## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for TUDOR.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | PIMP (%) | 100 |
| M5-60 (mm) | 18.000 | Add Flow / Climate Change (%) | 35 |
| Ratio R | 0.327 | Minimum Backdrop Height (m) | 0.200 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 0.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 0.75 |
| Volumetric Runoff Coeff. | 0.750 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Network Design Table for TUDOR.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 17.949 | 0.179 | 100.0 | 0.010 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.001 | 12.052 | 0.366 | 33.0 | 0.004 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 2.000 | 12.309 | 0.123 | 100.1 | 0.010 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 2.001 | 17.209 | 0.172 | 100.1 | 0.005 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.002 | 8.170 | 0.044 | 185.7 | 0.011 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.003 | 18.249 | 0.147 | 124.1 | 0.019 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 3.000 | 9.936 | 0.054 | 184.0 | 0.009 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 3.001 | 9.965 | 0.054 | 184.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 50.00 | 5.30 | 68.000 | 0.010 | 0.0 | 0.0 | 0.5 | 1.00 | 17.8 | 1.8 |
| 1.001 | 50.00 | 5.41 | 67.821 | 0.014 | 0.0 | 0.0 | 0.7 | 1.76 | 31.1 | 2.6 |
| 2.000 | 50.00 | 5.20 | 67.750 | 0.010 | 0.0 | 0.0 | 0.5 | 1.00 | 17.8 | 1.8 |
| 2.001 | 50.00 | 5.49 | 67.627 | 0.015 | 0.0 | 0.0 | 0.7 | 1.00 | 17.8 | 2.7 |
| 1.002 | 50.00 | 5.68 | 67.455 | 0.040 | 0.0 | 0.0 | 1.9 | 0.73 | 13.0 | 7.3 |
| 1.003 | 50.00 | 6.01 | 67.411 | 0.059 | 0.0 | 0.0 | 2.8 | 0.90 | 15.9 | 10.8 |
| 3.000 | 50.00 | 5.22 | 67.420 | 0.009 | 0.0 | 0.0 | 0.4 | 0.74 | 13.0 | 1.6 |
| 3.001 | 50.00 | 5.45 | 67.366 | 0.009 | 0.0 | 0.0 | 0.4 | 0.74 | 13.0 | 1.6 |

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## Network Design Table for TUDOR.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type |
|---|---|---|---|---|---|---|---|---|---|---|
| 4.000 | 3.665 | 0.020 | 183.3 | 0.019 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 3.002 | 8.852 | 0.048 | 184.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.004 | 25.386 | 0.137 | 185.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit |
| 5.000 | 11.399 | 0.062 | 183.9 | 0.013 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.005 | 11.862 | 0.064 | 185.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit |
| 6.000 | 25.477 | 0.138 | 184.6 | 0.026 | 5.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit |
| 1.006 | 5.150 | 0.028 | 183.9 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit |
| 1.007 | 4.087 | 0.054 | 75.7 | 0.000 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4.000 | 50.00 | 5.08 | 67.332 | 0.019 | 0.0 | 0.0 | 0.9 | 0.74 | 13.1 | 3.5 |
| 3.002 | 50.00 | 5.65 | 67.312 | 0.028 | 0.0 | 0.0 | 1.3 | 0.74 | 13.0 | 5.1 |
| 1.004 | 50.00 | 6.45 | 67.189 | 0.087 | 0.0 | 0.0 | 4.1 | 0.96 | 38.1 | 15.9 |
| 5.000 | 50.00 | 5.26 | 67.189 | 0.013 | 0.0 | 0.0 | 0.6 | 0.74 | 13.0 | 2.4 |
| 1.005 | 50.00 | 6.66 | 67.052 | 0.100 | 0.0 | 0.0 | 4.7 | 0.96 | 38.1 | 18.3 |
| 6.000 | 50.00 | 5.58 | 67.201 | 0.026 | 0.0 | 0.0 | 1.2 | 0.74 | 13.0 | 4.8 |
| 1.006 | 50.00 | 6.75 | 66.988 | 0.126 | 0.0 | 0.0 | 6.0 | 0.96 | 38.2 | 23.0 |
| 1.007 | 50.00 | 6.80 | 66.960 | 0.126 | 0.0 | 0.0 | 6.0 | 1.50 | 59.8 | 23.0 |

