WORKFLOW CASE STUDY

Drainage Vertical Alignment Extraction

AI-assisted extraction of invert levels, cover levels, and pipe schedules from AutoCAD long-section drawings; validated, structured, and ready to price.

QStimating

PROJECT CONTEXT

The Challenge: Reading AutoCAD Sections

At tender stage, drainage design information is typically issued as a set of AutoCAD-exported PDFs. In addition to plan-view layout drawings, engineers produce vertical alignment sheets; long-section profiles showing each pipe run from upstream to downstream, with invert levels, cover levels, gradients, and pipe lengths tabulated below each profile panel.

For the quantity surveyor, these sheets carry the most precise design data available; the engineer's own Civil 3D model values. The challenge is extracting that data accurately, consistently, and quickly across multiple sections sheets containing dozens of pipe links.

Manual Reading Risk

Reading invert levels manually from a Civil 3D long-section table is error-prone. Each intermediate manhole carries two invert values; the incoming DS IL to its left and the outgoing US IL to its right. Confusion between the two is the most common source of incorrect gradients and depth classifications in drainage BoQs.

Scale of Data

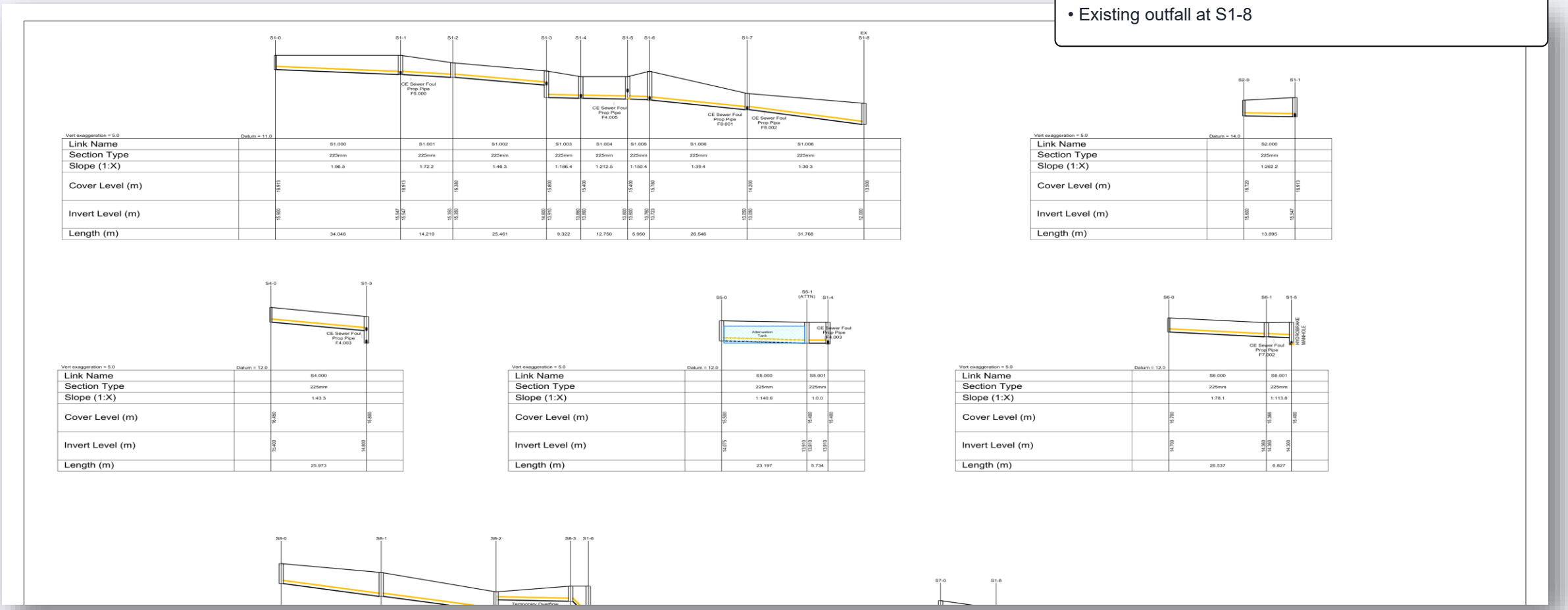
A typical LRD drainage package contains separate sections sheets for surface water and foul networks, each covering a main run plus multiple spurs. A single sheet may carry 15–25 pipe links across 8–12 section panels, each with its own datum. Manually tabulating and cross-checking this data is time-consuming and offers no built-in verification step.

