

Sample: Water utility, Cape Town: report

Project: Sample: Water utility, Cape Town

Goal: Describe the project Sample: Water utility, Cape Town: run the analyses that tell the most about its data, draw every result, and write a cited report.

Run: e33b2a03-f978-4654-94e4-ffd327ff8f7b (running, 11 agent run(s))

Generated: 2026-10-18T05:36:20Z, version 1

Model cost: USD 0.0000 over 0 model call(s)

Data used

Data	Kind	Rows	Time span	Summary	Source
Pressure zones	vector, Polygon	8		8 polygon (area) features; 'connections' 6,967 to 15,525 (mean 1.113e+04); 'target_pressure_m' 35 to 50 (mean 42.5); named by 'name' (e.g. Millbrook zone, Canal Side zone, Station Quarter zone); total area 41.98 km2; extent 18.4313,-33.9878 to 18.5086,-33.9322. Areas (Pressure zones) with connections to compare and map.	[96]
Water mains	vector, LineString	2,130		2,130 line features; 'material' has 5 values (top: uPVC 655, cast iron 514, asbestos cement 393); 'diameter_mm' 75 to 200 (mean 133.3); 'install_year' 1,938 to 2,024 (mean 1983); 'length_m' 120 to 271 (mean 191.3); total length 408.3 km; extent 18.4321,-33.9871 to 18.5080,-33.9329. Lines (Water mains) such as routes or networks.	[97]
Leak and burst repairs	vector, Point	950	2023-10-01 to 2026-09-30	950 point features; dated by 'reported_at' from 2023-10-01 to 2026-09-30; 'type' has 4 values (top: leak 447, burst 273, joint failure 163); 'material' has 5 values (top: cast iron 609, asbestos cement 201, uPVC 71); 'water_lost_kl' 0.6 to 401.9 (mean 24.65); 'repair_hours' 1.1 to 26.8 (mean 5.718); extent 18.4325,-33.9862 to 18.5076,-33.9336. Dated point events by type: where and when Leak and burst repairs happen.	[2]
Reservoirs	vector, Point	4		4 point features; 'capacity_ml' 27 to 77 (mean 55.5); 'top_water_level_m' 141 to 228 (mean 175.5); named by 'name' (e.g. Kloof Reservoir, Berg Reservoir, Vlei Reservoir); extent 18.4404,-33.9811 to 18.5008,-33.9377. Point locations of Reservoirs.	[98]
Valves	vector, Point	300		300 point features; 'type' has 3 values (top: isolation 148, air release 79, pressure reducing 73); 'status' has 3 values (top: open 178, closed 63, unknown 59); 'exercised_year' 2,008 to 2,026 (mean 2017); extent 18.4322,-33.9863 to 18.5081,-33.9330. Point locations of Valves by type.	[99]
Fire hydrants	vector, Point	250		250 point features; 'flow_l_s' 8 to 40 (mean 23.98); 'last_test_year' 2,019 to 2,026 (mean 2023); extent 18.4333,-33.9861 to 18.5076,-33.9337. Point locations of Fire hydrants.	[100]
Customer complaints	vector, Point	520	2025-10-01 to 2026-09-29	520 point features; dated by 'date' from 2025-10-01 to 2026-09-29; 'issue' has 4 values (top: low pressure 199, high bill 146, no water 128); extent 18.4339,-33.9870 to 18.5063,-33.9328. Dated point events by issue: where and when Customer complaints happen.	[3]

Data	Kind	Rows	Time span	Summary	Source
Zone meter readings by month	table	192	2024-10-01 to 2026-09-01	Table of 192 rows and 6 columns without geometry; dated by 'month' from 2024-10-01 to 2026-09-01; 'supplied_ml' 3260 to 1.097e+04 (mean 6319); 'billed_ml' 2602 to 7144 (mean 4924); 'nrw_pct' 13.1 to 39 (mean 21.25). A table of Zone meter readings by month without locations.	[4]
Pipe replacement plan	table	220		Table of 220 rows and 4 columns without geometry; 'priority' 1 to 4 (mean 2.364); 'planned_year' 2,027 to 2,030 (mean 2028); 'est_cost_zar' 568,625 to 1,685,831 (mean 1,043,948). A table of Pipe replacement plan without locations.	[101]
Non-revenue water briefing	document			1-page md document 'Non-revenue water briefing'; language en; mentions 3 place(s): Foundry Row zone (3), Foundry Row (2), Kloof Reservoir (1). A document about Foundry Row zone, Foundry Row, Kloof Reservoir.	[102]
Sample: Water utility, Cape Town	record				[103]
Emerging hot spots: Leak and burst repairs	layer, Polygon	71			[104]
Emerging hot spots: Customer complaints	layer, Polygon	75			[105]
Hot spot analysis: Valves	layer, Polygon	53			[106]
Hot spot analysis: Leak and burst repairs	layer, Polygon	184			[107]
Hot spot analysis: Customer complaints	layer, Polygon	185			[108]
Calculate density: Valves	layer, Polygon	257			[109]
Calculate density: Leak and burst repairs	layer, Polygon	1,220			[110]
Calculate density: Customer complaints	layer, Polygon	1,200			[111]
Summarize within: Pressure zones	layer, Polygon	8			[112]
Summarize within: Pressure zones	layer, Polygon	8			[113]
Summarize within: Pressure zones	layer, Polygon	8			[114]
Find point clusters: Valves	layer, Point	300			[115]
Find point clusters: cluster hulls	layer, Polygon	11			[116]
Find point clusters: Leak and burst repairs	layer, Point	950			[117]
Find point clusters: cluster hulls	layer, Polygon	3			[118]
Find point clusters: Customer complaints	layer, Point	520			[119]
Find point clusters: cluster hulls	layer, Polygon	3			[120]
Find outliers: Pressure zones	layer, Polygon	8			[121]

Data	Kind	Rows	Time span	Summary	Source
Repeat and near repeat classification: Leak and burst repairs	layer, Point	950			[122]

Timeline

Timeline: events per month by dataset

Per month: 36 months from 2023-10-01 to 2026-09-01; trend +2.5 per month; first half 454, second half 1,208 (+166.1%)

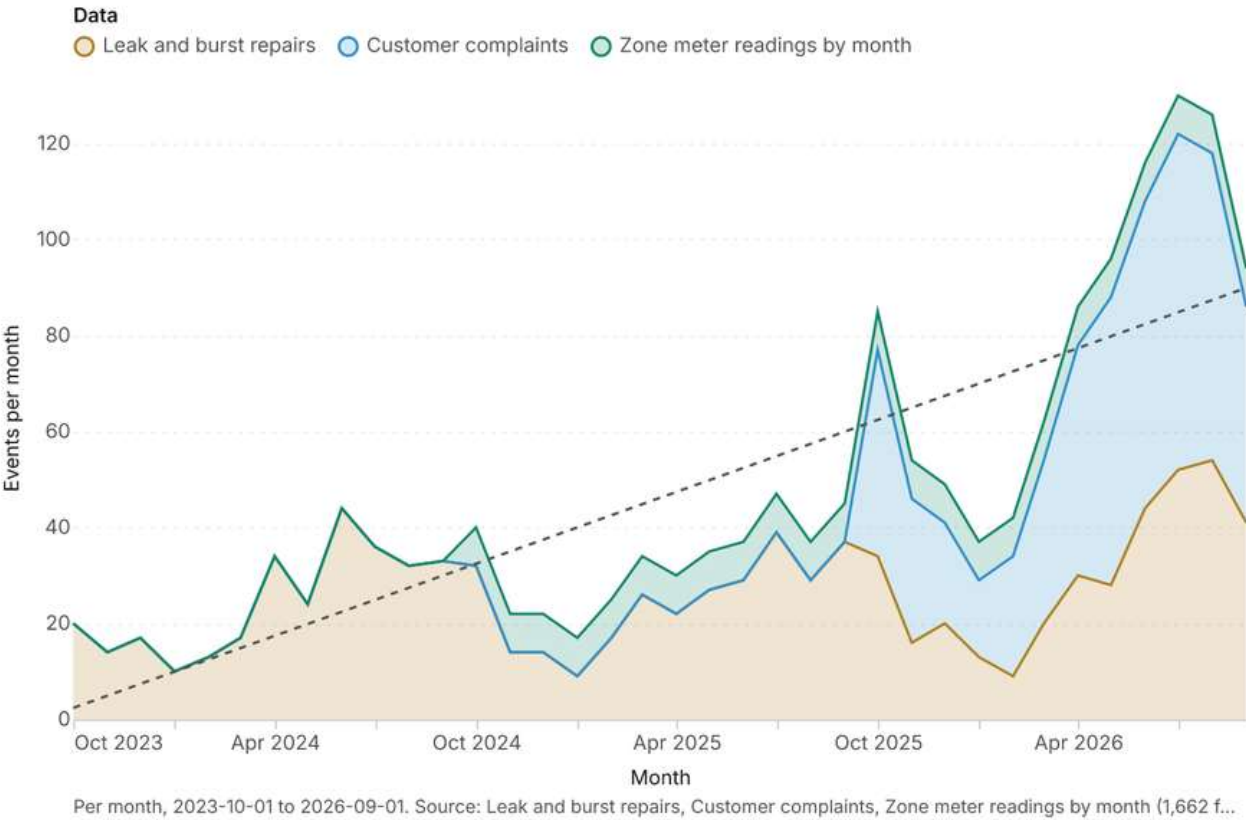


Figure 1. Timeline: events per month by dataset [1]. Per month, 2023-10-01 to 2026-09-01. Source: Leak and burst repairs, Customer complaints, Zone meter readings by month (1,662 features). The data is in the appendix.

The timeline counts 1,662 dated events in Leak and burst repairs, Customer complaints, Zone meter readings by month per month, from October 2023 to September 2026 [1][2][3][4]. By dataset: Leak and burst repairs 950; Customer complaints 520; Zone meter readings by month 192 [1]. The trend is +2.5 events per month; the second half of the months has 1,208 against 454 in the first (+166.1%) [1].

Busiest months

- July 2026: 130 events [1]
- August 2026: 126 events [1]
- June 2026: 116 events [1]

Quietest months

- January 2024: 10 events [1]
- February 2024: 13 events [1]
- November 2023: 14 events [1]

Space time hot spots

What this analysis is. Emerging hot spots: Where hot spots are new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating or historical over time [5]. In ArcGIS it is Emerging Hot Spot Analysis or Create Space Time Cube [5].

Why it was run on this data. Leak and burst repairs carry dates in 'reported_at': emerging hot spot analysis finds new, intensifying and fading hot spots per month [6].

What it found. The analysis generated 1 layer saved named Emerging hot spots: Leak and burst repairs [7]. Processing the Leak and burst repairs data [8] resulted in a count of 71 features [7]. In total, 950 features were used during this execution [7], which took an elapsed time of 19 ms [7]. The billing cost for this operation was 0.1475 [7].

Result	Value
result, count	71
result, elapsed ms	19
result, resolution	8
result, features used	950
result, time neighbors	0
billing, cost	0.1475
billing, list price	0.1475
billing, upstream cost	0

Findings

Evidenced: Space time hot spots on Leak and burst repairs: Emerging hot spots: 1 layer saved: Emerging hot spots: Leak and burst repairs (71 features) [7][8].

Evidenced: It reported result, count 71; result, elapsed ms 19; result, resolution 8; result, features used 950; result, time neighbors 0; billing, cost 0.1475 [7].

Tool gp_space_time_hot_spots; parameters {"project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)"}, "interval": "month", "bin_shape": "h3", "resolution": 8, "time_field": "reported_at"}

Space time hot spots

What this analysis is. Emerging hot spots: Where hot spots are new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating or historical over time [5]. In ArcGIS it is Emerging Hot Spot Analysis or Create Space Time Cube [5].

Why it was run on this data. Customer complaints carry dates in 'date': emerging hot spot analysis finds new, intensifying and fading hot spots per week [9].

What it found. Space time hot spots on Customer complaints: Emerging hot spots: 1 layer saved: Emerging hot spots: Customer complaints (75 features) [10][11]. It reported result, count 75; result, elapsed ms 15; result, resolution 8; result, features used 520; result, time neighbors 0; billing, cost 0.126 [10].

Result	Value
result, count	75
result, elapsed ms	15
result, resolution	8
result, features used	520
result, time neighbors	0
billing, cost	0.126
billing, list price	0.126
billing, upstream cost	0

Findings

Evidenced: Space time hot spots on Customer complaints: Emerging hot spots: 1 layer saved: Emerging hot spots: Customer complaints (75 features) [10][11].

Evidenced: It reported result, count 75; result, elapsed ms 15; result, resolution 8; result, features used 520; result, time neighbors 0; billing, cost 0.126 [10].

Tool gp_space_time_hot_spots; parameters {"project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Customer complaints (56e8a858)"}, "interval": "week", "bin_shape": "h3", "resolution": 8, "time_field": "date"}

Hot spots

What this analysis is. Hot spot analysis: Getis-Ord Gi* hot and cold spots with z-scores, p-values and confidence bins [12]. In ArcGIS it is Find Hot Spots or Hot Spot Analysis (Getis-Ord Gi*); in QGIS, qgis:hotspot (plugin) [12].

Why it was run on this data. 300 points: Getis-Ord Gi* tests whether the concentrations in Valves are statistically significant [13].

What it found. Hot spots on Valves: Hot spot analysis: 1 layer saved: Hot spot analysis: Valves (53 features) [14][15]. It reported result, bins 53; result, count 53; result, elapsed ms 6; result, cell size m 1,000; result, incidents used 300; result, distance band m 1,000 [14].

Result	Value
result, bins	53
result, count	53
result, elapsed ms	6
result, cell size m	1,000
result, incidents used	300
result, distance band m	1,000
billing, cost	0.056
billing, list price	0.056
billing, upstream cost	0

Findings

Evidenced: Hot spots on Valves: Hot spot analysis: 1 layer saved: Hot spot analysis: Valves (53 features) [14][15].

Evidenced: It reported result, bins 53; result, count 53; result, elapsed ms 6; result, cell size m 1,000; result, incidents used 300; result, distance band m 1,000 [14].

Tool gp_hot_spots; parameters {"project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Valves (c6aeca7)"}, "aggregation": "hexagon", "cell_size_m": 1000.0, "distance_band_m": 1000.0}

Hot spots

What this analysis is. Hot spot analysis: Getis-Ord Gi* hot and cold spots with z-scores, p-values and confidence bins [12]. In ArcGIS it is Find Hot Spots or Hot Spot Analysis (Getis-Ord Gi*); in QGIS, qgis:hotspot (plugin) [12].

Why it was run on this data. 950 points: Getis-Ord Gi* tests whether the concentrations in Leak and burst repairs are statistically significant [16].

What it found. Hot spots on Leak and burst repairs: Hot spot analysis: 1 layer saved: Hot spot analysis: Leak and burst repairs (184 features) [8][17]. It reported result, bins 184; result, count 184; result, elapsed ms 11; result, cell size m 500; result, incidents used 950; result, distance band m 500 [17].

Result	Value
result, bins	184
result, count	184
result, elapsed ms	11
result, cell size m	500

Result	Value
result, incidents used	950
result, distance band m	500
billing, cost	0.069
billing, list price	0.069
billing, upstream cost	0

Findings

Evidenced: Hot spots on Leak and burst repairs: Hot spot analysis: 1 layer saved: Hot spot analysis: Leak and burst repairs (184 features) [8][17].

Evidenced: It reported result, bins 184; result, count 184; result, elapsed ms 11; result, cell size m 500; result, incidents used 950; result, distance band m 500 [17].

Tool gp_hot_spots; parameters {"project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)"}, "aggregation": "hexagon", "cell_size_m": 500.0, "distance_band_m": 500.0}

Hot spots

What this analysis is. Hot spot analysis: Getis-Ord Gi* hot and cold spots with z-scores, p-values and confidence bins [12]. In ArcGIS it is Find Hot Spots or Hot Spot Analysis (Getis-Ord Gi*); in QGIS, qgis:hotspot (plugin) [12].

Why it was run on this data. 520 points: Getis-Ord Gi* tests whether the concentrations in Customer complaints are statistically significant [18].

What it found. Hot spots on Customer complaints: Hot spot analysis: 1 layer saved: Hot spot analysis: Customer complaints (185 features) [11][19]. It reported result, bins 185; result, count 185; result, elapsed ms 9; result, cell size m 500; result, incidents used 520; result, distance band m 500 [19].

Result	Value
result, bins	185
result, count	185
result, elapsed ms	9
result, cell size m	500
result, incidents used	520
result, distance band m	500
billing, cost	0.0604
billing, list price	0.0604
billing, upstream cost	0

Findings

Evidenced: Hot spots on Customer complaints: Hot spot analysis: 1 layer saved: Hot spot analysis: Customer complaints (185 features) [11][19].

