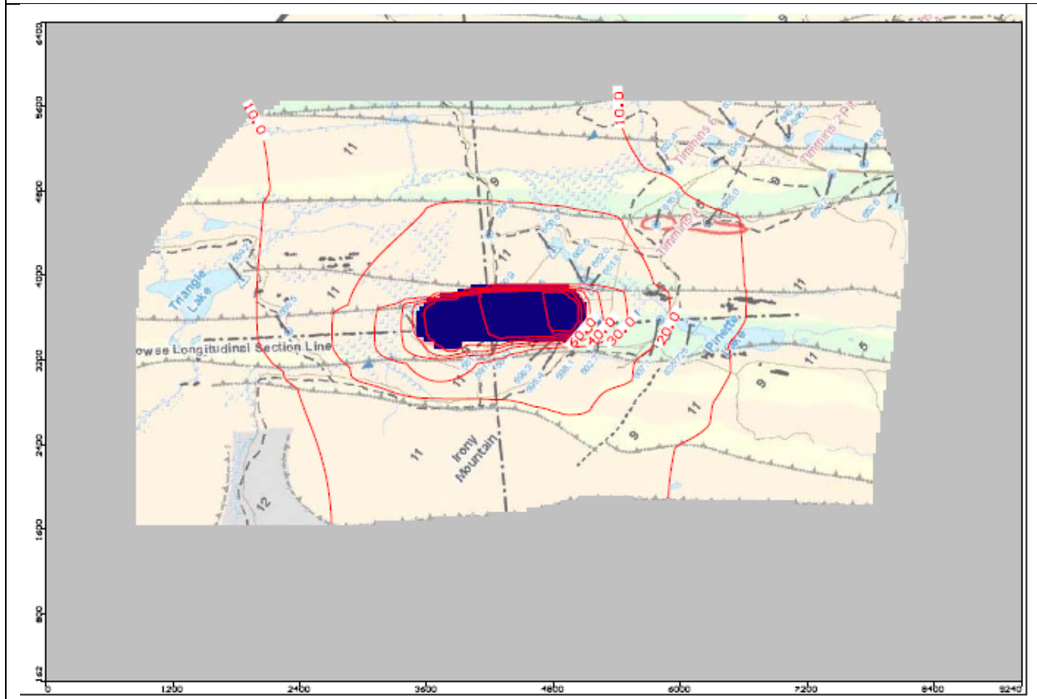
Table Sensitivity analysis – Case 6

Zone	Kx (m/s)		Ky (m/s)		Kz (m/s)	
	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis	Calibrated	Sensitivity analysis
Overburden	1,00E-05	2,00E-05	1,00E-05	2,00E-05	1,00E-05	2,00E-05
Sokoman	9,40E-06	1,88E-05	9,40E-06	1,88E-05	9,40E-06	1,88E-05
Wishart	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07	8,00E-07
Shale	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07	1,00E-07
Faults zones	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07	2,60E-07

Recharge (mm/year)	Calibrated	Sensitivity analysis
R(1)	100	250

Highlighted values were modified)