SOURCE DRAWING

Surface Water Drainage Sections Sheet

Drawing contains:

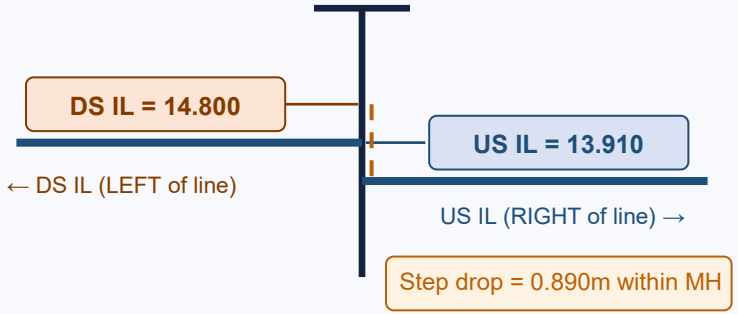
- 8 section panels (main run + 4 spurs)
- 19 pipe links — all 225mm proposed SW
- Manhole refs S1-0 through S7-0
- Existing outfall at S1-8



Drawing: 221295-PUNCH-XX-XX-DR-C-0177 | Proposed Surface Water Drainage Sections Sheet | Rev C03 | Scale 1:500 @ A1 | PUNCH Consulting Engineers

How the Workflow Reads a Sections Drawing

The Critical Reading Rule — Invert Level Convention



Each intermediate manhole on a Civil 3D long-section carries two invert level values;one on each side of its vertical symbol. The value to the RIGHT is the US IL (upstream invert of the outgoing pipe). The value to the LEFT is the DS IL (downstream invert of the incoming pipe).

Where these two values differ, a step drop occurs within the manhole; indicating a backdrop or cascade arrangement. Both values are recorded faithfully.

01

Extract PDF Text

pypdf reads all table row values from each section panel: Link Name, Section Type, Slope, Cover Levels, Invert Levels, Lengths.

02

Assign ILs per Link

Top row = US ILs. Bottom row = DS ILs. Each link takes US IL[i] and DS IL[i] from its panel's two-row block.

03

Slope Cross-Check

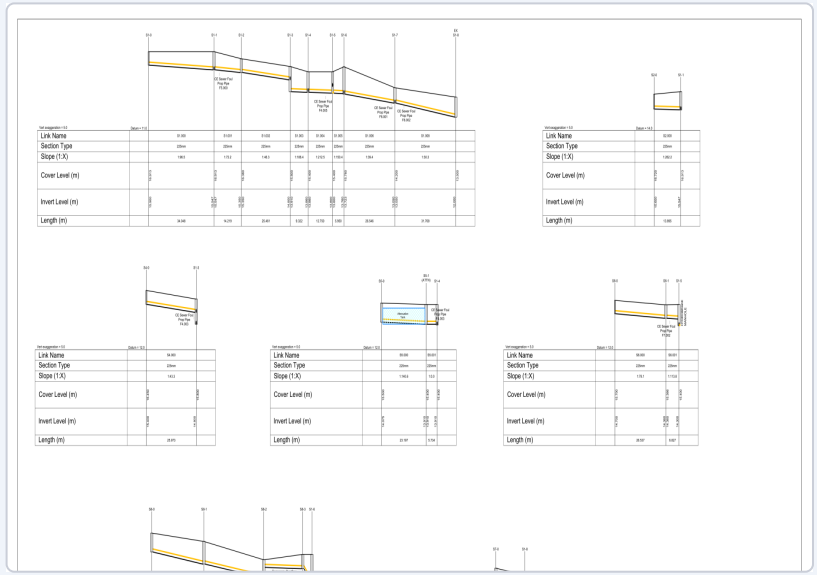
For every link: calculated slope = length ÷ (US IL − DS IL). Must match stated slope ±2. No output until all links verify.

04

Excel Output

Structured schedule: one row per link. Separate colour-coded sheets for SW (blue) and Foul (terracotta). Frozen header, 0.000 number format.

Structured Excel Schedule: 19 Pipe Links Extracted & Verified



Source: SW Drainage Sections Sheet

Link Name	US Manhole	US CL (m)	US IL (m)	DS Manhole	DS CL (m)	DS IL (m)	Type	Slope (1:X)	Length (m)
S1.000	S1-0	16.913	15.900	S1-1	16.913	15.547	225mm	96.5	34.048
S1.001	S1-1	16.913	15.547	S1-2	16.380	15.350	225mm	72.2	14.219
S1.002	S1-2	16.380	15.350	S1-3	15.800	14.800	225mm	46.3	25.461
S1.003	S1-3	15.800	13.910	S1-4	15.400	13.860	225mm	186.4	9.322
S1.004	S1-4	15.400	13.860	S1-5	15.400	13.800	225mm	212.5	12.750
S1.005	S1-5	15.400	13.800	S1-6	15.780	13.760	225mm	150.4	5.950
S1.006	S1-6	15.780	13.723	S1-7	14.200	13.050	225mm	39.4	26.546
S1.008	S1-7	14.200	13.050	S1-8	13.500	12.000	225mm	30.3	31.768
S2.000	S2-0	16.720	15.600	S1-1	16.913	15.547	225mm	262.2	13.895

