South Queensferry cutting
Calculation of radius of influence and pumping rate

** range for sandstone updated in this revision to give lower minimum K value (taken from old falling head tests DPS27)
** updated southern launch depths incorporated (only making the cutting at section I 0.75m deeper and the cutting at section J a max of 1m deeper)

Linear Excavation **Echline Corner (covered by long section G)** **(Scenario 1)** Use section A

DUPUIT-THIEM EQUATION (unconfined aquifer, steady state conditions)
Q=piK(H_o^2-h_w^2)/2.3log(R_0/re)

Empirical Formula of Sichardt
R_0=C(h_0 - h)SQRT(K)

Where,
r_e rectangular excavation = SQRT(ab/pi) though CIRIA 515 says r_e = (a+b)/pi

Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s (K test results for sandstone though book value range 1e-10 - 1e-6m/s)
D=aquifer thickness Sandstone max 8m thick (av thickness of sstn/gravel at S78 and DPS22)
Ro=radius of influence Calculated
r_e=effective radius 82.1 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Assume approx top of sstn (worst case) & 5.5m above aquifer base (elevation of properties)
h_w=dynamic water level 2.5m above aquifer base (worst case, where sandstone is deepest, S78) corresponds to target drawdown inside excavation
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) =	45
Length of excavation (m) =	470
Chainage 3250 - 3720m	
Assume same depth throughout	

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
6.03E-06	8	8	2.5	27.01	82.1	109.1	0.00385	333	3.85	Sandstone K range
6.03E-06	8	5.5	2.5	14.73	82.1	96.8	0.00276	238	2.76	
6.64E-08	8	8	2.5	2.83	82.1	84.9	0.00036	31	0.36	
6.64E-08	8	5.5	2.5	1.55	82.1	83.6	0.00027	23	0.27	

Linear Excavation **Echline Corner (covered by long section G)** **(Scenario 2)** Use section B

DUPUIT-THIEM EQUATION (unconfined aquifer, steady state conditions)
Q=piK(H_o^2-h_w^2)/2.3log(R_0/re)

Empirical Formula of Sichardt
R_0=C(h_0 - h)SQRT(K)

Where,
r_e rectangular excavation = SQRT(ab/pi) though CIRIA 515 says r_e = (a+b)/pi

Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s (K test results for sandstone though book value range 1e-10 - 1e-6m/s). 4E-5 m/s also shown as this gives upper K range for tested mudstone
D=aquifer thickness Sandstone max 12m thick (av thickness of sstn at CSRO03A/CSRO05A/BHS1020)
Ro=radius of influence Calculated
r_e=effective radius 82.1 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Assume approx top of sstn (worst case) & 8m above aquifer base (elevation of properties)
h_w=dynamic water level 6m above aquifer base, corresponds to target drawdown inside excavation
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) =	45
Length of excavation (m) =	470
Chainage 3250 - 3720m	
Assume same depth throughout	

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
6.03E-06	12	12	6	29.47	82.1	111.5	0.00668	577	6.68	Sandstone K range
6.03E-06	12	8	6	9.82	82.1	91.9	0.00470	406	4.70	
6.64E-08	12	12	6	3.09	82.1	85.1	0.00061	53	0.61	
6.64E-08	12	8	6	1.03	82.1	83.1	0.00047	40	0.47	
4.00E-05	12	12	6	75.89	82.1	157.9	0.02075	1792	20.75	Heighest K value when maximum mudstone K included in the range (included as CSRO03A used for thickness input and this BH includes interbedded sstn and mudstone. Highly Unlikely. CRT in this area gave K = 7.34 E-7 m/s
4.00E-05	12	8	6	25.30	82.1	107.3	0.01311	1132	13.11	

Linear Excavation **Springfield (south) (covered by long section K)** **(Scenario 1)** Use section D
Where,
Q=flow rate
K=hydraulic conductivity Range 1e-9 - 1e-7m/s (K test results for clayey drift. Book value range for Boulder Clay 1e-12 - 1e-6m/s)
D=aquifer thickness Boulder Clay max 9m thick
Ro=radius of influence Calculated
r_e=effective radius 69.8 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Approx top of boudler clay (worst case) or 4m above aquifer base where water strike in TPS96, though gw appears to be assoc with sandy lenses.
h_w=dynamic water level 0m above aquifer base as boulder clay base approx same at deepest part of cutting
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 340
Chainage 3720 - 4060m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
1.00E-07	9	9	0	5.69	69.8	75.5	0.00032	28	0.32	Range of K values for boulder clay/superficials
1.00E-07	9	4	0	2.53	69.8	72.3	0.00014	12	0.14	
1.00E-09	9	9	0	0.57	69.8	70.4	0.00003	3	0.03	
1.00E-09	9	4	0	0.25	69.8	70.0	0.00001	1	0.01	
6.03E-06	9	9	0	44.20	69.8	114.0	0.00313	271	3.13	Using upper K limit for
6.03E-06	9	4	0	19.64	69.8	89.4	0.00122	106	1.22	