Evidenced: It reported result, bins 185; result, count 185; result, elapsed ms 9; result, cell size m 500; result, incidents used 520; result, distance band m 500 [19].

Tool gp_hot_spots; parameters {"project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Customer complaints (56e8a858)"}, "aggregation": "hexagon", "cell_size_m": 500.0, "distance_band_m": 500.0}

Calculate density

What this analysis is. Calculate density: Kernel density per square kilometer on a grid [20]. In ArcGIS it is Calculate Density or Kernel Density; in QGIS, native:heatmapkerneldensityestimation [20].

Why it was run on this data. 300 points in Valves: a density surface shows where they concentrate [21].

What it found. Calculate density on Valves: Calculate density: 1 layer saved: Calculate density: Valves (257 features) [15][22]. It reported result, count 257; result, elapsed ms 9; result, bandwidth m 1,000; result, cell size m 500; result, excluded null 0; result, max density per km2 14.42 [22].

Result	Value
result, count	257
result, elapsed ms	9
result, bandwidth m	1,000
result, cell size m	500
result, excluded null	0
result, max density per km2	14.42
billing, cost	0.056
billing, list price	0.056
billing, upstream cost	0

Findings

Evidenced: Calculate density on Valves: Calculate density: 1 layer saved: Calculate density: Valves (257 features) [15][22].

Evidenced: It reported result, count 257; result, elapsed ms 9; result, bandwidth m 1,000; result, cell size m 500; result, excluded null 0; result, max density per km2 14.42 [22].

Tool gp_calculate_density; parameters {"kernel": "quartic", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Valves (c6aeca7)"}, "bandwidth_m": 1000.0, "cell_size_m": 500.0}

Calculate density

What this analysis is. Calculate density: Kernel density per square kilometer on a grid [20]. In ArcGIS it is Calculate Density or Kernel Density; in QGIS, native:heatmapkerneldensityestimation [20].

Why it was run on this data. 950 points in Leak and burst repairs: a density surface shows where they concentrate [23].

What it found. The density calculation utilized the Leak and burst repairs data [8], resulting in 1,220 features [24]. The analysis determined that the maximum density observed was 133.9 per km2 [24].

Result	Value
result, count	1,220
result, elapsed ms	36
result, bandwidth m	500
result, cell size m	200
result, excluded null	0
result, max density per km2	133.9
billing, cost	0.069
billing, list price	0.069
billing, upstream cost	0

Findings

Evidenced: Calculate density on Leak and burst repairs: Calculate density: 1 layer saved: Calculate density: Leak and burst repairs (1220 features) [8][24].

Evidenced: It reported result, count 1,220; result, elapsed ms 36; result, bandwidth m 500; result, cell size m 200; result, excluded null 0; result, max density per km2 133.9 [24].

Tool gp_calculate_density; parameters {"kernel": "quartic", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)"}, "bandwidth_m": 500.0, "cell_size_m": 200.0}

Calculate density

What this analysis is. Calculate density: Kernel density per square kilometer on a grid [20]. In ArcGIS it is Calculate Density or Kernel Density; in QGIS, native:heatmapkerneldensityestimation [20].

Why it was run on this data. 520 points in Customer complaints: a density surface shows where they concentrate [25].

What it found. Calculate density on Customer complaints: Calculate density: 1 layer saved: Calculate density: Customer complaints (1200 features) [11][26]. It reported result, count 1,200; result, elapsed ms 34; result, bandwidth m 500; result, cell size m 200; result, excluded null 0; result, max density per km2 55.38 [26].

Result	Value
result, count	1,200
result, elapsed ms	34
result, bandwidth m	500
result, cell size m	200
result, excluded null	0
result, max density per km2	55.38
billing, cost	0.0604
billing, list price	0.0604
billing, upstream cost	0

Findings

Evidenced: Calculate density on Customer complaints: Calculate density: 1 layer saved: Calculate density: Customer complaints (1200 features) [11][26].

Evidenced: It reported result, count 1,200; result, elapsed ms 34; result, bandwidth m 500; result, cell size m 200; result, excluded null 0; result, max density per km2 55.38 [26].

Tool gp_calculate_density; parameters {"kernel": "quartic", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Customer complaints (56e8a858)"}, "bandwidth_m": 500.0, "cell_size_m": 200.0}

Summarize within

What this analysis is. Summarize within: Count and aggregate the features inside each polygon (or bin), proportionally for lines and polygons [27]. In ArcGIS it is Summarize Within or Aggregate Points; in QGIS, native:countpointsinpolygon or native:sumlinelengths [27].

Why it was run on this data. Count Valves inside each feature of Pressure zones by type; the counts map as a choropleth (natural breaks, sequential colors) [28].

What it found. Summarize within on Valves, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [15][29][30]. It reported result, count 8; result, elapsed ms 1; billing, cost 0.01618; billing, list price 0.01618; billing, upstream cost 0 [29].

Result	Value
result, count	8
result, elapsed ms	1
billing, cost	0.01618
billing, list price	0.01618
billing, upstream cost	0

Findings

Evidenced: Summarize within on Valves, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [15][29][30].

Evidenced: It reported result, count 8; result, elapsed ms 1; billing, cost 0.01618; billing, list price 0.01618; billing, upstream cost 0 [29].

Tool gp_summarize_within; parameters {"stats": [{"stat": "sum", "field": "exercised_year"}], "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Valves (c6aeca7)", "group_by": "type", "polygons": {"layer": "Pressure zones (a4c55d18)"}}

Summarize within

What this analysis is. Summarize within: Count and aggregate the features inside each polygon (or bin), proportionally for lines and polygons [27]. In ArcGIS it is Summarize Within or Aggregate Points; in QGIS, native:countpointsinpolygon or native:sumlinelengths [27].

Why it was run on this data. Count Valves inside each feature of Pressure zones by type; the counts map as a choropleth (natural breaks, sequential colors) [28].

What it found. Summarize within on Leak and burst repairs, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [8][30][31]. It reported result, count 8; result, elapsed ms 2; billing, cost 0.02918; billing, list price 0.02918; billing, upstream cost 0 [31].

Result	Value
result, count	8
result, elapsed ms	2
billing, cost	0.02918
billing, list price	0.02918
billing, upstream cost	0

Findings

Evidenced: Summarize within on Leak and burst repairs, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [8][30][31].

Evidenced: It reported result, count 8; result, elapsed ms 2; billing, cost 0.02918; billing, list price 0.02918; billing, upstream cost 0 [31].

Tool gp_summarize_within; parameters {"stats": [{"stat": "sum", "field": "water_lost_kl"}], "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)", "group_by": "type", "polygons": {"layer": "Pressure zones (a4c55d18)"}}

Summarize within

What this analysis is. Summarize within: Count and aggregate the features inside each polygon (or bin), proportionally for lines and polygons [27]. In ArcGIS it is Summarize Within or Aggregate Points; in QGIS, native:countpointsinpolygon or native:sumlinelengths [27].

Why it was run on this data. Count Valves inside each feature of Pressure zones by type; the counts map as a choropleth (natural breaks, sequential colors) [28].

What it found. Summarize within on Customer complaints, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [11][30][32]. It reported result, count 8; result, elapsed ms 1; billing, cost 0.02056; billing, list price 0.02056; billing, upstream cost 0 [32].

Result	Value
result, count	8
result, elapsed ms	1
billing, cost	0.02056
billing, list price	0.02056
billing, upstream cost	0

Findings

Evidenced: Summarize within on Customer complaints, Pressure zones: Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features) [11][30][32].

Evidenced: It reported result, count 8; result, elapsed ms 1; billing, cost 0.02056; billing, list price 0.02056; billing, upstream cost 0 [32].

Tool gp_summarize_within; parameters {"stats": [], "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Customer complaints (56e8a858)"}, "group_by": "issue", "polygons": {"layer": "Pressure zones (a4c55d18)"}}

Find point clusters

What this analysis is. Find point clusters: Density-based clusters (DBSCAN, HDBSCAN or OPTICS, optionally space-time) with hulls and noise [33]. In ArcGIS it is Find Point Clusters or Density-based Clustering; in QGIS, native:dbscanclustering or native:stdbcanclustering [33].

Why it was run on this data. DBSCAN finds dense groups of Valves and separates noise [34].

What it found. The analysis utilized the `gp\_find\_point\_clusters` tool [35] with Valves data as the input [15]. This process saved two resulting layers: Find point clusters: Valves with 300 features, and Find point clusters: cluster hulls with 11 features [35].

Result	Value
result, count	300
result, noise	114
result, distance m	500
result, elapsed ms	8
result, min points	8
billing, cost	0.056
billing, list price	0.056
billing, upstream cost	0

Findings

Evidenced: Find point clusters on Valves: Find point clusters: 2 layers saved: Find point clusters: Valves (300 features); Find point clusters: cluster hulls (11 features) [15][35].

Evidenced: It reported result, count 300; result, noise 114; result, distance m 500; result, elapsed ms 8; result, min points 8; billing, cost 0.056 [35].

Tool gp_find_point_clusters; parameters {"method": "dbscan", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Valves (c6aeca7)"}, "distance_m": 500.0, "min_points": 8}

Find point clusters

What this analysis is. Find point clusters: Density-based clusters (DBSCAN, HDBSCAN or OPTICS, optionally space-time) with hulls and noise [33]. In ArcGIS it is Find Point Clusters or Density-based Clustering; in QGIS, native:dbscanclustering or native:stdbcanclustering [33].

Why it was run on this data. DBSCAN finds dense groups of Leak and burst repairs and separates noise [36].

What it found. Find point clusters on Leak and burst repairs: Find point clusters: 2 layers saved: Find point clusters: Leak and burst repairs (950 features); Find point clusters: cluster hulls (3 features) [8][37]. It reported result, count 950; result, noise 830; result, distance m 200; result, elapsed ms 12; result, min points 20; billing, cost 0.069 [37].

Result	Value
result, count	950
result, noise	830
result, distance m	200

Result	Value
result, elapsed ms	12
result, min points	20
billing, cost	0.069
billing, list price	0.069
billing, upstream cost	0

Findings

Evidenced: Find point clusters on Leak and burst repairs: Find point clusters: 2 layers saved: Find point clusters: Leak and burst repairs (950 features); Find point clusters: cluster hulls (3 features) [8][37].

Evidenced: It reported result, count 950; result, noise 830; result, distance m 200; result, elapsed ms 12; result, min points 20; billing, cost 0.069 [37].

Tool gp_find_point_clusters; parameters {"method": "dbscan", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)"}, "distance_m": 200.0, "min_points": 20}

Find point clusters

What this analysis is. Find point clusters: Density-based clusters (DBSCAN, HDBSCAN or OPTICS, optionally space-time) with hulls and noise [33]. In ArcGIS it is Find Point Clusters or Density-based Clustering; in QGIS, native:dbscanclustering or native:stdbcanclustering [33].

Why it was run on this data. DBSCAN finds dense groups of Customer complaints and separates noise [38].

What it found. Find point clusters on Customer complaints: Find point clusters: 2 layers saved: Find point clusters: Customer complaints (520 features); Find point clusters: cluster hulls (3 features) [11][39]. It reported result, count 520; result, noise 196; result, distance m 500; result, elapsed ms 8; result, min points 13; billing, cost 0.0604 [39].

Result	Value
result, count	520
result, noise	196
result, distance m	500
result, elapsed ms	8
result, min points	13
billing, cost	0.0604
billing, list price	0.0604
billing, upstream cost	0

Findings

Evidenced: Find point clusters on Customer complaints: Find point clusters: 2 layers saved: Find point clusters: Customer complaints (520 features); Find point clusters: cluster hulls (3 features) [11][39].

Evidenced: It reported result, count 520; result, noise 196; result, distance m 500; result, elapsed ms 8; result, min points 13; billing, cost 0.0604 [39].

Tool gp_find_point_clusters; parameters {"method": "dbscan", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Customer complaints (56e8a858)"}, "distance_m": 500.0, "min_points": 13}

Outliers

What this analysis is. Find outliers: Anselin local Moran's I: HH, LL clusters and HL, LH outliers [40]. In ArcGIS it is Find Outliers or Cluster and Outlier Analysis (Anselin Local Moran's I) [40].

Why it was run on this data. Local Moran's I maps clusters and outliers of 'connections' [41].

What it found. Outliers on Pressure zones: Find outliers: 1 layer saved: Find outliers: Pressure zones (8 features) [30][42]. It reported result, count 8; result, elapsed ms 3; result, permutations 199; result, excluded null 0; result, distance band m 2,338; billing, cost 0.05024 [42].

Result	Value
result, count	8
result, elapsed ms	3
result, permutations	199
result, excluded null	0
result, distance band m	2,338
billing, cost	0.05024
billing, list price	0.05024
billing, upstream cost	0

Findings

Evidenced: Outliers on Pressure zones: Find outliers: 1 layer saved: Find outliers: Pressure zones (8 features) [30][42].

Evidenced: It reported result, count 8; result, elapsed ms 3; result, permutations 199; result, excluded null 0; result, distance band m 2,338; billing, cost 0.05024 [42].

Tool gp_outliers; parameters {"field": "connections", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Pressure zones (a4c55d18)"}, "aggregation": "hexagon"}

Spatial autocorrelation

What this analysis is. Spatial autocorrelation: Global Moran's I: is the pattern clustered, dispersed or random [43]. In ArcGIS it is Spatial Autocorrelation (Global Moran's I) [43].

Why it was run on this data. Global Moran's I says whether similar values of 'connections' sit next to each other [44].

What it found. The gp_spatial_autocorrelation tool was executed using Pressure zones as input [30], [45].

Result	Value
result, n	8
result, p value	0.3743
result, z score	-0.8884
result, morans i	-0.3913
result, variance	0.07821
result, elapsed ms	1
result, expected i	-0.1429
result, excluded null	0
result, distance band m	2,338
result, p value normality	0.3878
result, z score normality	-0.8636
result, variance normality	0.08277
billing, cost	0.02
billing, list price	0.02
billing, upstream cost	0

Findings

Evidenced: Spatial autocorrelation on Pressure zones: Spatial autocorrelation: done; no map output [30][45].

Evidenced: It reported result, n 8; result, p value 0.3743; result, z score -0.8884; result, morans i -0.3913; result, variance 0.07821; result, elapsed ms 1 [45].

Tool gp_spatial_autocorrelation; parameters {"field": "connections", "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Pressure zones (a4c55d18)"}}

Near repeat

What this analysis is. Repeat and near repeat classification: Classify incidents as originators, repeats (same place) or near repeats within a distance and time window, with a Knox test table [46]. In ArcGIS it is Repeat and Near Repeat Classification or Near Repeat Calculator [46].

Why it was run on this data. Near repeat analysis tests whether Leak and burst repairs close in space also follow each other within 30 days [47].

What it found. Near repeat on Leak and burst repairs: Repeat and near repeat classification: 1 layer saved: Repeat and near repeat classification: Leak and burst repairs (950 features) [8][48]. It reported result, days 30; result, count 950; result, chains 114; result, distance m 200; result, elapsed ms 20; result, pairs linked 246 [48].

Result	Value
result, days	30
result, count	950
result, chains	114
result, distance m	200
result, elapsed ms	20
result, pairs linked	246
billing, cost	0.0785
billing, list price	0.0785
billing, upstream cost	0

Findings

Evidenced: Near repeat on Leak and burst repairs: Repeat and near repeat classification: 1 layer saved: Repeat and near repeat classification: Leak and burst repairs (950 features) [8][48].

Evidenced: It reported result, days 30; result, count 950; result, chains 114; result, distance m 200; result, elapsed ms 20; result, pairs linked 246 [48].

Tool gp_near_repeat; parameters {"days": 30, "project": "0f6d1895-598a-4c17-a195-fc538533c4a3", "features": {"layer": "Leak and burst repairs (7e6cb18c)"}, "distance_m": 200.0, "time_field": "reported_at"}

Maps and charts

The run also made 20 map image(s) [49][50][51][52][53][54][55][56][57][58][59][60][61][62][63][64][65][66][67][68] and 27 chart(s) [69][70][71][72][73][74][75][76][77][78][79][80][81][82][83][84][85][86][87][88][89][90][91][92][93][94][95].