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## Manhole Schedules for TUDOR.SWS

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | Pipe Out PN | Pipe Out Invert Level (m) | Pipe Out Diameter (mm) | Pipes In PN | Pipes In Invert Level (m) | Pipes In Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 68.600 | 0.600 | Open Manhole | 1200 | 1.000 | 68.000 | 150 | | | | |
| 2 | 68.450 | 0.629 | Open Manhole | 1200 | 1.001 | 67.821 | 150 | 1.000 | 67.821 | 150 | |
| 10 | 68.450 | 0.700 | Open Manhole | 1200 | 2.000 | 67.750 | 150 | | | | |
| 11 | 68.300 | 0.673 | Open Manhole | 1200 | 2.001 | 67.627 | 150 | 2.000 | 67.627 | 150 | |
| 3 | 68.300 | 0.845 | Open Manhole | 1200 | 1.002 | 67.455 | 150 | 1.001 | 67.455 | 150 | |
| | | | | | | | | 2.001 | 67.455 | 150 | |
| 4 | 68.300 | 0.889 | Open Manhole | 1200 | 1.003 | 67.411 | 150 | 1.002 | 67.411 | 150 | |
| 12 | 68.300 | 0.880 | Open Manhole | 1200 | 3.000 | 67.420 | 150 | | | | |
| 13 | 68.300 | 0.934 | Open Manhole | 1200 | 3.001 | 67.366 | 150 | 3.000 | 67.366 | 150 | |
| 15 | 68.300 | 0.968 | Open Manhole | 1200 | 4.000 | 67.332 | 150 | | | | |
| 14 | 68.300 | 0.988 | Open Manhole | 1200 | 3.002 | 67.312 | 150 | 3.001 | 67.312 | 150 | |
| | | | | | | | | 4.000 | 67.312 | 150 | |
| 5 | 68.300 | 1.111 | Open Manhole | 1200 | 1.004 | 67.189 | 225 | 1.003 | 67.264 | 150 | |
| | | | | | | | | 3.002 | 67.264 | 150 | |
| 16 | 68.150 | 0.961 | Open Manhole | 1200 | 5.000 | 67.189 | 150 | | | | |
| 6 | 68.150 | 1.098 | Open Manhole | 1200 | 1.005 | 67.052 | 225 | 1.004 | 67.052 | 225 | |
| | | | | | | | | 5.000 | 67.127 | 150 | |
| 17 | 68.150 | 0.949 | Open Manhole | 1200 | 6.000 | 67.201 | 150 | | | | |
| 7 | 68.100 | 1.112 | Open Manhole | 1200 | 1.006 | 66.988 | 225 | 1.005 | 66.988 | 225 | |
| | | | | | | | | 6.000 | 67.063 | 150 | |
| 8 | 68.240 | 1.280 | Open Manhole | 1200 | 1.007 | 66.960 | 225 | 1.006 | 66.960 | 225 | |
| 9 | 67.878 | 0.972 | Open Manhole | 0 | | OUTFALL | | 1.007 | 66.906 | 225 | |

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## PIPELINE SCHEDULES for TUDOR.SWS

