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E1

PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

BASIC PIPELINE DESIGN		
Question	**Description**	**Solution**
E1Q1	Calculated pipe diameter = Commercial diameter = Pipe material =	**283 mm** **315 mm** **mPVC**
E1Q2	Maximum pressure downstream of pump based on calculated HGL =	**183,63 m (based on k_s = 0,06 mm)**
E1Q3	Section 1 = Section 2 = Section 3 = Section 4 = Section 5 =	**From 0 m to 4245 m - Class 20** **From 4245 m to 8845 m - Class 16** **From 8845 m to 10605 m - Class 12** **From 10605 m to 18170 m - Class 9**
E1Q4	Pump detail = Duty point – Q = H =	**KSB WKLn 80/4 2900 rpm** **145,8 m³/h** **196 m**
E1Q5	a) What is the pressure at the node J12?	**118,4 m**
	b) What will be the maximum pressure in the pipeline if an isolating valve is closed upstream of Reservoir R9 (T1)?	**296 m (cut-off head of pump)**
	c) What is the unit loss (m/km) in pipe P5 and P28? Why do they vary?	**P5 = 1,29 m/n** **P28 = 0,96 m/m (different inner diameters)**
	d) Is the system optimized?	**50:50**
	e) What will happen to the flow rate if Reservoir R9 operates at minimum level?	**Flow rate will increase to 43,59 l/s**

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PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE

E2

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

LIFE CYCLE COSTING ANALYSIS		
Question	**Description**	**Solution**
E2Q1	What is the maximum flow rate for Alternative 1 at the end of the design life (Ml/day)?	**147,230 m³/h**
E2Q2	What and where is the lowest pressure (m) in the pipeline (year 1) for alternative 1?	**The lowest pressure would be a the end reservoir i.e. 10 m**
E2Q3	What is the capital cost of Alternative 1?	**R17 742 520 (Pipeline cost)** **R2 280 000 (Mechanical cost)** **R456 000 (Electrical cost)** **R20 478 520 (Total capital cost)**
E2Q4	What is the IRR of Alternative 1?	**10,423%**
E2Q5	What is the annual operating cost in year 15 for alternative 1?	**R1 097 166**
E2Q6	Which alternative would you recommend and why?	**Only 1 analysed (compare your solution with Alternative 1)**
E2Q7	What other options do you have that will improve the system, providing you with a better alternative?	o **Increase diameter which will increase capital costs but reduce energy costs.** o **Smoother pipe which would reduce friction.** o **Phased approach, providing the correct sized pipe at the appropriate time depending on the design flow (not applicable in this example).**
E2Q8	Where do you think are the restriction is in the system? Explain….	**The limitation of maximum pressure. The static height difference is fixed and thus there will always be a large component associated with energy costs to overcome this static height. Other…**
E2Q9	What will the outcome of the decision be if energy escalated by 20%?	**The $NPV_{Expenditure}$ is now greater than the NPV_{Income} and thus IRR = 0.0%. Energy costs made this alternative solution infeasible.**

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PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE

E3

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

NETWORK ANALYSIS AND OPTIMIZATION

Nr	Question	Answer
E3Q1	List your final selection of pipe diameters.	(see table below)
E3Q2	What is the minimum pressure in your system for your selected set of pipe diameters and at which node?	**31,143 at Node 6**
E3Q3	What is the optimum system obtained with GANEO	(see table below)
E3Q4	How long did the optimization process take on your machine?	**84 seconds (but depends on speed of your computer)**
E3Q5	List a number of locations in a water supply system where there could be a potential for conduit hydropower development.	**1.) At break pressure tank** **2.) At any off take** **3.) At Pressure Reducing Stations** **4.) Inline** **5.) Intake into WTW**

E3Q1:

Pipe nr	Diameter (mm)	Cost (R)
1	**508**	**170 000**
2	**254**	**32 000**
3	**457,2**	**130 000**
4	**203,2**	**23 000**
5	**355,6**	**60 000**
6	**254**	**32 000**
7	**152**	**16 000**
8	**101,6**	**11 000**
Total		**474 000**

E3Q3:

Pipe nr	Diameter (mm)	Cost (R)
1	**508**	**170 000**
2	**254**	**32 000**
3	**406,4**	**90 000**
4	**25,4**	**2 000**
5	**355,6**	**60 000**
6	**254**	**32 000**
7	**254**	**32 000**
8	**50,8**	**5 000**
Total		**423 000**