Emerging hot spots: Leak and burst repairs

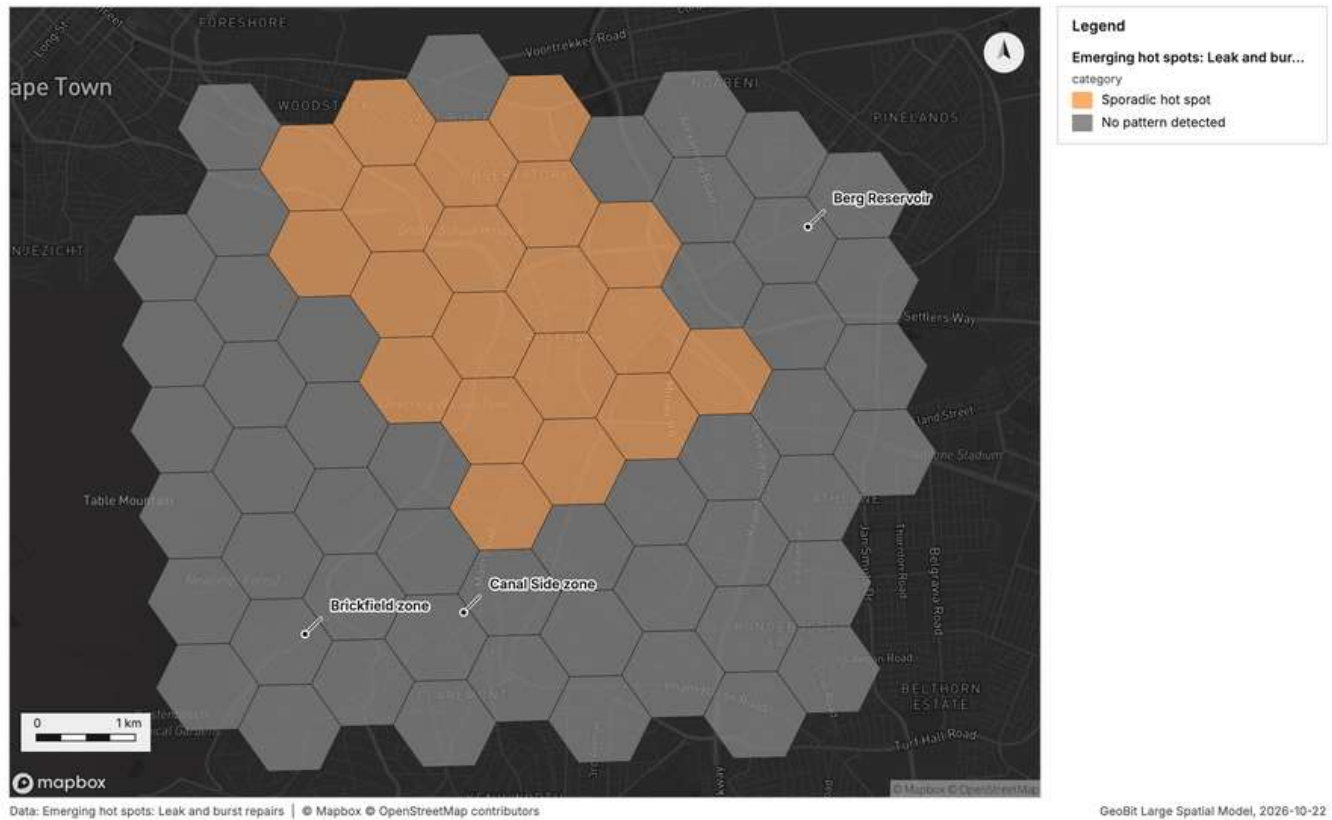


Figure 2. Emerging hot spots: Leak and burst repairs [49]

Emerging hot spots: Customer complaints

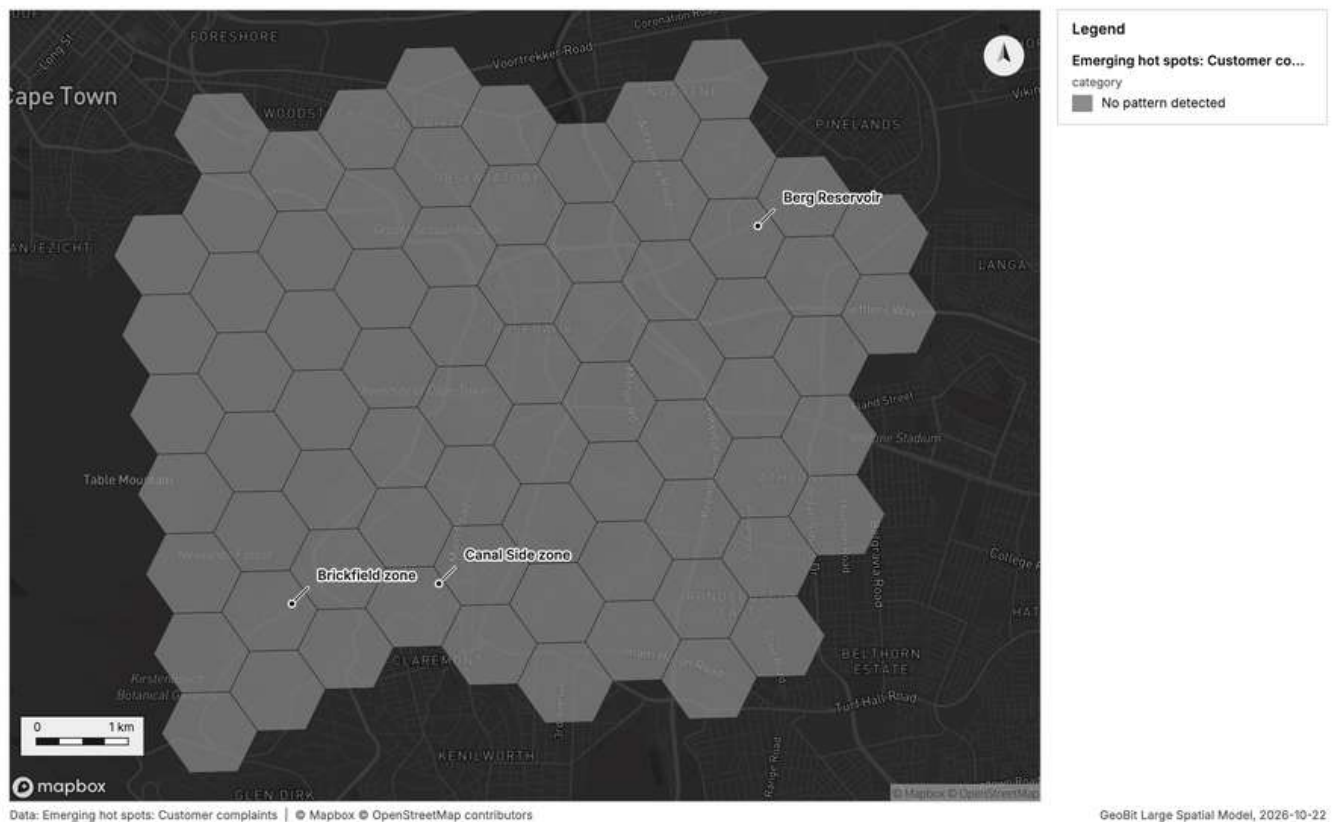


Figure 3. Emerging hot spots: Customer complaints [50]

Hot spot analysis: Valves

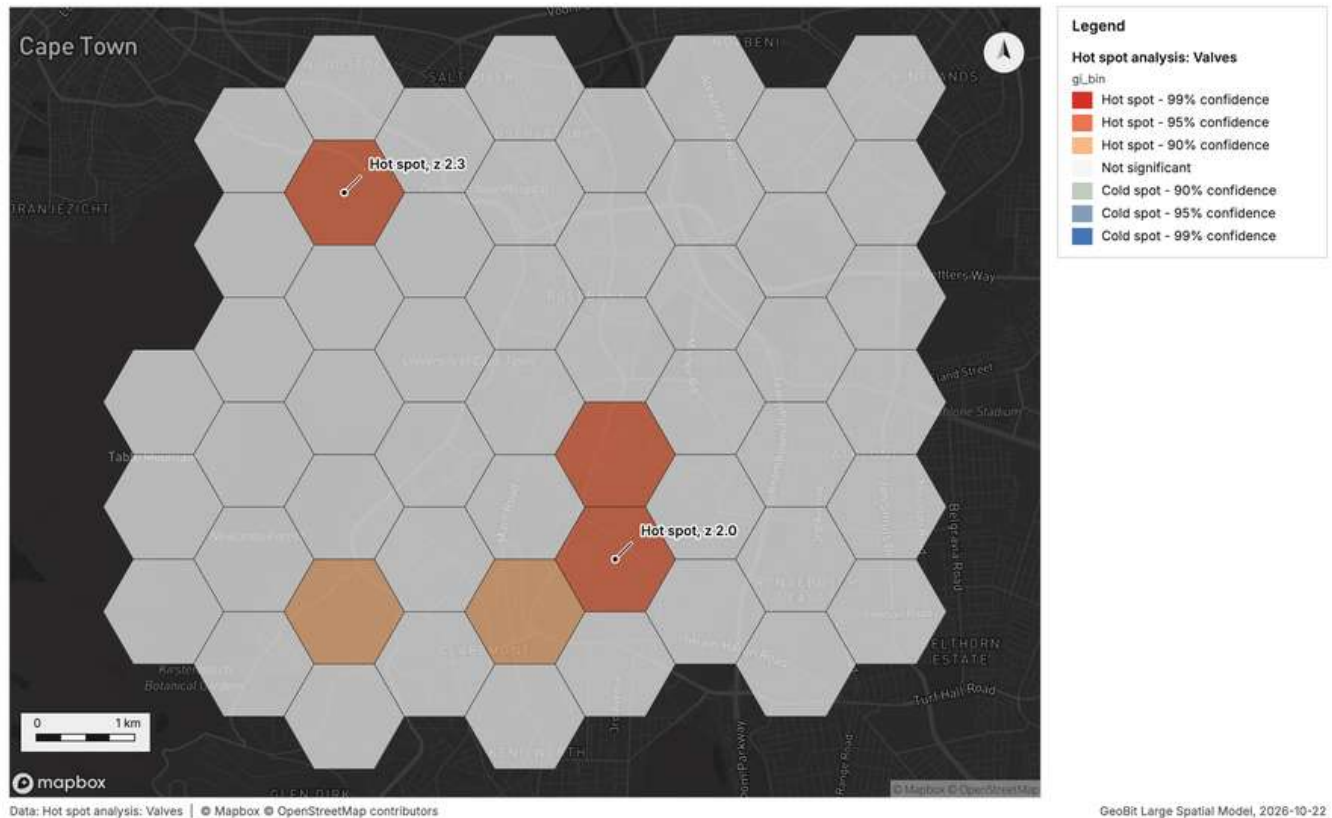


Figure 4. Hot spot analysis: Valves [51]

Hot spot analysis: Leak and burst repairs

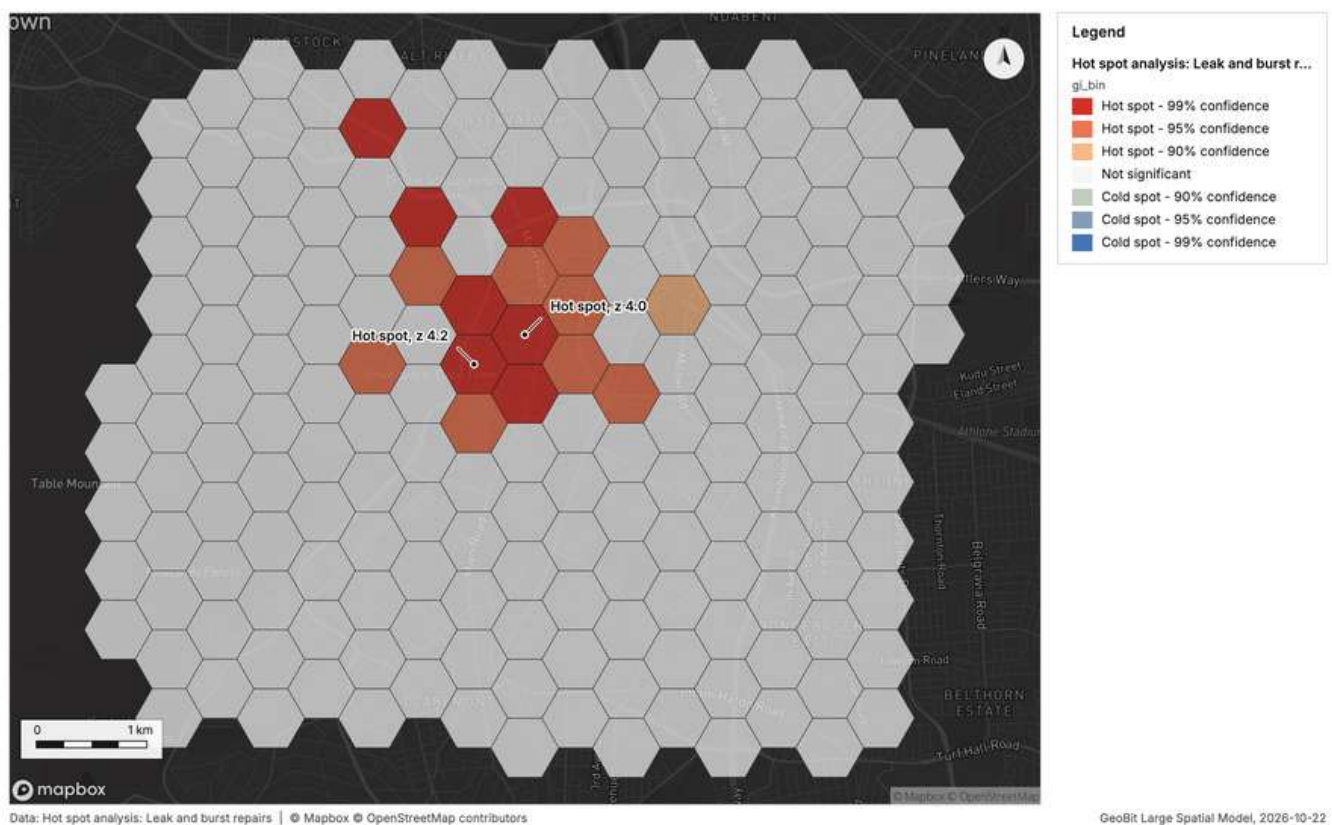


Figure 5. Hot spot analysis: Leak and burst repairs [52]

Hot spot analysis: Customer complaints

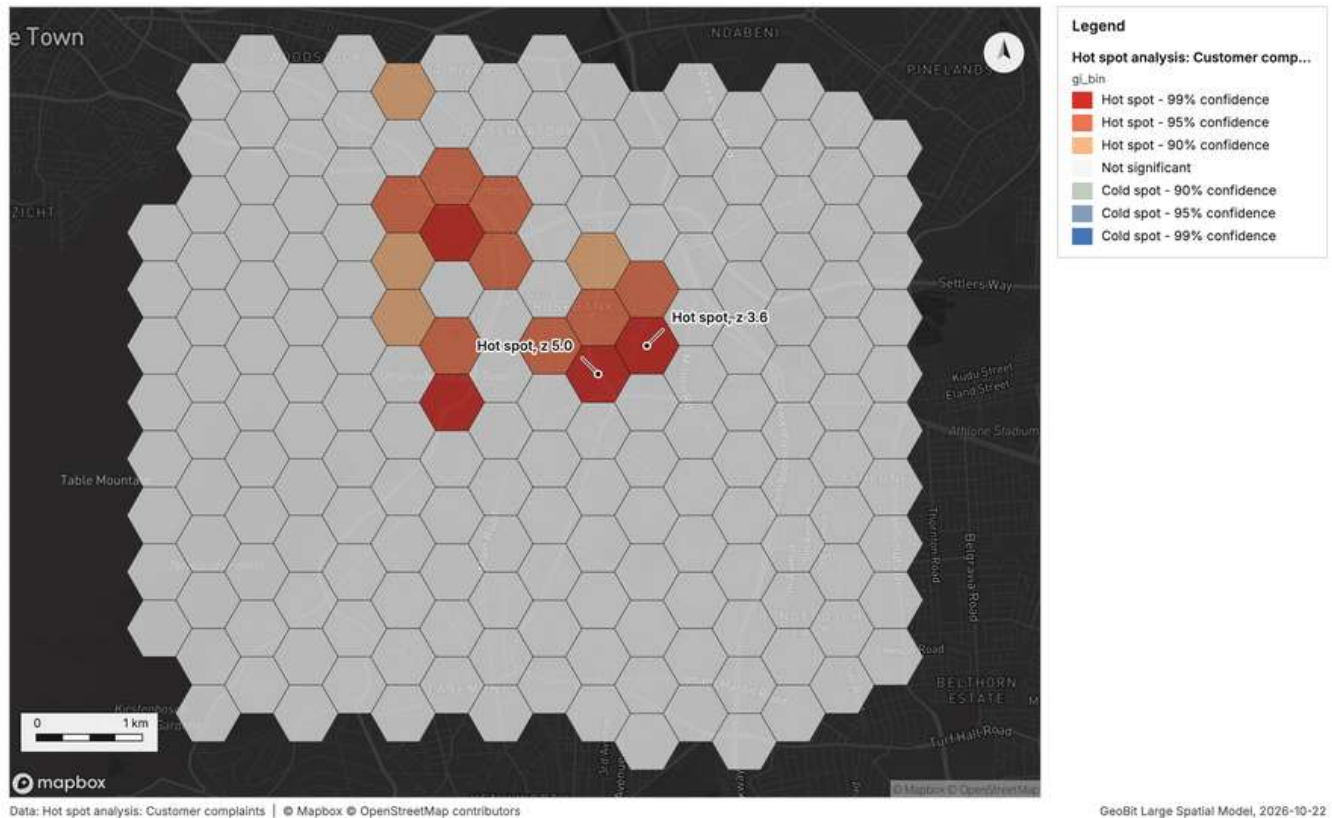


Figure 6. Hot spot analysis: Customer complaints [53]