Groundwater Drawdown – 10 m drawdown isocontours



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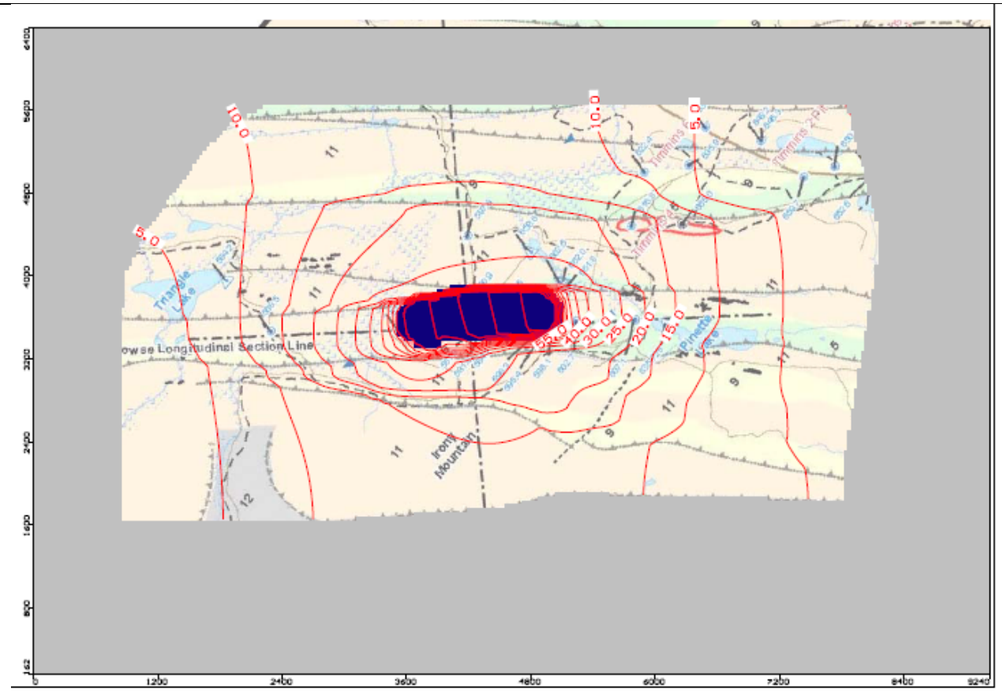
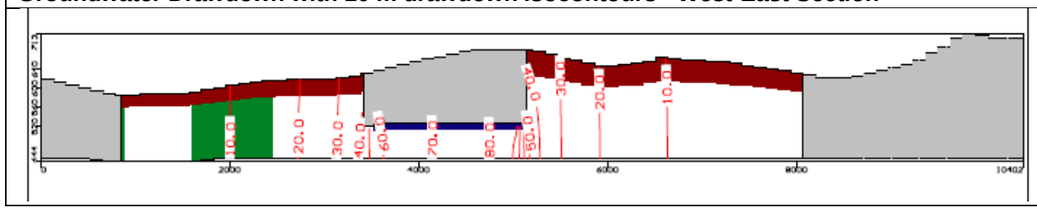
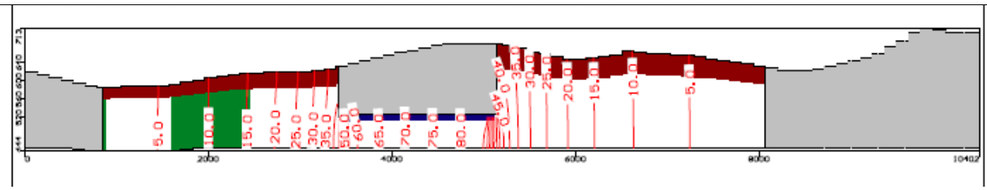


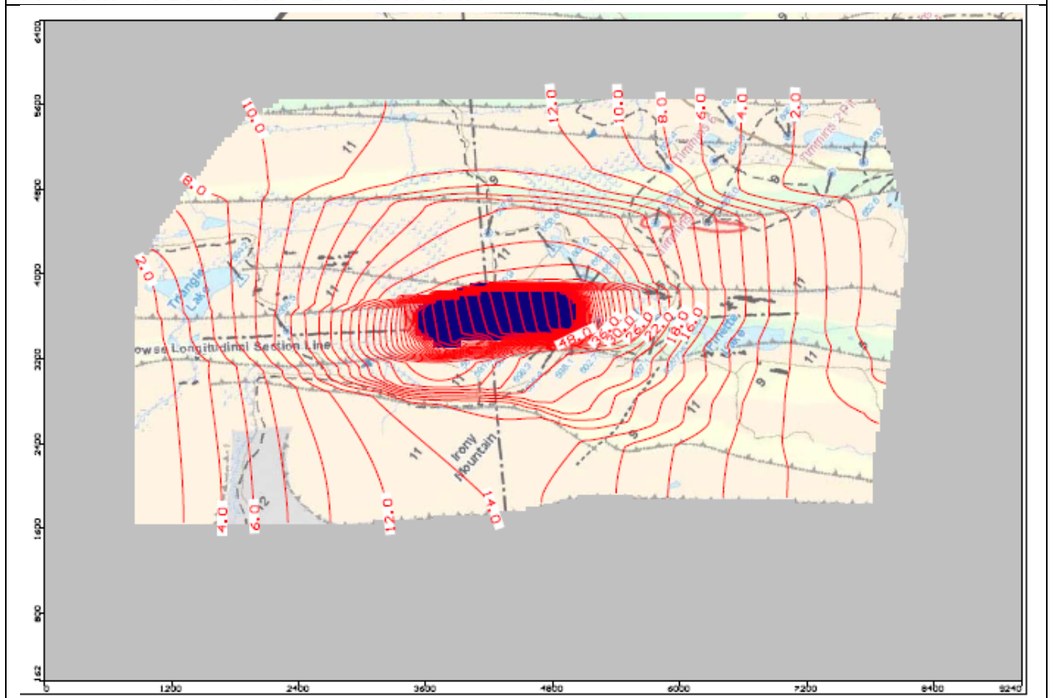
Groundwater Drawdown with 10 m drawdown isocontours - West-East Section



Groundwater Drawdown with 5 m drawdown isocontours - West-East Section



Groundwater Drawdown – 2 m drawdown isocontours



Groundwater Drawdown with 2 m drawdown isocontours - West-East Section