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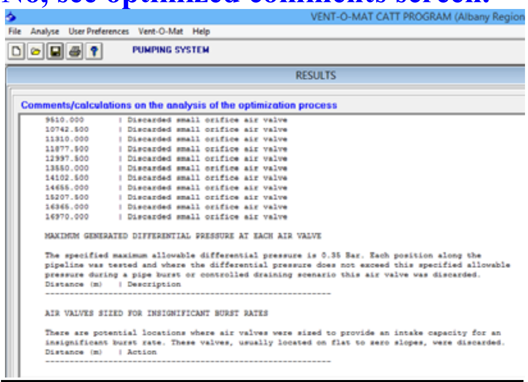
PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE **E4**

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

<table>
<tr><th colspan="3">VALVE SIZING AND POSITIONING</th></tr>
<tr><th>Question</th><th>Description</th><th>Answer</th></tr>
<tr><td>E4Q1a</td><td>How many isolating valves do you recommend for this pipeline?</td><td>6 isolating valves</td></tr>
<tr><td>E4Q1b</td><td>List the positions where isolating valves will be placed (chainages).</td><td>Chainage 0 m (at pump station)
Chainage 4 245 m
Chainage 9 390 m
Chainage 12 445 m
Chainage 15 760 m
Chainage 18 170 m (at end reservoir)</td></tr>
<tr><td>E4Q1c</td><td>What is the size of you scour points?</td><td>75 mm (approximately 35% of pipe diameter, although this is only a guide)</td></tr>
<tr><td>E2Q2a</td><td>What size air valve is required for Node J3?</td><td>Based on the Vent-O-Mat CATT air valve analysis the air valves required at nodes
Node J3 = 050RBX16 1
Node 28 = 080RBX16 1</td></tr>
<tr><td>E4Q2b</td><td>Will air be transported between J4 and J5 (chainage 1760 and 2400 m) for the design flow rate?</td><td>Typically every 600 m although they are crucial on sections where Vc < V as seen on the Comments page of the Vent-O-Mat CATT program results screen.</td></tr>
<tr><td>E4Q3a</td><td>The specified maximum allowable differential pressure is set by the user. Each position along the pipeline was tested and where the differential pressure does not exceed this specified allowable pressure during a pipe burst or controlled draining scenario this air valve was discarded. Where any valves on this pipeline discarded based on this criterion?</td><td rowspan="2">No, see optimized comments screen.

</td></tr>
<tr><td>E4Q3b</td><td>There are potential locations where air valves were sized to provide an intake capacity for an insignificant burst rate. These valves, usually located on flat to zero slopes, were discarded. Were any valves on this pipeline discarded based on this criterion?</td></tr>
</table>

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PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE

E5

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

THRUST BLOCK DESIGN		
Question	**Description**	**Solution**
E5Q1	Compare the results of your hand calculation with the forces obtained with UPThrust.	**Hand calculations** **$F_{upstream}$ = 152,961 kN** **$F_{downstream}$ = 153,375 kN** **Forces are similar when calculated using UPThrust**
E5Q2	What should the thrust block areas be?	**A for upstream force = 0,765 m²** **A for downstream force = 0,767 m²**
E5Q3	What are the resultant forces (F_R) in this pipe section and its working angle (θ)?	**As indicated above, angle is 0° i.e. direction of flow**
E5Q4	What is the maximum required mass of the concrete block to prevent horizontal movement (if there are no other passive reaction forces exerted by the in-situ trench sides)?	**Based on the maximum force ($F_{upstream}$) and assuming only weight of concrete and not pipe and water weight. Mc = 34 743 kg**