Calculate density: Valves

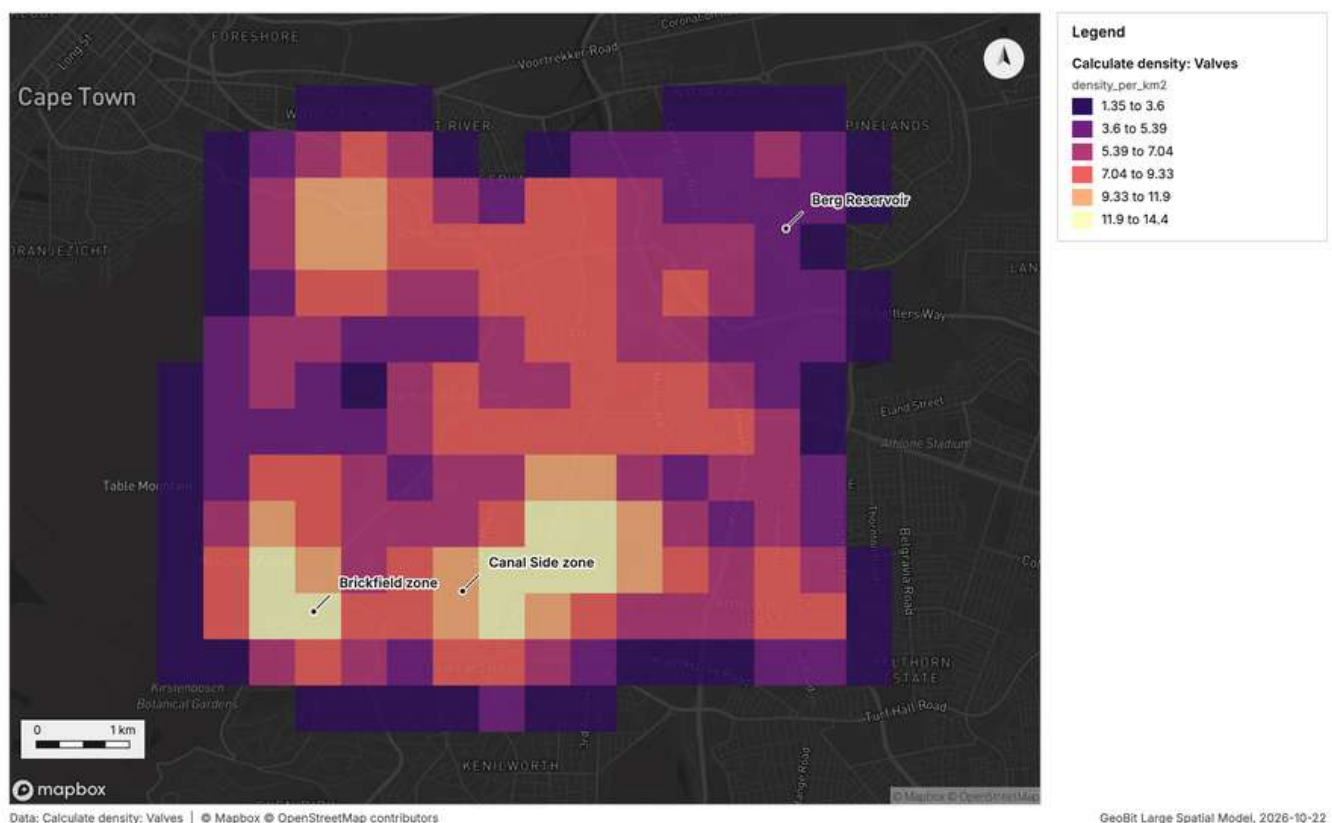


Figure 7. Calculate density: Valves [54]

Calculate density: Leak and burst repairs

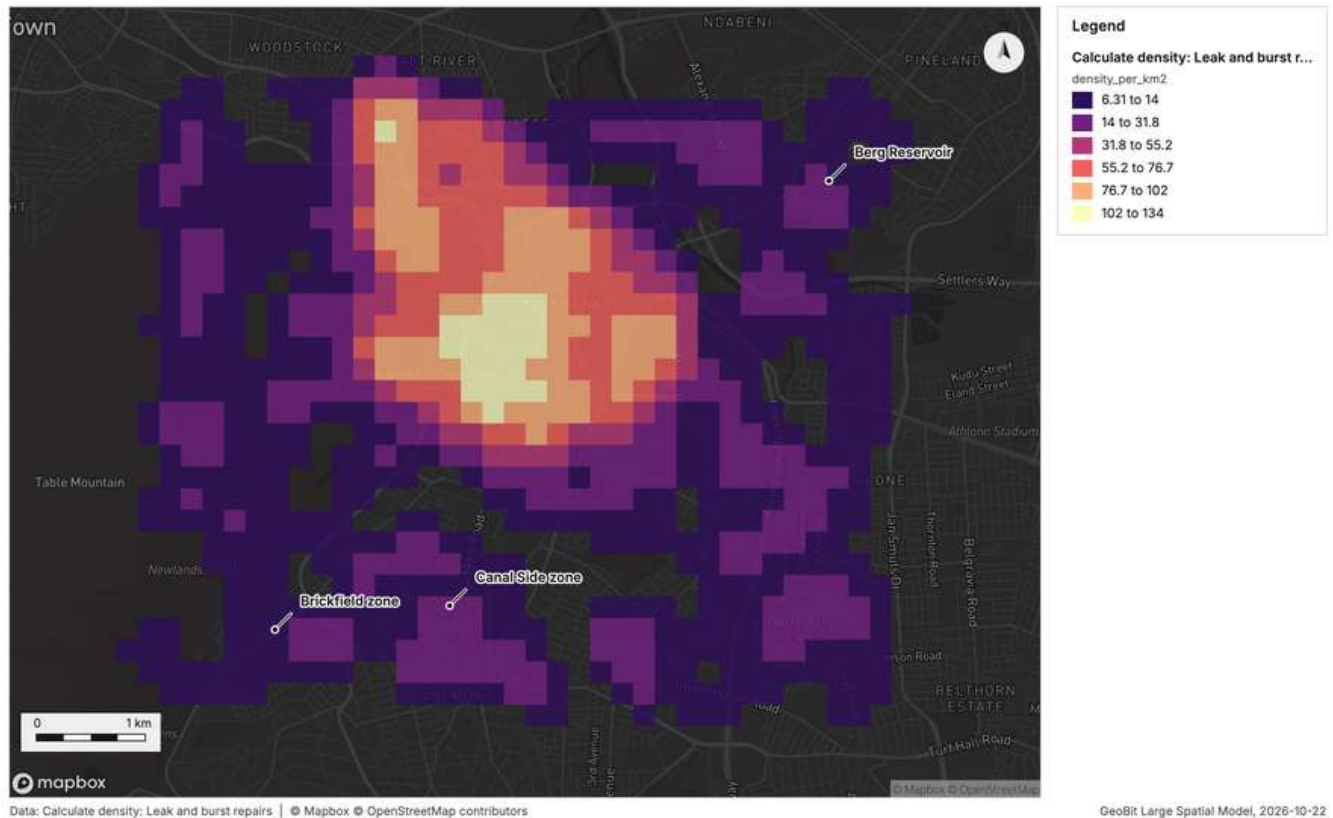


Figure 8. Calculate density: Leak and burst repairs [55]

Calculate density: Customer complaints

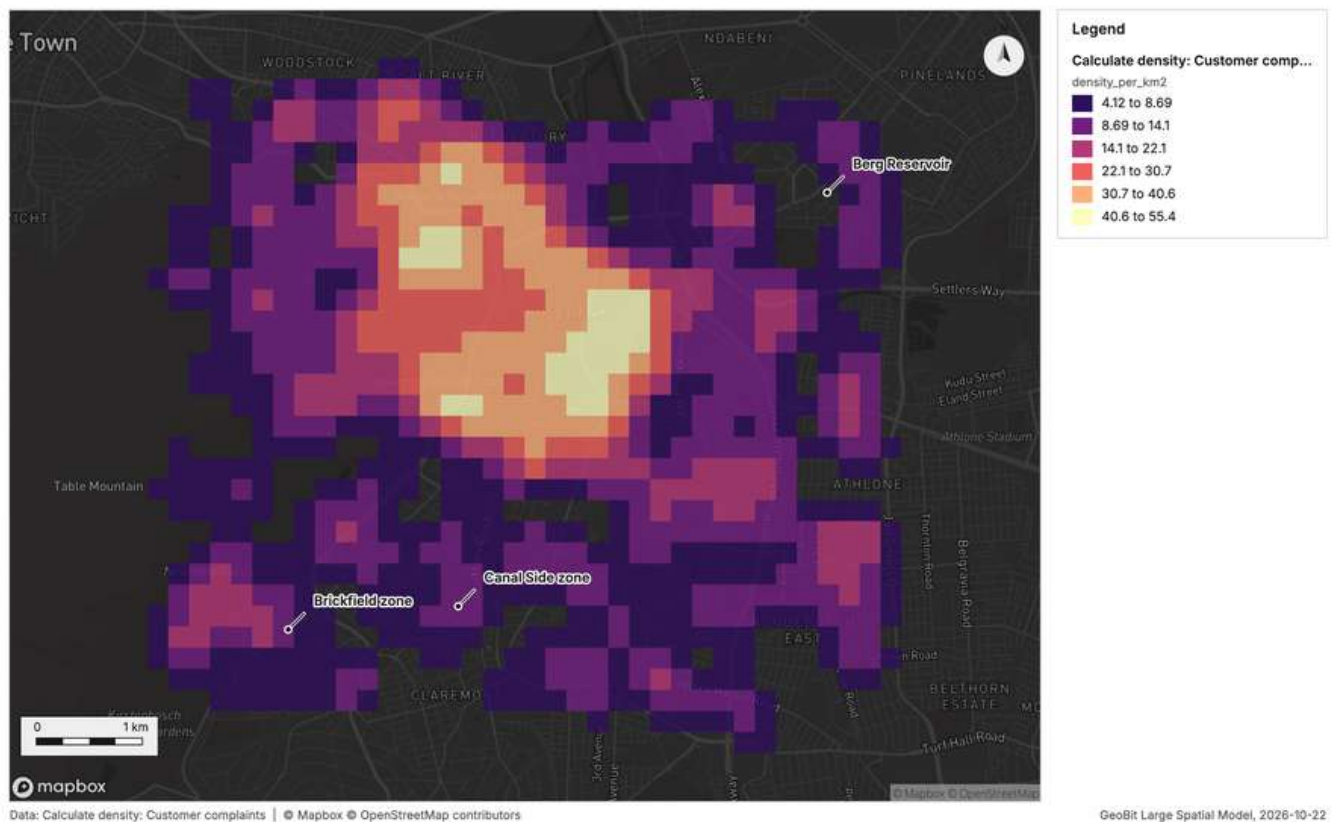


Figure 9. Calculate density: Customer complaints [56]

Summarize within: Pressure zones

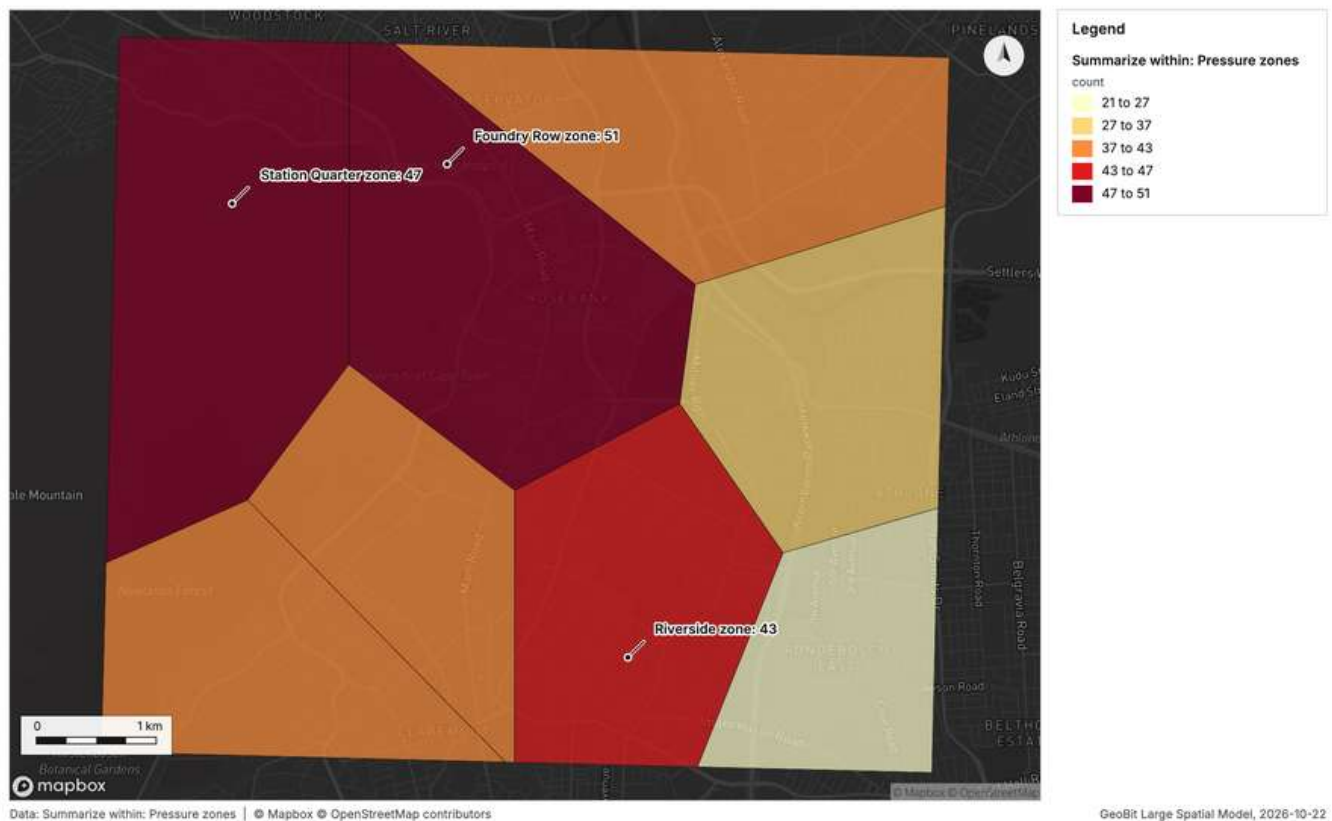


Figure 10. Summarize within: Pressure zones [57]