Linear Excavation **Springfield (south) (covered by long section K)** **(Scenario 2)** Use section E
Where,
Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s (K test results for sandstone though book value range 1e-10 - 1e-6m/s)
D=aquifer thickness Use depth of base of sandstone to
Ro=radius of influence Calculated
r_e=effective radius 69.8 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Max w.l. recorded approx. 10m above aquifer base at DPS39 (though the installation covers the whole section and max water level recording is questionable therefore conservative)
h_w=dynamic water level 2.5m above sstn aquifer base at deepest part of cutting
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 340
Chainage 3720 - 4060m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
6.03E-06	6.5	10	2.5	36.83	69.8	106.6	0.00419	362	4.19	Sandstone K range
6.64E-08	6.5	10	2.5	3.87	69.8	73.7	0.00036	31	0.36	

Linear Excavation **Springfield (north)(covered by long section L)** **(Scenario 1)** Use section M
Where,
Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s K test results for sandstone and 2.5E-5 m/s tested K for dolerite
D=aquifer thickness Use depth of base of sandstone (+ small section of dolerite - group together)
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Elevation of properties above aquifer base (11), or top of aquifer (4) (no reliable sstn/dolerite w.l.s within the cutting for this section so use height of houses as worst case scenario)
h_w=dynamic water level 0m as base of cutting coincides with aquifer base
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
2.50E-05	4	11	0	110.00	69.8	179.8	0.01005	869	10.05	Tested dolerite and sandstone K range
2.50E-05	4	4	0	40.00	69.8	109.8	0.00278	240	2.78	
6.64E-08	4	11	0	5.67	69.8	75.5	0.00032	28	0.32	
6.64E-08	4	4	0	2.06	69.8	71.8	0.00011	10	0.11	

Linear Excavation **Springfield (north) (covered by long section L)** **(Scenario 2)** Use section I
Where,
Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s K test results for sandstone
D=aquifer thickness Use depth of base of sandstone
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Top of aquifer (15m). NB. BHS1031 sstn installation is dry (no water recorded in the cutting) so this is a very conservative estimate
h_w=dynamic water level 12.5 = base of cutting above base of aquifer
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
6.03E-06	15	15	12.5	12.28	69.8	82.1	0.00805	695	8.05	Tested dolerite and sandstone K range
6.64E-08	15	15	12.5	1.29	69.8	71.1	0.00078	68	0.78	

Linear Excavation **Linn Mill (covered by long section L)** Use section I and F
Where,
Q=flow rate
K=hydraulic conductivity Range 6.64e-8 - 6.03e-6m/s K test results for sandstone
D=aquifer thickness Use depth of base of sandstone
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Elevation of properties above aquifer base (16m - worst case), or top of aquifer (15m - as recorded)
h_w=dynamic water level 12.5 = base of cutting above base of aquifer
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
6.03E-06	15	16	12.5	17.19	69.8	87.0	0.00859	742	8.59	Tested dolerite and sandstone K range
6.03E-06	15	15	12.5	12.28	69.8	82.1	0.00805	695	8.05	
6.64E-08	15	16	12.5	1.80	69.8	71.6	0.00082	71	0.82	
6.64E-08	15	15	12.5	1.29	69.8	71.1	0.00078	68	0.78	

Note: Linn Mill Burn is at approx the same elevation as the top of the aquifer (35mAOD) so use Ho = 15, and Ro + re above to see if dewatering will affect Linn Mill Burn

Note: Society Road properties approx. 20 mAOD so far below the base of the cutting

South Queensferry cutting
Calculation of radius of influence and pumping rate

****Using mean K value from pump tests analysis** 7.34E-07

** range for sandstone updated in this revision to give lower minimum K value (taken from old falling head tests DPS27 - previously missed)
** updated southern launch depths incorporated (only making the cutting at section I 0.75m deeper and the cutting at section J a max of 1m deeper)

Linear Excavation **Echline Corner (covered by long section G)** **(Scenario 1)** Use section A

DUPUIT-THIEM EQUATION (unconfined aquifer, steady state conditions)
Q=piK(H_o^2-h_w^2)/2.3log(R_0/re)

Empirical Formula of Sichardt
R_0=C(h_0 - h)SQRT(K)