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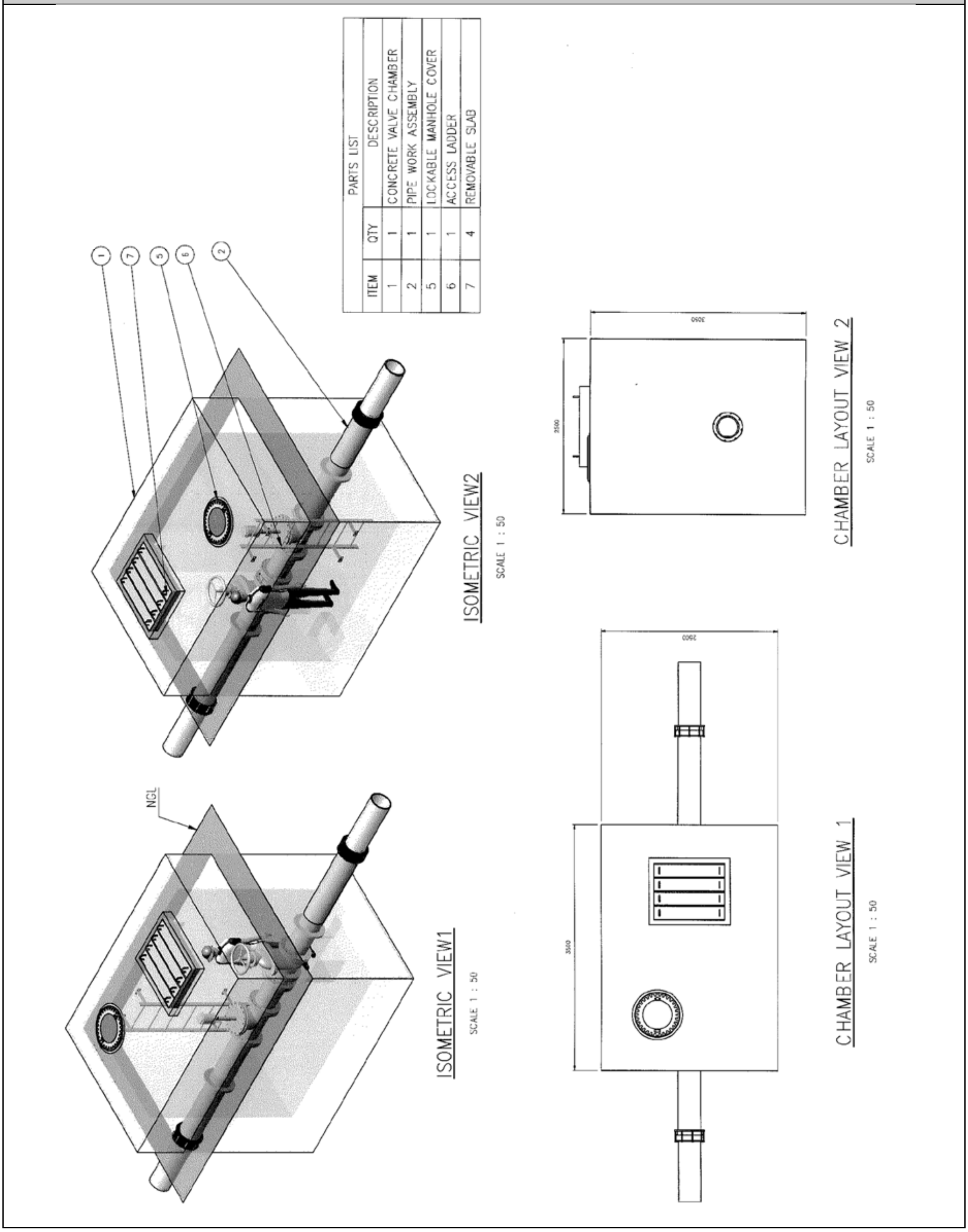
E6