Summarize within: Pressure zones

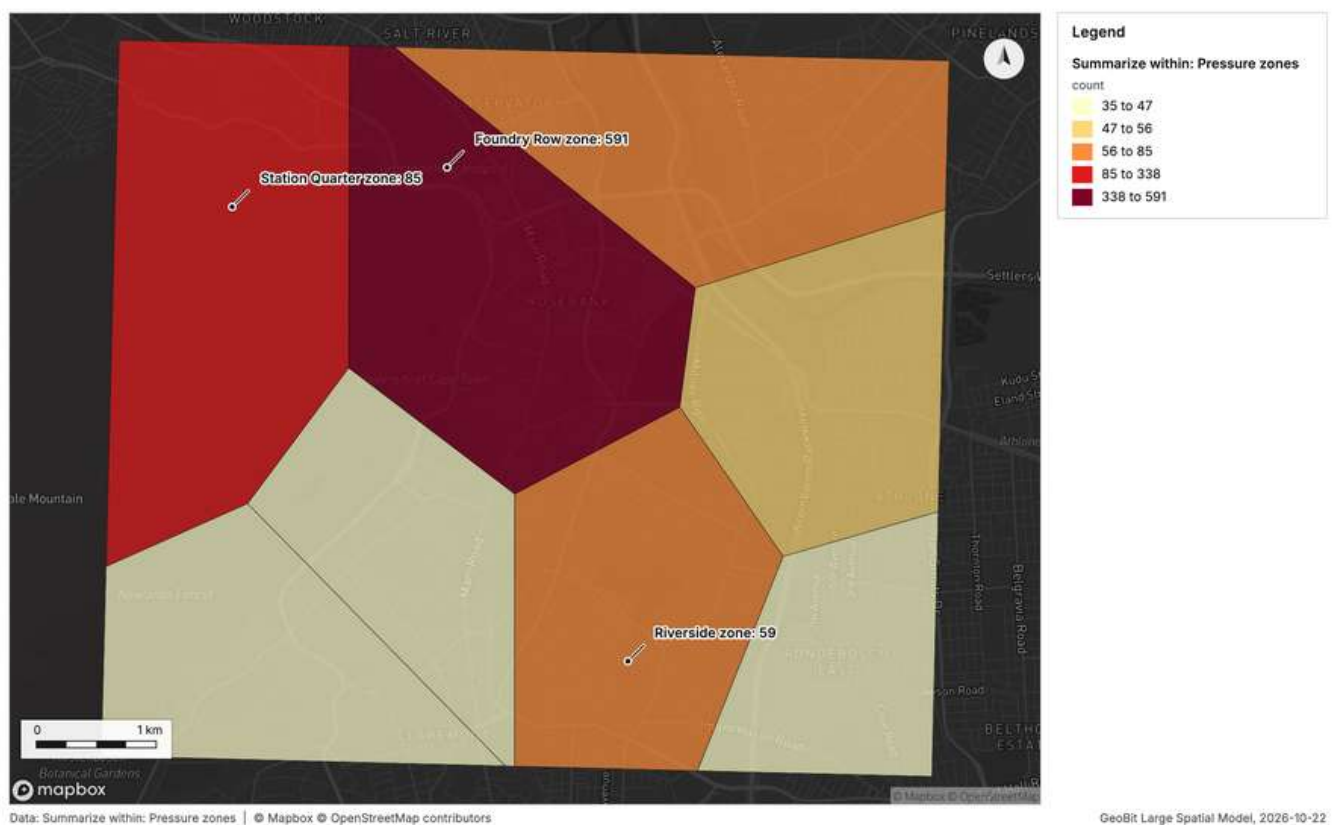


Figure 11. Summarize within: Pressure zones [58]

Summarize within: Pressure zones



Figure 12. Summarize within: Pressure zones [59]

Find point clusters: Valves

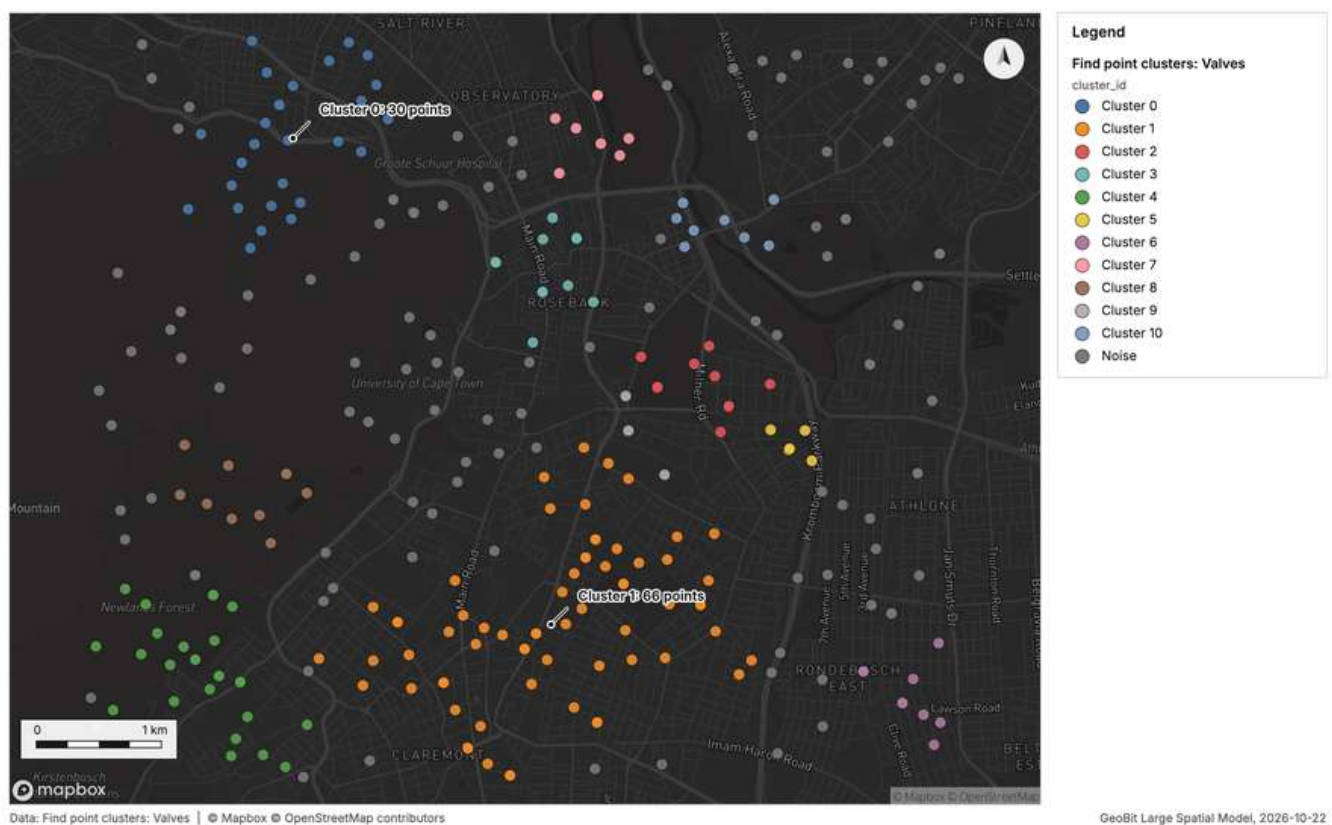


Figure 13. Find point clusters: Valves [60]

Find point clusters: cluster hulls

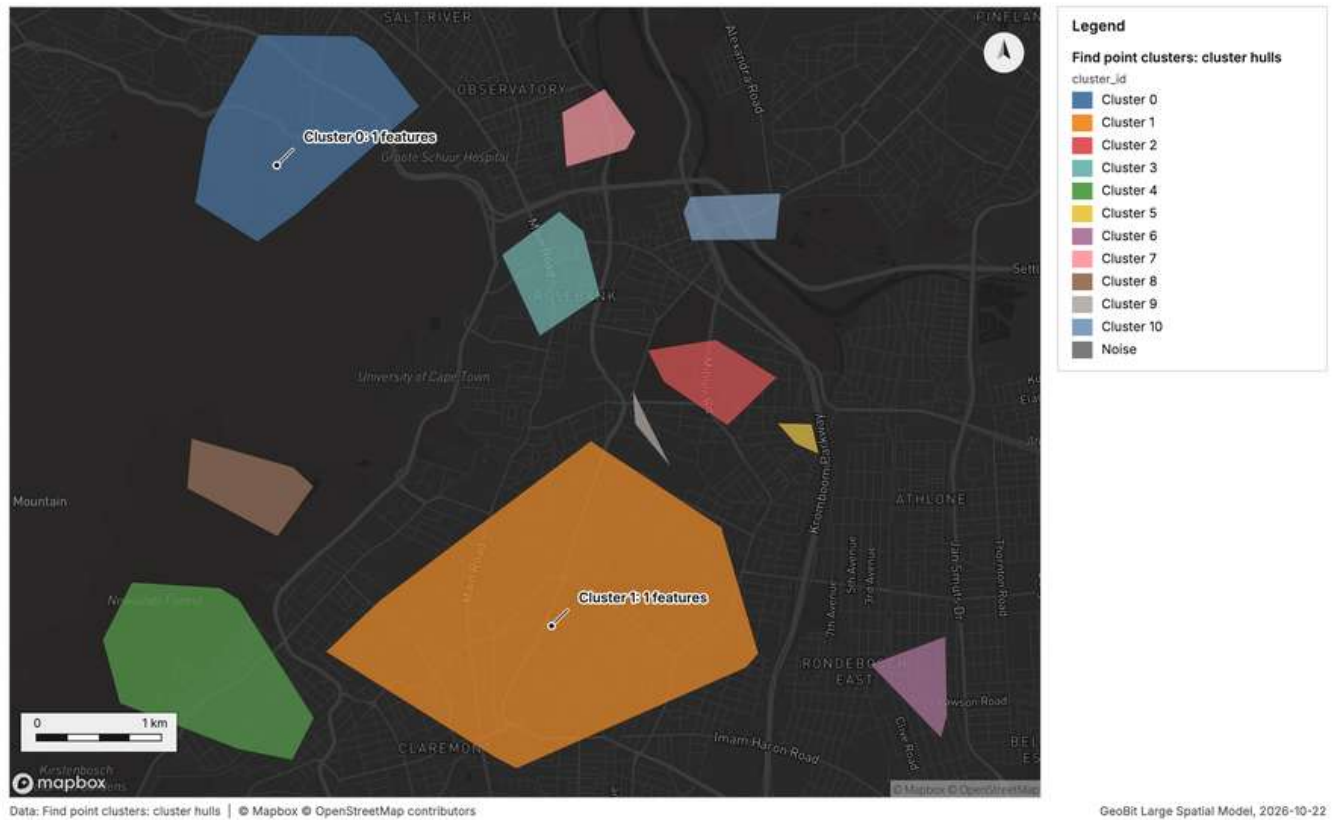


Figure 14. Find point clusters: cluster hulls [61]

Find point clusters: Leak and burst repairs



Figure 15. Find point clusters: Leak and burst repairs [62]

Find point clusters: cluster hulls



Figure 16. Find point clusters: cluster hulls [63]

Find point clusters: Customer complaints

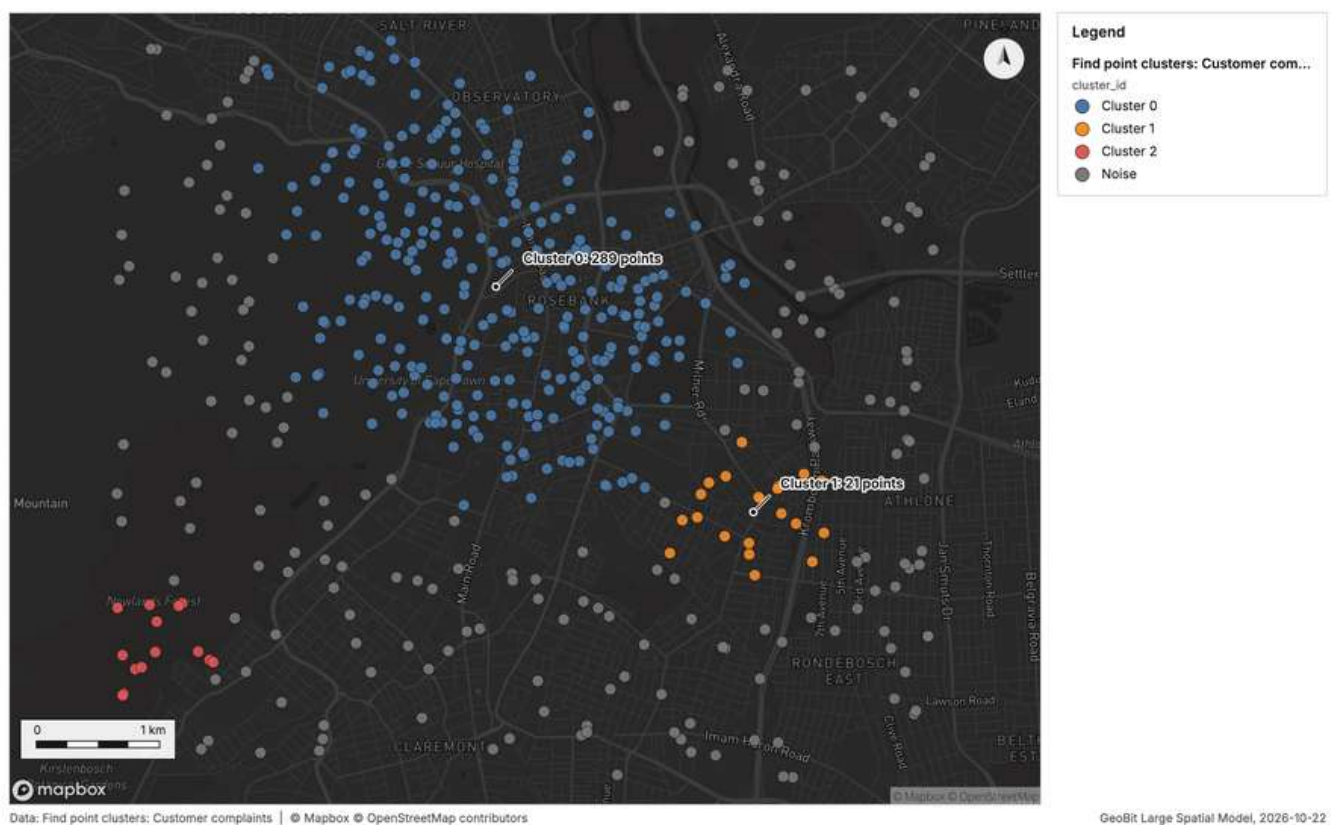


Figure 17. Find point clusters: Customer complaints [64]

Find point clusters: cluster hulls

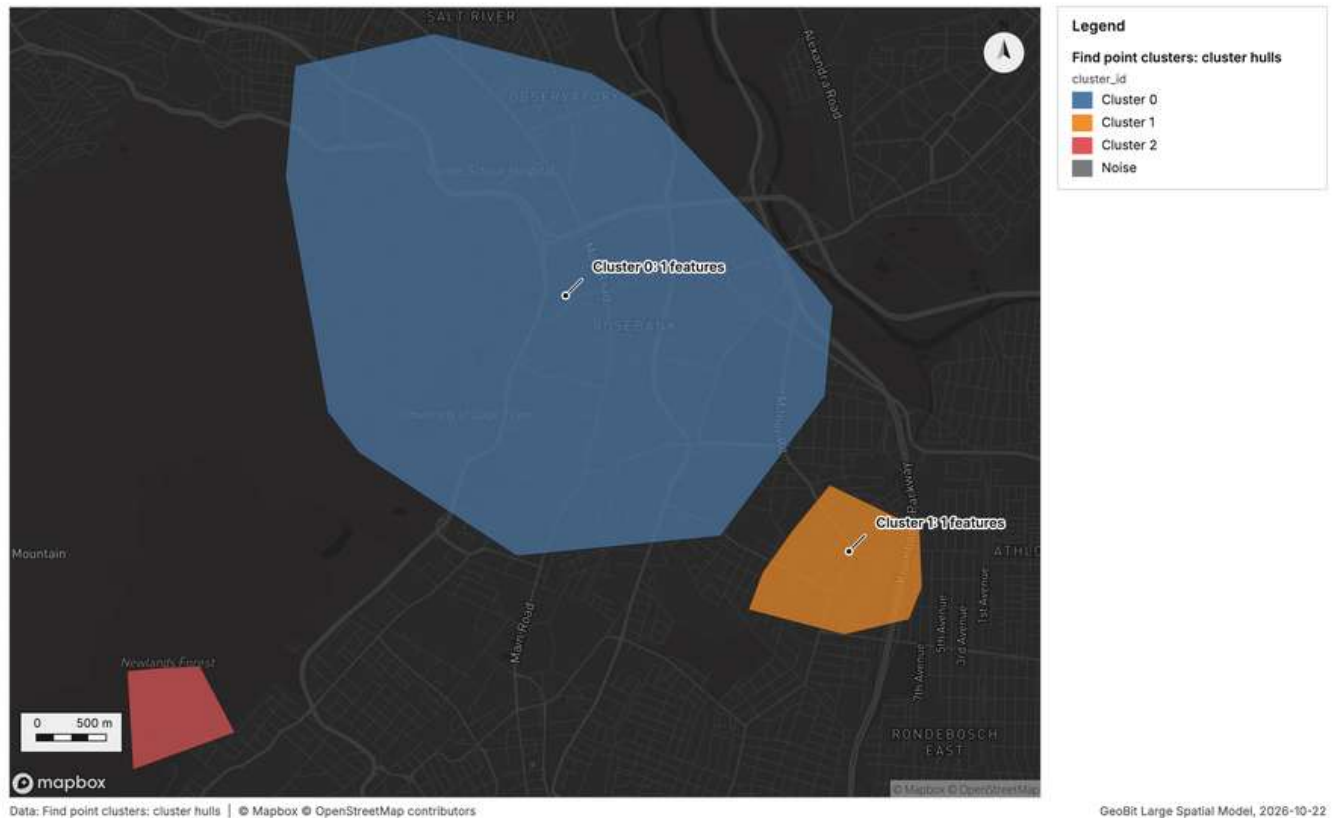


Figure 18. Find point clusters: cluster hulls [65]