Where,
Q=flow rate
K=hydraulic conductivity 7.34E-07 sstn (pump test)
D=aquifer thickness Sandstone max 8m thick (av thickness of sstn/gravel at S78 and DPS22)
Ro=radius of influence Calculated
r_e=effective radius 82.1 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Assume approx top of sstn (worst case) & 5.5m above aquifer base (elevation of properties)
h_w=dynamic water level 2.5m above aquifer base (worst case, where sandstone is deepest, S78) corresponds to target drawdown inside excavation
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

r_e rectangular excavation = SQRT(ab/pi) though CIRIA 515 says r_e = (a+b)/pi

Width of excavation (m) = 45
Length of excavation (m) = 470
Chainage 3250 - 3720m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
7.34E-07	8	8	2.5	9.42	82.1	91.5	0.00123	106	1.23	Sandstone K range
7.34E-07	8	5.5	2.5	5.14	82.1	87.2	0.00091	79	0.91	

Linear Excavation **Echline Corner (covered by long section G)** **(Scenario 2)** Use section B

DUPUIT-THIEM EQUATION (unconfined aquifer, steady state conditions)
Q=piK(H_o^2-h_w^2)/2.3log(R_0/re)

Empirical Formula of Sichardt
R_0=C(h_0 - h)SQRT(K)

Where,
Q=flow rate

K=hydraulic conductivity 7.34E-7 m/s (pumpt test sstn), 4e-5 m/s also shown as this gives upper K range for tested mudstone
D=aquifer thickness Sandstone max 12m thick (av thickness of sstn at CSRO03A/CSRO10/BHS1020)
Ro=radius of influence Calculated
r_e=effective radius 82.1 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Assume approx top of sstn (worst case) & 8m above aquifer base (elevation of properties)
h_w=dynamic water level 6m above aquifer base, corresponds to target drawdown inside excavation
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

r_e rectangular excavation = SQRT(ab/pi) though CIRIA 515 says r_e = (a+b)/pi

Width of excavation (m) = 45
Length of excavation (m) = 470
Chainage 3250 - 3720m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
7.34E-07	12	12	6	10.28	82.1	92.3	0.00211	182	2.11	
7.34E-07	12	8	6	3.43	82.1	85.5	0.00158	136	1.58	
4.00E-05	12	12	6	75.89	82.1	157.9	0.02075	1792	20.75	Heighest K value when maximum mudstone K included in the range (included as CSRO03A used for thickness input and this BH includes interbedded sstn and mudstone. Highly Unlikely. CRT in this area gave K = 7.34 E-7 m/s
4.00E-05	12	8	6	25.30	82.1	107.3	0.01311	1132	13.11	

Linear Excavation **Springfield (south) (covered by long section K)** **(Scenario 1)** Use section D
Where,
Q=flow rate
K=hydraulic conductivity Range 1e-9 - 1e-7m/s (K test results for clayey drift. Book value range for Boulder Clay 1e-12 - 1e-6m/s)
D=aquifer thickness Boulder Clay max 9m thick
Ro=radius of influence Calculated
r_e=effective radius 69.8 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Approx top of boudler clay (worst case) or 4m above the aquifer base (water strike in TPS96), though gw appears to be assoc with sandy lenses.
h_w=dynamic water level 0m above aquifer base as boulder clay base approx same at deepest part of cutting
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 340
Chainage 3720 - 4060m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
1.00E-07	9	9	0	5.69	69.8	75.5	0.00032	28	0.32	Range of K values for boulder clay/superficials
1.00E-07	9	4	0	2.53	69.8	72.3	0.00014	12	0.14	
1.00E-09	9	9	0	0.57	69.8	70.4	0.00003	3	0.03	
1.00E-09	9	4	0	0.25	69.8	70.0	0.00001	1	0.01	
7.34E-07	9	9	0	15.42	69.8	85.2	0.00094	81	0.94	Using sandstone K
7.34E-07	9	4	0	6.85	69.8	76.6	0.00039	34	0.39	

Linear Excavation **Springfield (south) (covered by long section K)** **(Scenario 2)** Use section E
Where,
Q=flow rate
K=hydraulic conductivity 7.34E-07 sstn (pump test)
D=aquifer thickness Use depth of base of sandstone to
Ro=radius of influence Calculated
r_e=effective radius 69.8 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Max w.l. recorded approx. 10m above aquifer base at DPS39 (though the installation covers the whole section and max levels are questionable therefore conservative estimates)
h_w=dynamic water level 2.5m above sstn aquifer base at deepest part of cutting
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 340
Chainage 3720 - 4060m
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
7.34E-07	6.5	10	2.5	12.85	69.8	82.6	0.00128	111	1.28	