Output: Excel Schedule — first 10 of 19 links shown

19

Pipe Links

All 225mm SW

7

Spurs / Sections

S1 main + 6 branches

100%

Slope Verified

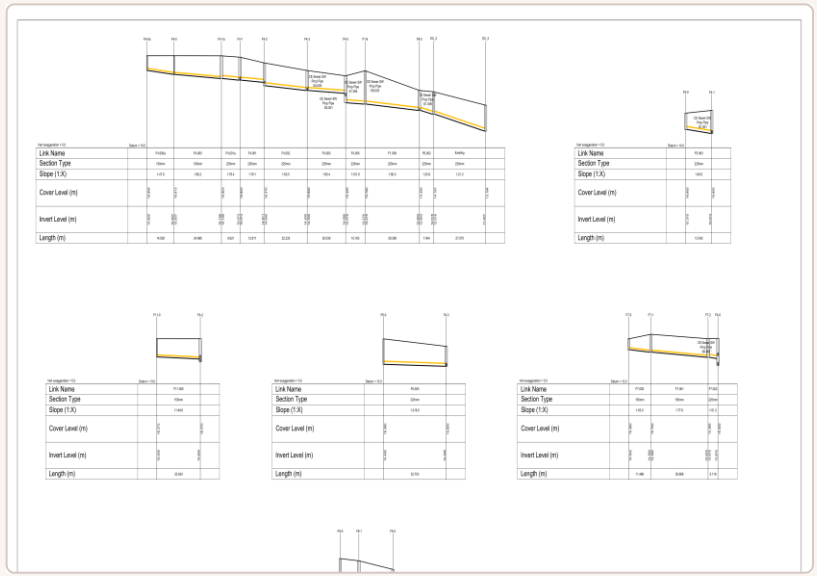
All links ±2 tolerance

1

Backdrop Identified

S1-3 step drop 0.89m

Structured Excel Schedule — 18 Pipe Links Extracted & Verified



Source: Foul Drainage Sections Sheet 1

Link Name	US Manhole	US CL (m)	US IL (m)	DS Manhole	DS CL (m)	DS IL (m)	Type	Slope (1:X)	Length (m)
F4.000a	F4-0a	16.906	15.800	F4-0	16.913	15.507	150mm	47.8	14.020
F4.000	F4-0	16.913	15.507	F4-1a	16.903	15.199	150mm	80.2	24.686
F4.001a	F4-1a	16.903	15.199	F4-1	16.800	15.073	225mm	76.4	9.621
F4.001	F4-1	16.800	15.073	F4-2	16.370	14.911	225mm	79.1	12.811
F4.002	F4-2	16.370	14.650	F4-3	15.800	14.300	225mm	63.5	22.233
F4.003	F4-3	15.800	14.300	F4-5	15.400	14.090	225mm	95.4	20.039
F4.005	F4-5	15.400	13.375	F1-8	15.780	13.275	225mm	101.6	10.163
F1.008	F1-8	15.780	13.275	F8-2	14.300	12.803	225mm	60.0	28.308
F8.002	F8-2	14.300	12.803	EX_2	14.197	12.516	225mm	25.8	7.404

Output: Excel Schedule — first 10 of 18 links shown

18

Pipe Links

150mm & 225mm Foul

5

Spurs / Sections

F4 main + 4 branches

100%

Slope Verified

All links ±2 tolerance

2

Backdrops Identified

F4-2 (0.26m), F4-5 (0.72m)

QUALITY ASSURANCE

Built-In Validation — Every Link Cross-Checked Before Output

The workflow does not produce an output schedule until every pipe link has passed a slope cross-check. The calculated gradient (length ÷ drop) must agree with the engineer's stated gradient within a tolerance of ±2 (1:X notation). Any mismatch flags an IL assignment error for investigation before the run continues.

CONDITION

Step drop within manhole

FLAG

Backdrop at [MH] — drop Xm within manhole

CONDITION

Calc slope differs from stated by > 2

FLAG

Slope mismatch on [Link] — IL assignment requires re-check

CONDITION

Rising pipe (US IL < DS IL)

FLAG

Rising invert on [Link] — confirm with engineer

CONDITION

Cover level conflict between panels

FLAG

CL discrepancy at [MH] — Xm vs Ym across two section panels

CONDITION

Flat gradient (slope = 0.0)

FLAG

Level connection on [Link] — verify intent (e.g. attenuation tank)

CONDITION

Diameter transition mid-run

FLAG

Diameter change at [MH]: Xmm → Ymm — classify separately in BoQ

From Drawing to Priced Schedule in One Structured Step

✓ **Engineer's Own Data**

Invert levels and gradients come directly from the Civil 3D model via the sections sheet; not scaled from a plan drawing or estimated from a bar scale.

✓ **Mandatory Verification Gate**

Every link is slope-checked before output is produced. The workflow cannot complete with an unresolved mismatch,catching transposition errors before they reach the BoQ.

✓ **Backdrop & Step Drop Detection**

Step drops within manholes are automatically identified and flagged; informing both depth classification and the drainage engineer's design intent.

✓ **ARM5-Ready Output**

The structured schedule feeds directly into ARM5 depth band classification, trench excavation, bed and surround, and manhole enumeration; the full drainage BoQ build-up.

Part of the QStimating Suite

Plan View Extraction

Vector geometry from Civil 3D layout PDFs: layer totals, solid vs dashed triage.

Bluebeam Measurement

Node-to-node schedule from Bluebeam PolyLine markup: immune to dashed line issues.

THIS

Sections Extraction

This workflow: IL/CL/gradient schedule from long-section profile drawings.

QStimating

AI-assisted quantity surveying & estimating workflows

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