Pressure zones by connections

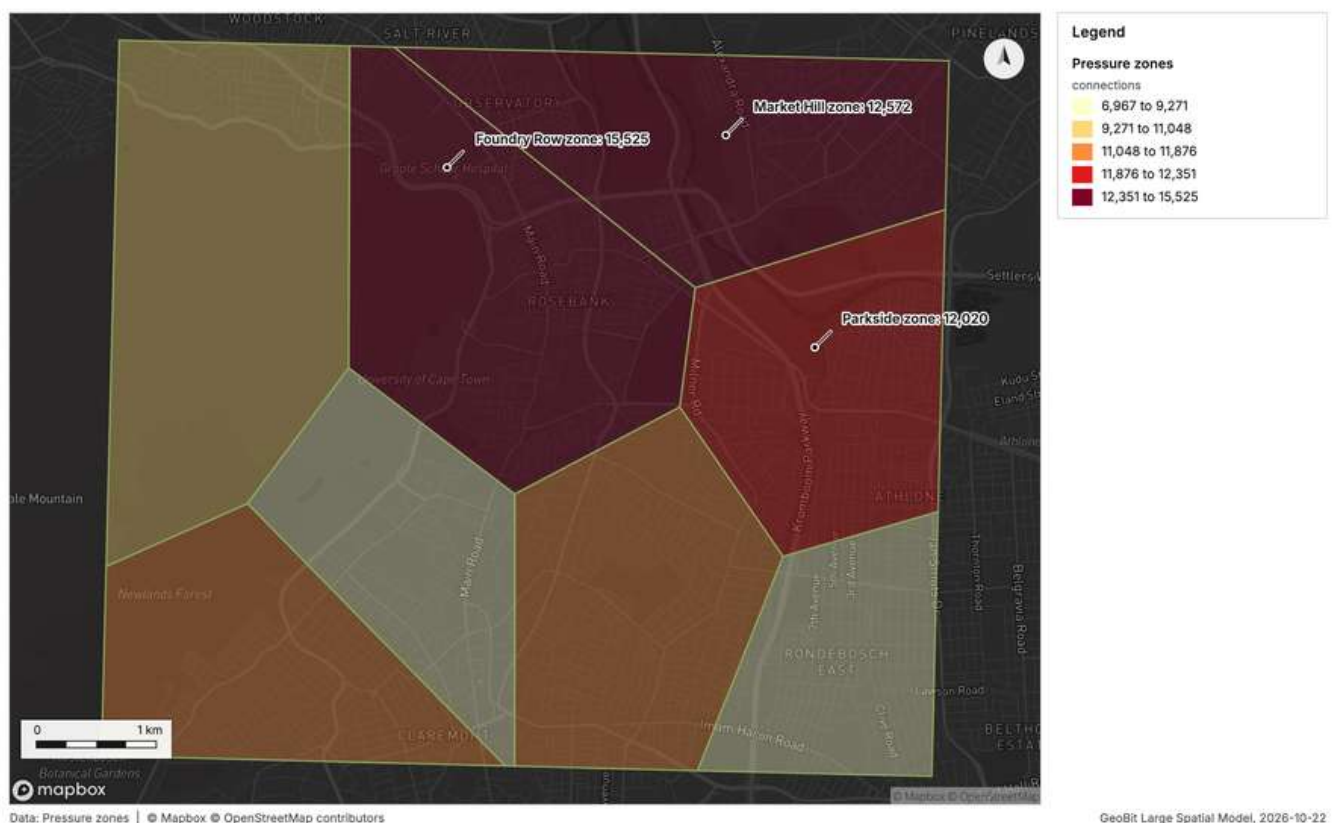


Figure 19. Pressure zones by connections [66]

Find outliers: Pressure zones



Figure 20. Find outliers: Pressure zones [67]

Repeat and near repeat classification: Leak and burst repairs



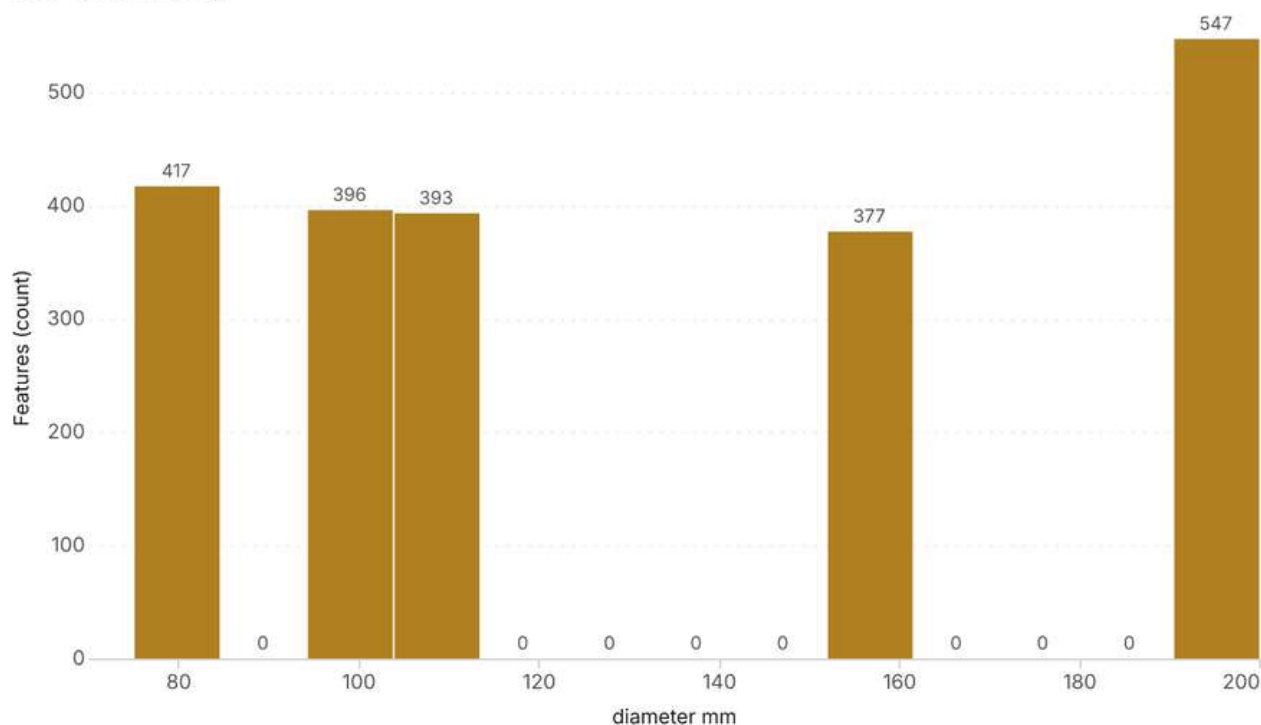
Figure 21. Repeat and near repeat classification: Leak and burst repairs [68]

What the map shows. The map displays emerging hot spots concerning leak and burst repairs, utilizing a classification of 'Sporadic hot spot' and 'No pattern detected.' A noticeable cluster of sporadic hot spots, indicated by the lighter orange coloring, is visible in the central-to-upper portion of the mapped area. In contrast, the majority of the tiles surrounding this central region are colored gray, corresponding to an absence of detected pattern. Overall, the analysis shows a localized concentration of repairs activity surrounded by areas where no significant spatial pattern was detected. [49]

Inferred: read from the image by gemma4:e4b, not evidence.

Distribution of diameter_mm

2,130 values in 13 bins



Source: Water mains (2,130 features).

Figure 22. Water mains over time (install_year) [69]. Source: Water mains (2,130 features). The data is in the appendix.

Count per month by reported_at and type

Per month: 36 months from 2023-10-01 to 2026-09-01; trend +0.466 per month; first half 406, second half 544 (+34.0%)

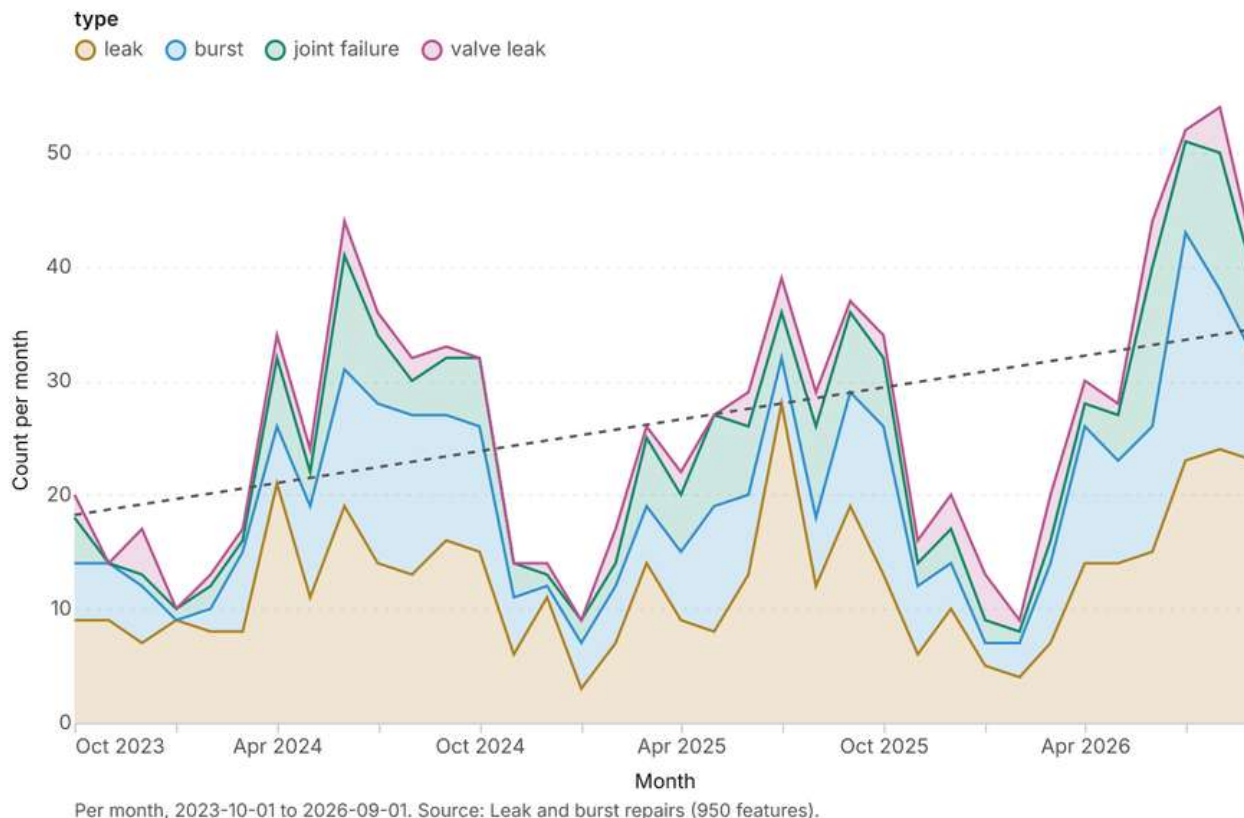


Figure 23. Leak and burst repairs over time (reported_at) [70]. Per month, 2023-10-01 to 2026-09-01. Source: Leak and burst repairs (950 features). The data is in the appendix.

Distribution of exercised_year

300 values in 10 bins

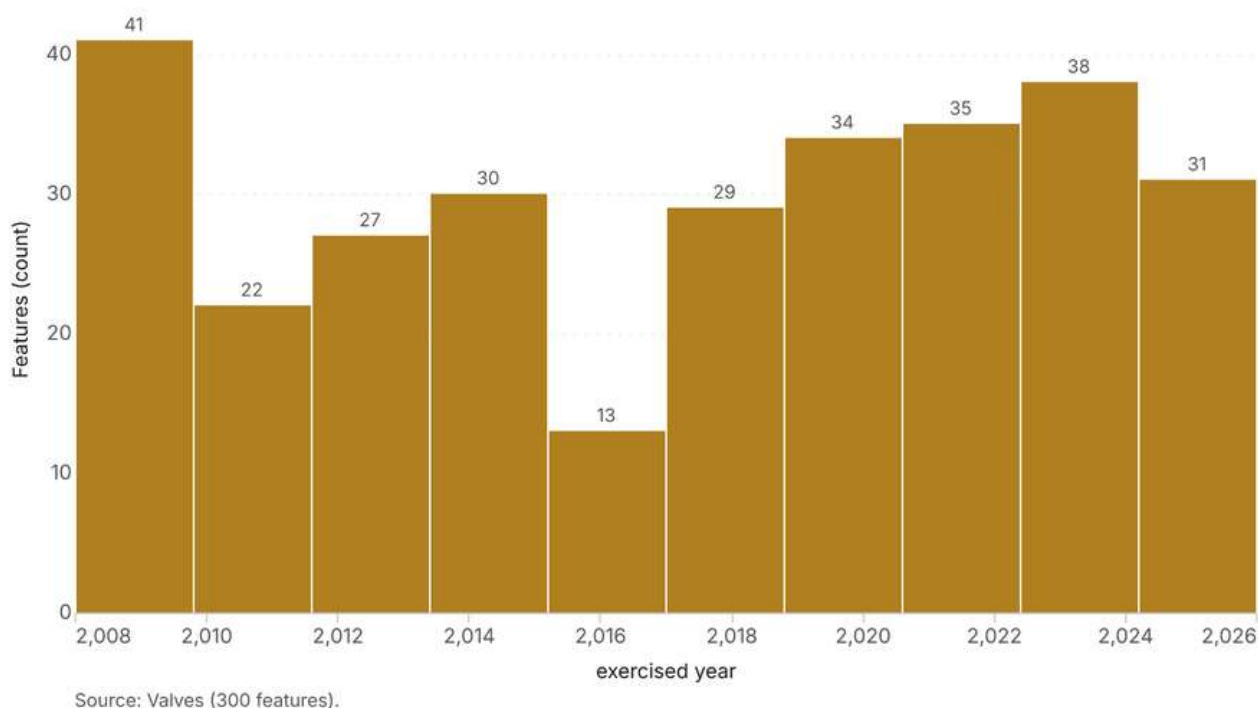


Figure 24. Valves over time (exercised_year) [71]. Source: Valves (300 features). The data is in the appendix.

Distribution of flow_l_s

250 values in 9 bins

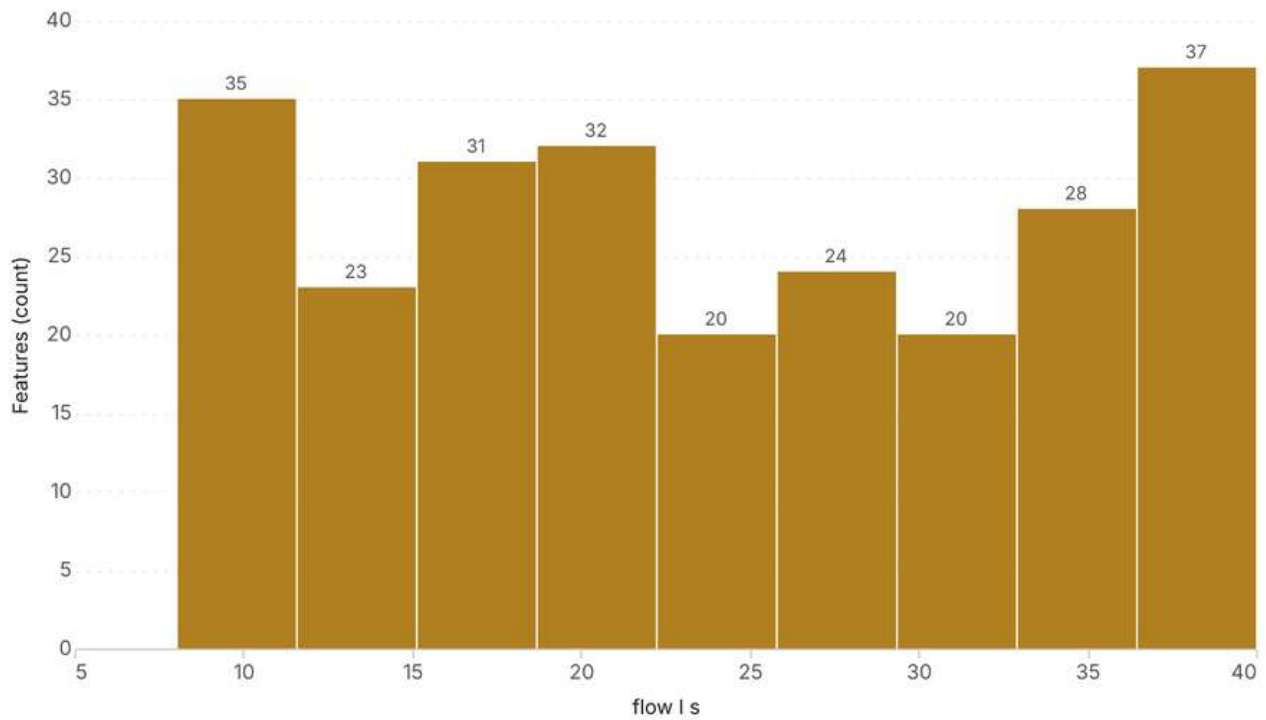


Figure 25. Fire hydrants over time (last_test_year) [72]. Source: Fire hydrants (250 features). The data is in the appendix.