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| 1.000 | o | 150 | 1 | 68.600 | 68.000 | 0.450 | Open Manhole | 1200 |
| 1.001 | o | 150 | 2 | 68.450 | 67.821 | 0.479 | Open Manhole | 1200 |
| 2.000 | o | 150 | 10 | 68.450 | 67.750 | 0.550 | Open Manhole | 1200 |
| 2.001 | o | 150 | 11 | 68.300 | 67.627 | 0.523 | Open Manhole | 1200 |
| 1.002 | o | 150 | 3 | 68.300 | 67.455 | 0.695 | Open Manhole | 1200 |
| 1.003 | o | 150 | 4 | 68.300 | 67.411 | 0.739 | Open Manhole | 1200 |
| 3.000 | o | 150 | 12 | 68.300 | 67.420 | 0.730 | Open Manhole | 1200 |
| 3.001 | o | 150 | 13 | 68.300 | 67.366 | 0.784 | Open Manhole | 1200 |
| 4.000 | o | 150 | 15 | 68.300 | 67.332 | 0.818 | Open Manhole | 1200 |
| 3.002 | o | 150 | 14 | 68.300 | 67.312 | 0.838 | Open Manhole | 1200 |
| 1.004 | o | 225 | 5 | 68.300 | 67.189 | 0.886 | Open Manhole | 1200 |
| 5.000 | o | 150 | 16 | 68.150 | 67.189 | 0.811 | Open Manhole | 1200 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 17.949 | 100.0 | 2 | 68.450 | 67.821 | 0.479 | Open Manhole | 1200 |
| 1.001 | 12.052 | 33.0 | 3 | 68.300 | 67.455 | 0.695 | Open Manhole | 1200 |
| 2.000 | 12.309 | 100.1 | 11 | 68.300 | 67.627 | 0.523 | Open Manhole | 1200 |
| 2.001 | 17.209 | 100.1 | 3 | 68.300 | 67.455 | 0.695 | Open Manhole | 1200 |
| 1.002 | 8.170 | 185.7 | 4 | 68.300 | 67.411 | 0.739 | Open Manhole | 1200 |
| 1.003 | 18.249 | 124.1 | 5 | 68.300 | 67.264 | 0.886 | Open Manhole | 1200 |
| 3.000 | 9.936 | 184.0 | 13 | 68.300 | 67.366 | 0.784 | Open Manhole | 1200 |
| 3.001 | 9.965 | 184.5 | 14 | 68.300 | 67.312 | 0.838 | Open Manhole | 1200 |
| 4.000 | 3.665 | 183.3 | 14 | 68.300 | 67.312 | 0.838 | Open Manhole | 1200 |
| 3.002 | 8.852 | 184.4 | 5 | 68.300 | 67.264 | 0.886 | Open Manhole | 1200 |
| 1.004 | 25.386 | 185.3 | 6 | 68.150 | 67.052 | 0.873 | Open Manhole | 1200 |
| 5.000 | 11.399 | 183.9 | 6 | 68.150 | 67.127 | 0.873 | Open Manhole | 1200 |

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## PIPELINE SCHEDULES for TUDOR.SWS

### Upstream Manhole

| PN | Hyd Sect | Diam (mm) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| 1.005 | o | 225 | 6 | 68.150 | 67.052 | 0.873 | Open Manhole | 1200 |
| 6.000 | o | 150 | 17 | 68.150 | 67.201 | 0.799 | Open Manhole | 1200 |
| 1.006 | o | 225 | 7 | 68.100 | 66.988 | 0.887 | Open Manhole | 1200 |
| 1.007 | o | 225 | 8 | 68.240 | 66.960 | 1.055 | Open Manhole | 1200 |

### Downstream Manhole

| PN | Length (m) | Slope (1:X) | MH Name | C.Level (m) | I.Level (m) | D.Depth (m) | MH Connection | MH DIAM., L*W (mm) |
|---|---|---|---|---|---|---|---|---|
| 1.005 | 11.862 | 185.3 | 7 | 68.100 | 66.988 | 0.887 | Open Manhole | 1200 |
| 6.000 | 25.477 | 184.6 | 7 | 68.100 | 67.063 | 0.887 | Open Manhole | 1200 |
| 1.006 | 5.150 | 183.9 | 8 | 68.240 | 66.960 | 1.055 | Open Manhole | 1200 |
| 1.007 | 4.087 | 75.7 | 9 | 67.878 | 66.906 | 0.747 | Open Manhole | 0 |

## Free Flowing Outfall Details for TUDOR.SWS

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.007 | 9 | 67.878 | 66.906 | 0.000 | 0 | 0 |

## Simulation Criteria for TUDOR.SWS

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.840 | Foul Sewage per hectare (l/s) | 0.000 |
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 35.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Run Time (mins) | 240 |
| Manhole Headloss Coeff (Global) | 0.500 | Output Interval (mins) | 4 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 1 |
| Number of Online Controls | 1 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | | |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Ratio R | 0.327 |
| Return Period (years) | 100 | Profile Type | Winter |
| Region | England and Wales | Cv (Summer) | 0.750 |
| M5-60 (mm) | 18.000 | Cv (Winter) | 0.840 |