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

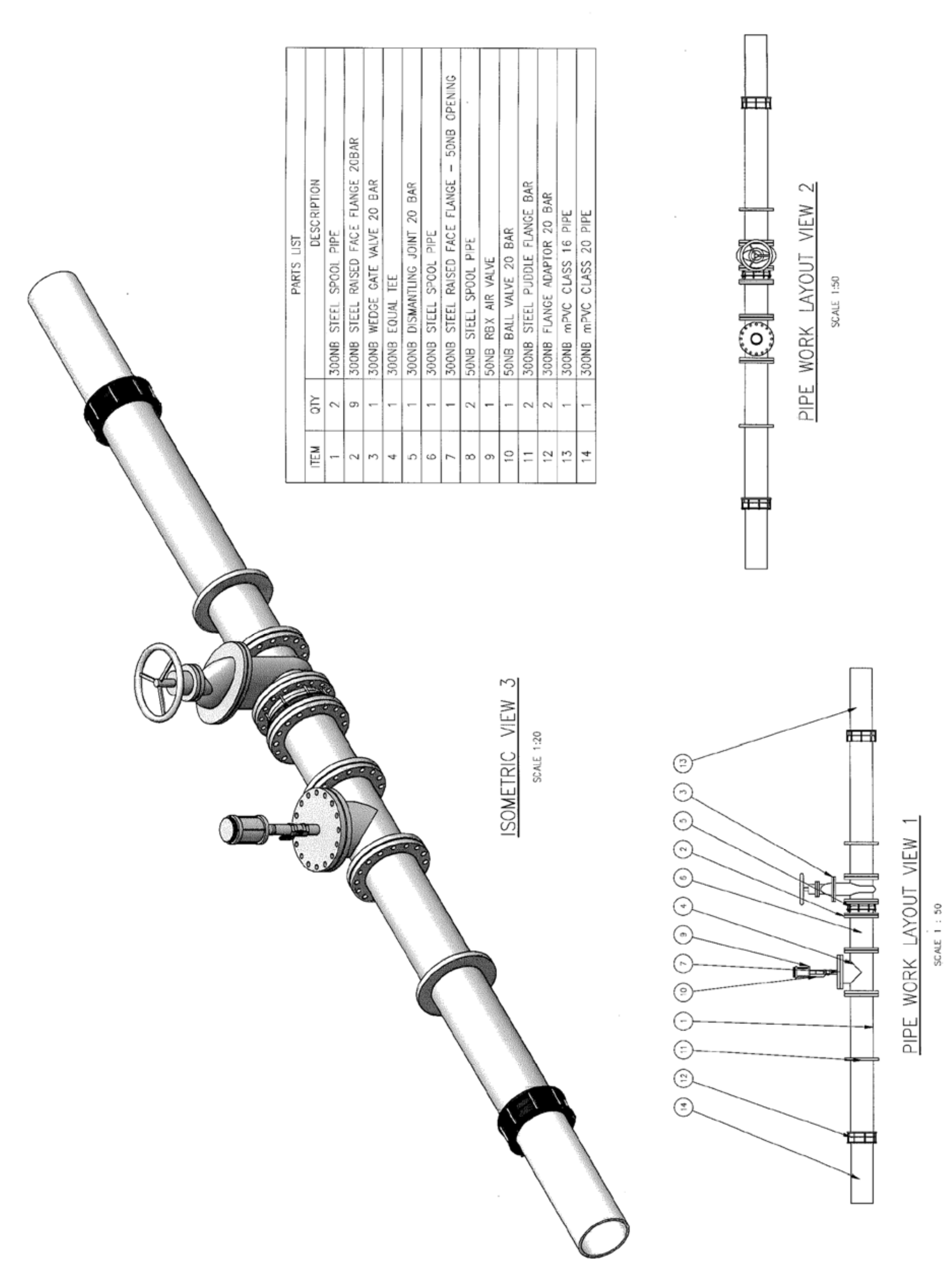
VALVE CHAMBER DESIGN



Drawings as produced by Mr R Mahaffey (Post graduate student). Personally we would have provided a by-pass around the isolating valve. Air valve is required on the upstream side of the isolating valve.

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

VALVE CHAMBER DESIGN



PARTS LIST

ITEM	QTY	DESCRIPTION
1	2	300NB STEEL SPOOL PIPE
2	9	300NB STEEL RAISED FACE FLANGE 20BAR
3	1	300NB WEDGE GATE VALVE 20 BAR
4	1	300NB EQUAL TEE
5	1	300NB DISMANTLING JOINT 20 BAR
6	1	300NB STEEL SPOOL PIPE
7	1	300NB STEEL RAISED FACE FLANGE – 50NB OPENING
8	2	50NB STEEL SPOOL PIPE
9	1	50NB RBX AIR VALVE
10	1	50NB BALL VALVE 20 BAR
11	2	300NB STEEL PUDDLE FLANGE BAR
12	2	300NB FLANGE ADAPTOR 20 BAR
13	1	300NB mPVC CLASS 16 PIPE
14	1	300NB mPVC CLASS 20 PIPE

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E7

PIPELINE DESIGN, OPERATION AND MAINTENANCE COURSE

CONTINUING PROFESSIONAL DEVELOPMENT RESULTS SHEET

SURGE ANALYSIS		
Question	**Description**	**Solution**
E7Q1	Is a pump bypass effective if the pump should be stopped?	**No**
E7Q2	c_{steel} = c_{uPVC} = $c_{ductile\ iron}$ =	**1119 m/s** **315 m/s** **1180 m/s**
E7Q3	What was the maximum surge pressure in the system and where was it generated for the pump trip?	**Maximum pressure was 196 m at the pump station**
E7Q4	Can all the negative pressures be controlled/ reduced with air valves?	**Air valves at J24 and J28 were too small. Increased these to reduce negative pressures. Additional air valves at points were the negatives are first generated could also be included. This is however not always the case and is dependent on the system layout.**
E7Q5	What generates the highest pressures in the system, pump trip (Scenario 1) or valve closure (Scenario 2)? Explain?	**The pressure for the valve closure generates the highest pressure of 256 m at the pump station. This is the cut-off head of the pump and if flow is reduces to 0 l/s then pressure rises to the cut-off head.**
E7Q6	What effect has the pipe material have on the generated pressures?	**Using a pipe with thicker wall thickness will increase generated pressures for pump trip or if the selected pipe material was steel or ductile iron since the wave celerity increases.**