Count per week by date and issue

Per week: 53 weeks from 2025-09-29 to 2026-09-28; trend +0.172 per week; first half 164, second half 344 (+109.8%)

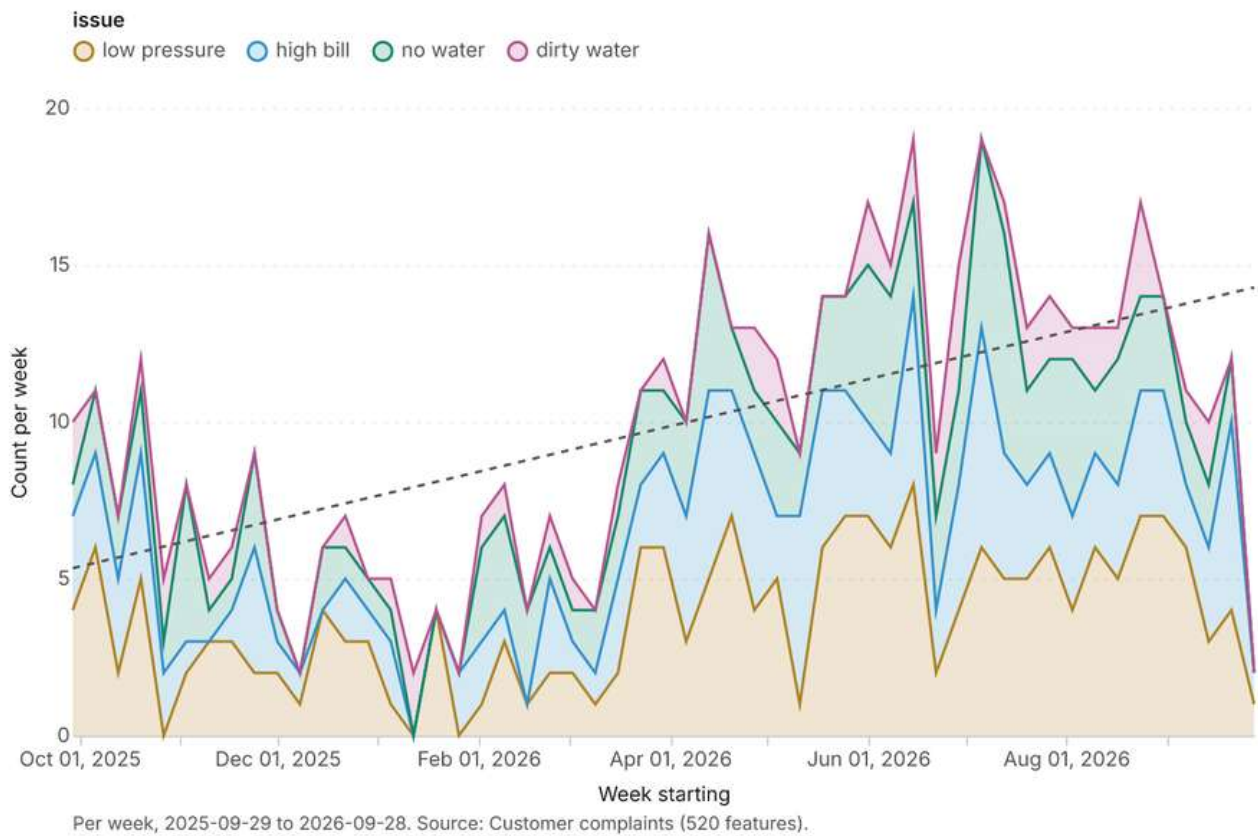
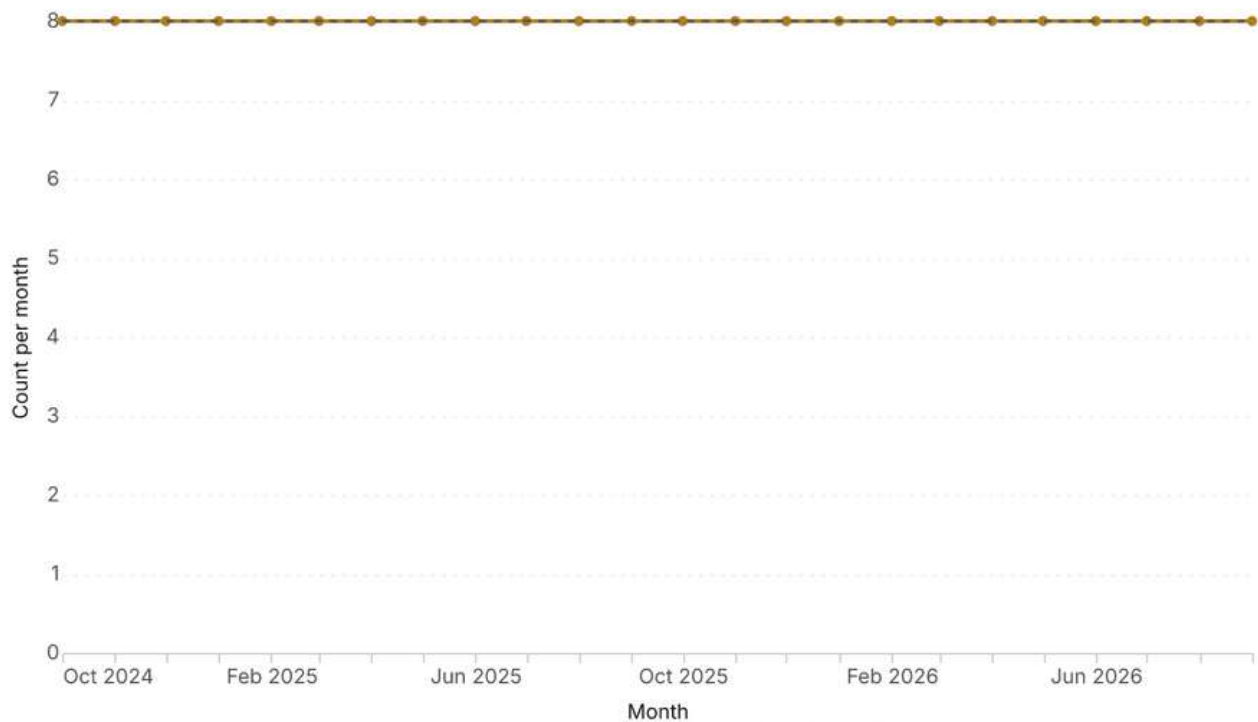


Figure 26. Customer complaints over time (date) [73]. Per week, 2025-09-29 to 2026-09-28. Source: Customer complaints (520 features). The data is in the appendix.

Count per month by month

Per month: 24 months from 2024-10-01 to 2026-09-01; trend +0 per month; first half 96, second half 96 (+0.0%)

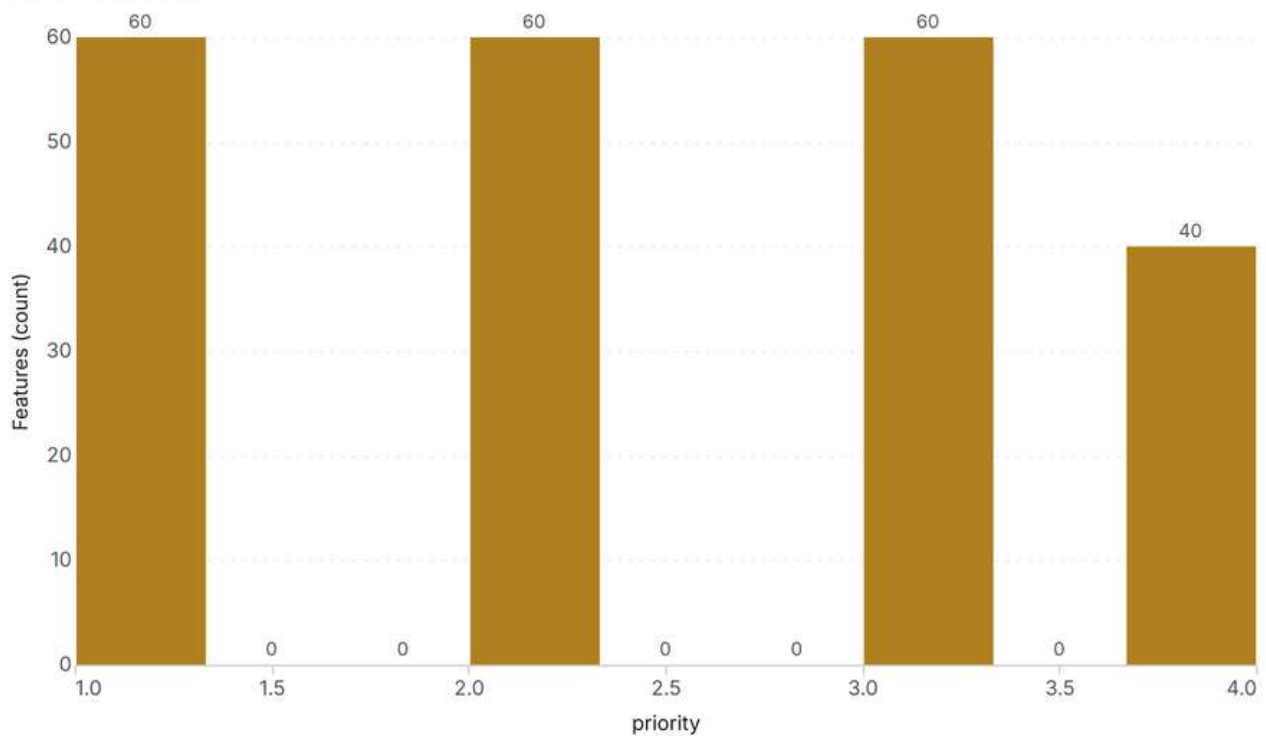


Per month, 2024-10-01 to 2026-09-01. Source: Zone meter readings by month (192 features).

Figure 27. Zone meter readings by month over time (month) [74]. Per month, 2024-10-01 to 2026-09-01. Source: Zone meter readings by month (192 features). The data is in the appendix.

Distribution of priority

220 values in 9 bins

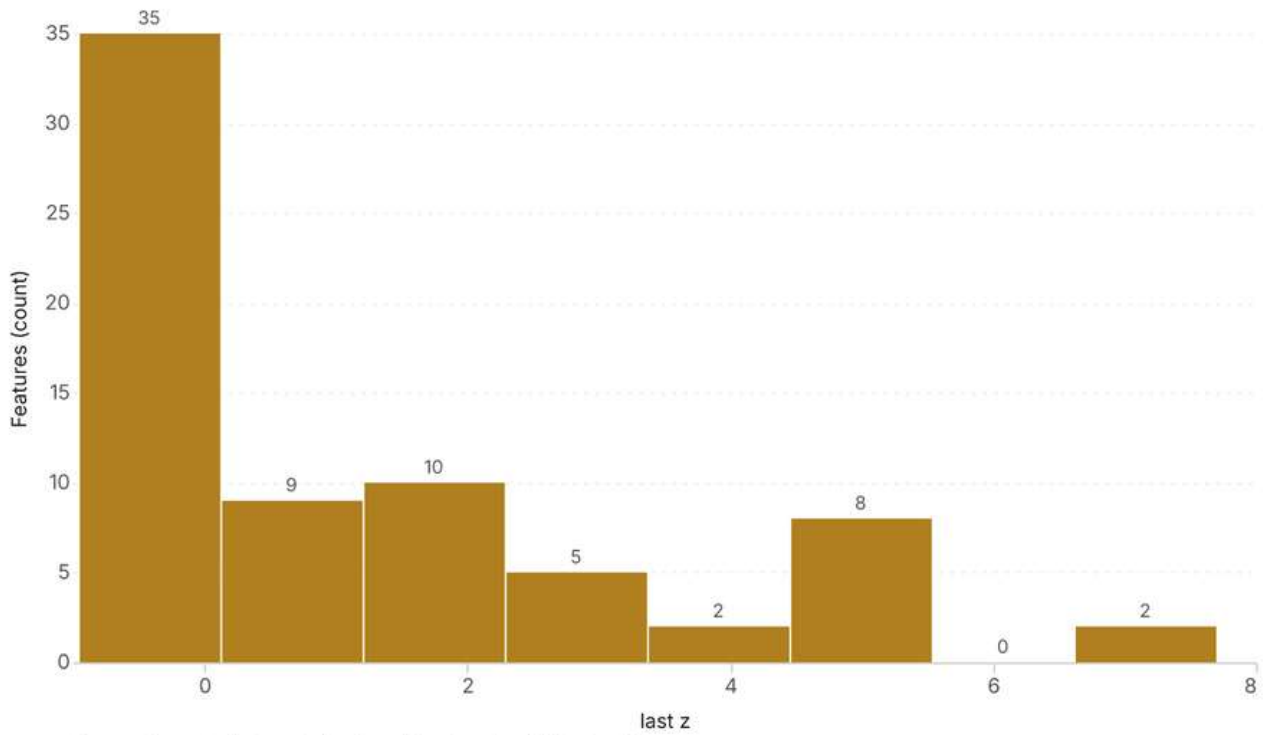


Source: Pipe replacement plan (220 features).

Figure 28. Pipe replacement plan over time (planned_year) [75]. Source: Pipe replacement plan (220 features). The data is in the appendix.

Distribution of last_z

71 values in 8 bins

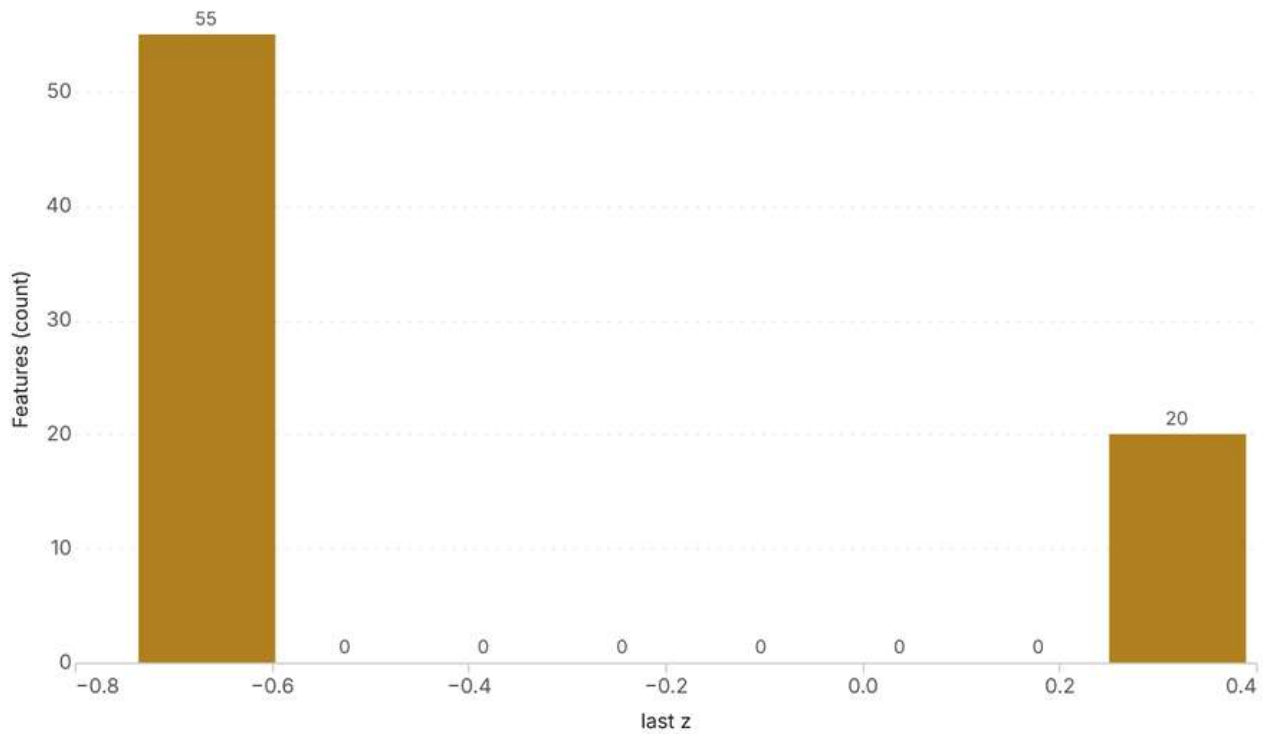


Source: Emerging hot spots: Leak and burst repairs (71 features).

Figure 29. Emerging hot spots: Leak and burst repairs [76]. Source: Emerging hot spots: Leak and burst repairs (71 features). The data is in the appendix.