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## Synthetic Rainfall Details

Storm Duration (mins) 120

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## Online Controls for TUDOR.SWS

### Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.006, Volume (m³): 2.1

| | |
|---|---|
| Unit Reference | MD-SHE-0105-5000-1000-5000 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 5.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 105 |
| Invert Level (m) | 66.988 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 1.000 | 5.0 | Kick-Flo® | 0.637 | 4.1 |
| Flush-Flo™ | 0.296 | 5.0 | Mean Flow over Head Range | - | 4.3 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.6 | 1.200 | 5.4 | 3.000 | 8.4 | 7.000 | 12.5 |
| 0.200 | 4.8 | 1.400 | 5.8 | 3.500 | 9.0 | 7.500 | 12.9 |
| 0.300 | 5.0 | 1.600 | 6.2 | 4.000 | 9.6 | 8.000 | 13.3 |
| 0.400 | 4.9 | 1.800 | 6.6 | 4.500 | 10.1 | 8.500 | 13.7 |
| 0.500 | 4.7 | 2.000 | 6.9 | 5.000 | 10.6 | 9.000 | 14.1 |
| 0.600 | 4.3 | 2.200 | 7.2 | 5.500 | 11.1 | 9.500 | 14.5 |
| 0.800 | 4.5 | 2.400 | 7.5 | 6.000 | 11.6 | | |
| 1.000 | 5.0 | 2.600 | 7.8 | 6.500 | 12.1 | | |

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## Storage Structures for TUDOR.SWS

### Tank or Pond Manhole: 6, DS/PN: 1.005

Invert Level (m) 67.052

| Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|
| 0.000 | 5.8 | 1.000 | 44.8 |

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## Summary of Results for 120 minute 100 year Winter (TUDOR.SWS)

| | |
|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 |
| Analysis Timestep | 2.5 Second Increment (Extended) |
| DTS Status | ON |
| DVD Status | ON |
| Inertia Status | ON |

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 68.041 | -0.109 | 0.000 | 0.11 | | 1.8 | OK |
| 1.001 | 2 | 68.039 | 0.068 | 0.000 | 0.09 | | 2.5 | SURCHARGED |
| 2.000 | 10 | 68.042 | 0.142 | 0.000 | 0.11 | | 1.7 | SURCHARGED |
| 2.001 | 11 | 68.040 | 0.263 | 0.000 | 0.14 | | 2.4 | FLOOD RISK |
| 1.002 | 3 | 68.036 | 0.431 | 0.000 | 0.47 | | 5.4 | FLOOD RISK |
| 1.003 | 4 | 68.031 | 0.470 | 0.000 | 0.52 | | 7.8 | FLOOD RISK |
| 3.000 | 12 | 68.026 | 0.456 | 0.000 | 0.09 | | 1.1 | FLOOD RISK |
| 3.001 | 13 | 68.025 | 0.509 | 0.000 | 0.08 | | 0.9 | FLOOD RISK |
| 4.000 | 15 | 68.025 | 0.543 | 0.000 | 0.27 | | 2.7 | FLOOD RISK |
| 3.002 | 14 | 68.023 | 0.561 | 0.000 | 0.26 | | 3.0 | FLOOD RISK |
| 1.004 | 5 | 68.019 | 0.605 | 0.000 | 0.29 | | 10.2 | FLOOD RISK |
| 5.000 | 16 | 68.013 | 0.674 | 0.000 | 0.15 | | 1.7 | FLOOD RISK |
| 1.005 | 6 | 68.011 | 0.735 | 0.000 | 0.15 | | 4.7 | FLOOD RISK |
| 6.000 | 17 | 68.011 | 0.660 | 0.000 | 0.31 | | 3.9 | FLOOD RISK |
| 1.006 | 7 | 68.079 | 0.866 | 0.000 | 0.18 | | 5.0 | FLOOD RISK |
| 1.007 | 8 | 67.018 | -0.167 | 0.000 | 0.15 | | 5.0 | OK |

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