Linear Excavation **Springfield (north)(covered by long section L)** **(Scenario 1)** Use section M
Where,
Q=flow rate
K=hydraulic conductivity 7.34e-7 (pump test sstn) and 2.5E-5 m/s tested K for dolerite
D=aquifer thickness Use depth of base of sandstone (+ small section of dolerite - group together)
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Elevation of properties above aquifer base (11), or top of aquifer (4) (no reliable w.l.s for this section so use height of houses as worst case scenario)
h_w=dynamic water level 0m as base of cutting coincides with aquifer base
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
2.50E-05	4	11	0	110.00	69.8	179.8	0.01005	869	10.05	Tested dolerite and CRT sandstone K range
2.50E-05	4	4	0	40.00	69.8	109.8	0.00278	240	2.78	
7.34E-07	4	11	0	18.85	69.8	88.6	0.00117	101	1.17	
7.34E-07	4	4	0	6.85	69.8	76.6	0.00039	34	0.39	

Linear Excavation **Springfield (north)(covered by long section L)** **(Scenario 2)** Use section I
Where,
Q=flow rate
K=hydraulic conductivity 7.34E-07 sstn (pump test)
D=aquifer thickness Use depth of base of sandstone
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Max w.l. recorded corresponds with top of aquifer (15m)
h_w=dynamic water level 12.5 = base of cutting above base of aquifer
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
7.34E-07	15	15	12.5	4.28	69.8	74.1	0.00266	230	2.66	

Linear Excavation **Linn Mill (covered by long section L)** Use section I and F
Where,
Q=flow rate
K=hydraulic conductivity 7.34E-07 sstn (pump test)
D=aquifer thickness Use depth of base of sandstone
Ro=radius of influence Calculated
r_e=effective radius 52.2 Calculated (X section of base of excavation typically 45m)
H_o=rest water level Elevation of properties above aquifer base (16m - worst case), or top of aquifer (15m - as recorded)
h_w=dynamic water level 12.5 = base of cutting above base of aquifer
Theim eqn assumes a radius of influence = R0+Re
Constant,C= 2000 (empirical calibration factor - 3000 for radial or 1500-2000 for linear excavation (3000 = worst case))

Width of excavation (m) = 45
Length of excavation (m) = 190
Chainage 4060 - 4250m (ending approx where the cutting stops)
Assume same depth throughout

Calculation of required flow (Thiem), Calculation of radius of influence (Sichardt)

Hydraulic Conductivity (m/s)	Aquifer Thickness (m)	H_0 (m)	h_w (m)	Calculated Radius of Influence Ro (m)	Effective Radius r_e (m)	Ro + re (m)	Calculated Flow Q (m^3/s)	Flow Q (m^3/d)	Flow Q (l/s)	
7.34E-07	15	16	12.5	6.00	69.8	75.8	0.00279	241	2.79	
7.34E-07	15	15	12.5	4.28	69.8	74.1	0.00266	230	2.66	

Note: Linn Mill Burn is at approx the same elevation as the top of the aquifer (35mAOD) so use Ho = 15, and Ro + re above to see if dewatering will affect Linn Mill Burn

Note: Society Road properties approx. 20 mAOD so far below the base of the cutting

Predicted Inflows

Cutting Section					
	Chainage	Length of section	Min estimted inflow (m^3/day)	Max. estimated inflow using max K derived from falling head test values (m^3/day)	Max estimated inflow using sandstone K derived from pumping test analysis (m3/day)
Ecline	3250 - 3720m	470	23	577 or 1792 (the latter figure if mudstone K of 4 x 10^{-5} m/s used)	182 or 1792 (if mudstone K of 4 x 10^{-5} m/s used)
Springfield (south)	3720 - 4060m	340	1	362	111
Springfield (north)	4060 - 4250m	190	10	869	869 * (dolerite higher K value)
Total Inflow			34	1808 or 3023	1162 or 2772

Predicted radius of influence and drawdown

	Minimum distance from centre of cutting to receptor (m), r_i	Max estimated R_o + re	Drawdown at radius r_i (m)
Ecline	180	157.9	0
Springfield (south)	270	114.0	0
Springfield (north)	227	179.8	0
Linn Mill properties	137	87.0	0
Linn Mill Burn	186	82.1	0
Society Road	The elevation of the properties is below the base of the cutting so dewatering will not occur		

Notes

R_o = calculated radius of influence

R_e = effective radius of excavation

r_i = minimum distance from the centre of the cutting to the receptor