Distribution of last_z

75 values in 8 bins



Source: Emerging hot spots: Customer complaints (75 features).

Figure 30. Emerging hot spots: Customer complaints [77]. Source: Emerging hot spots: Customer complaints (75 features). The data is in the appendix.

Gi* z-score distribution

53 features: 5 hot and 0 cold at 90% confidence or more

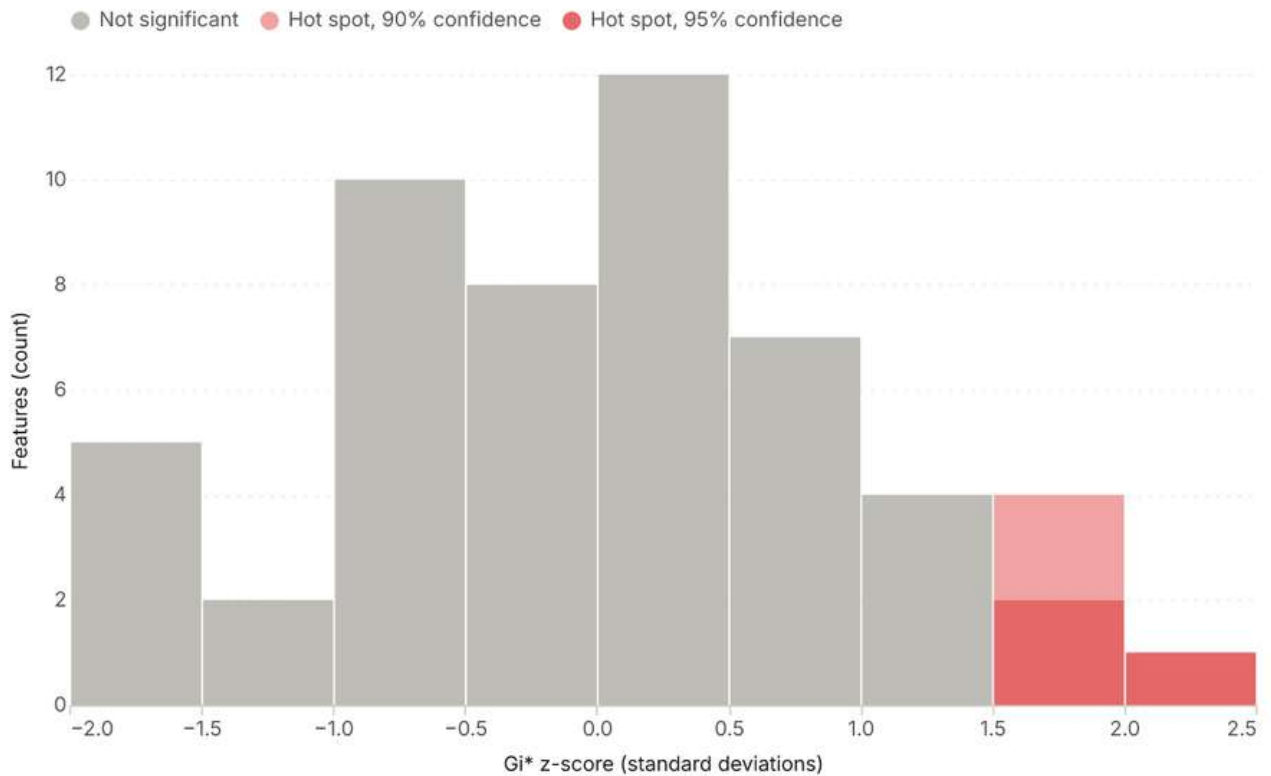


Figure 31. Hot spot analysis: Valves [78]. Source: Hot spot analysis: Valves (53 features). The data is in the appendix.

Gi* z-score distribution

184 features: 16 hot and 0 cold at 90% confidence or more

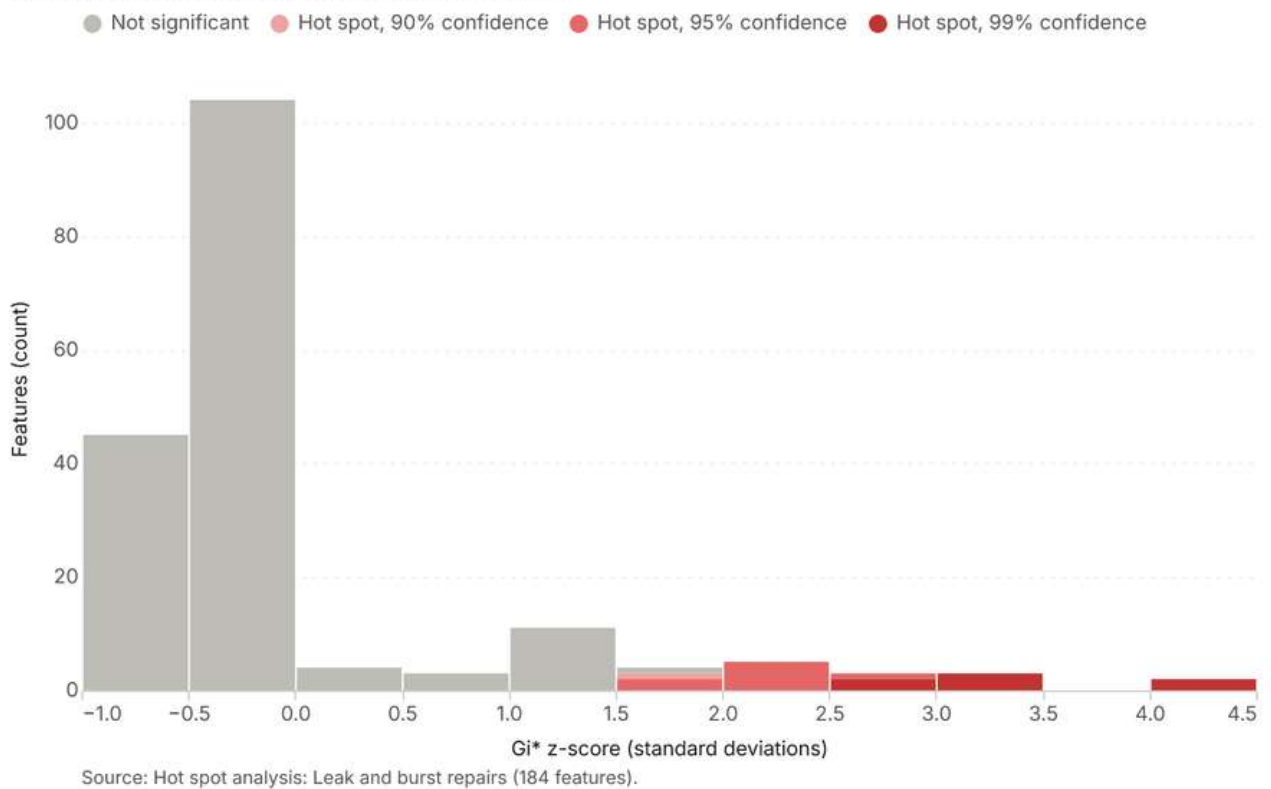
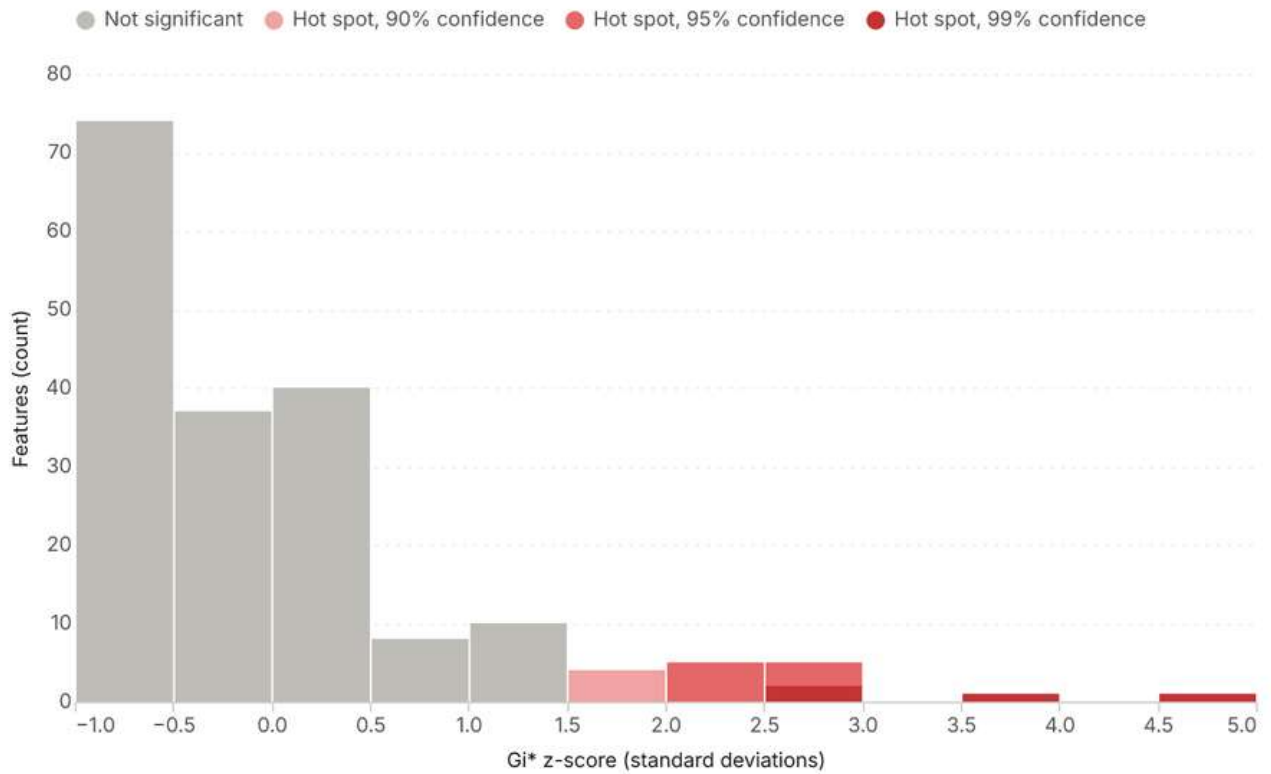


Figure 32. Hot spot analysis: Leak and burst repairs [79]. Source: Hot spot analysis: Leak and burst repairs (184 features). The data is in the appendix.

Gi* z-score distribution

185 features: 16 hot and 0 cold at 90% confidence or more

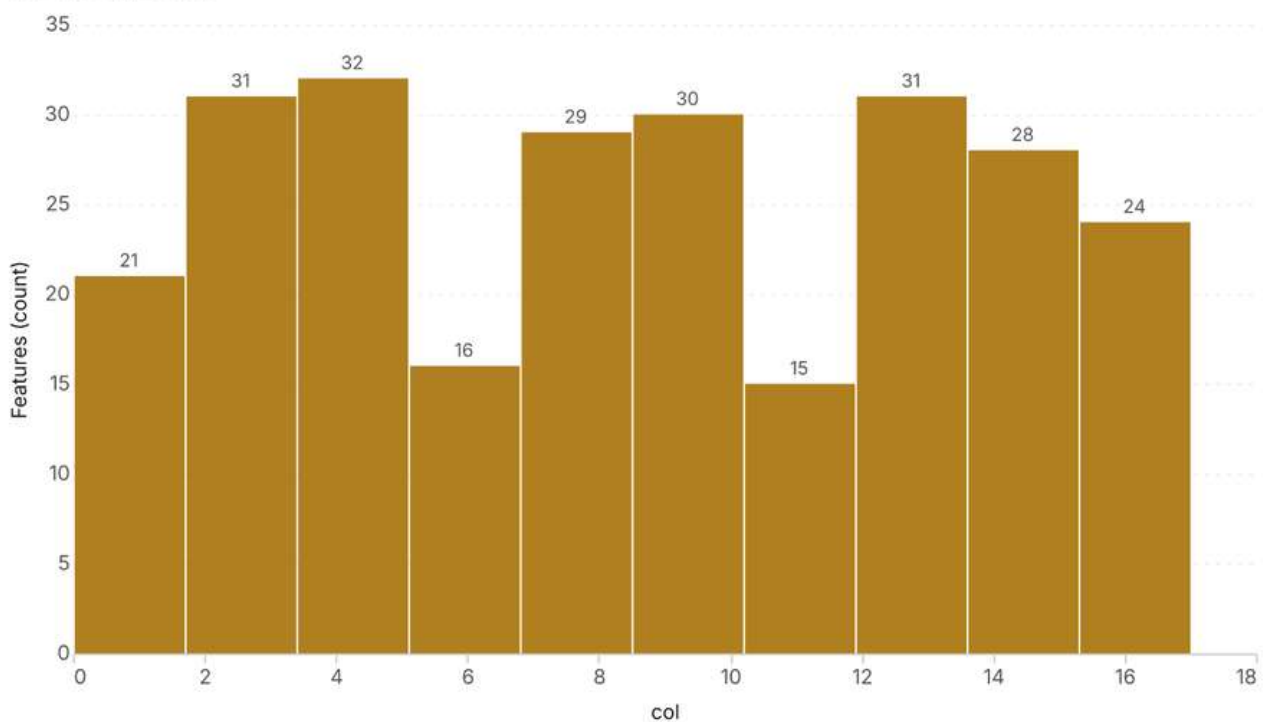


Source: Hot spot analysis: Customer complaints (185 features).

Figure 33. Hot spot analysis: Customer complaints [80]. Source: Hot spot analysis: Customer complaints (185 features). The data is in the appendix.

Distribution of col

257 values in 10 bins



Source: Calculate density: Valves (257 features).

Figure 34. Calculate density: Valves [81]. Source: Calculate density: Valves (257 features). The data is in the appendix.

Distribution of col

1,220 values in 12 bins

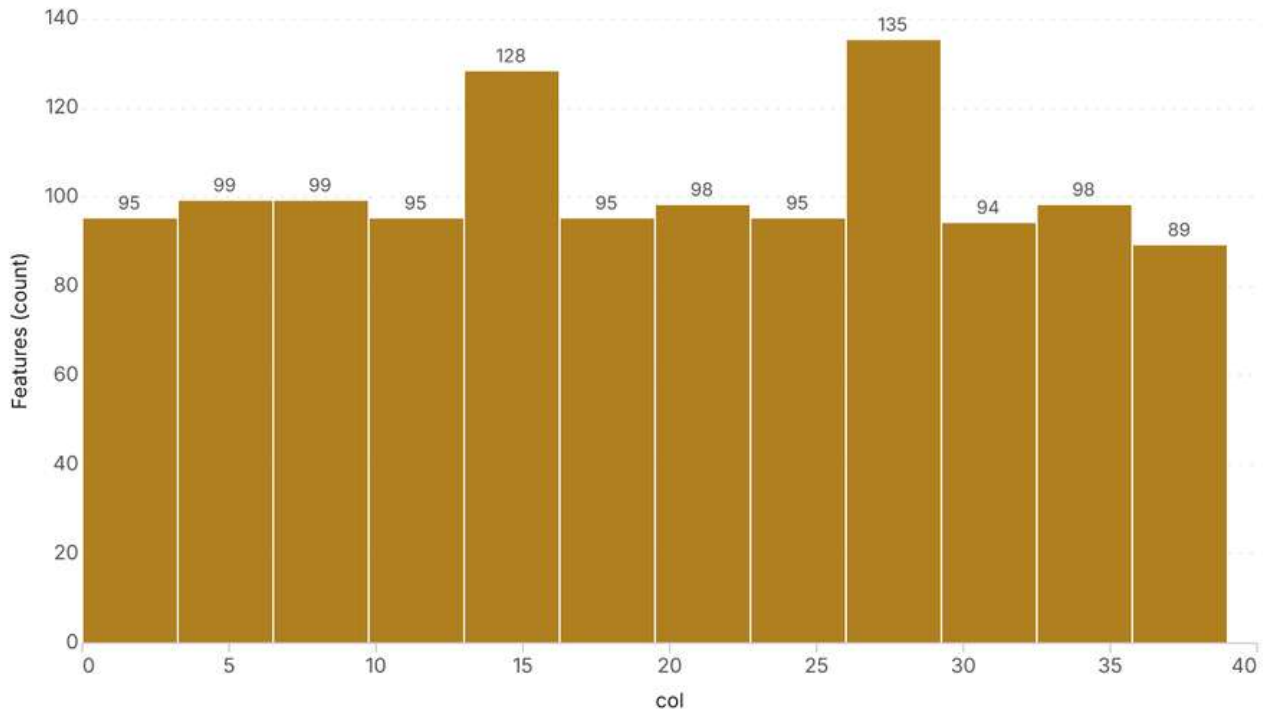


Figure 35. Calculate density: Leak and burst repairs [82]. Source: Calculate density: Leak and burst repairs (1,220 features). The data is in the appendix.

Distribution of col

1,200 values in 12 bins

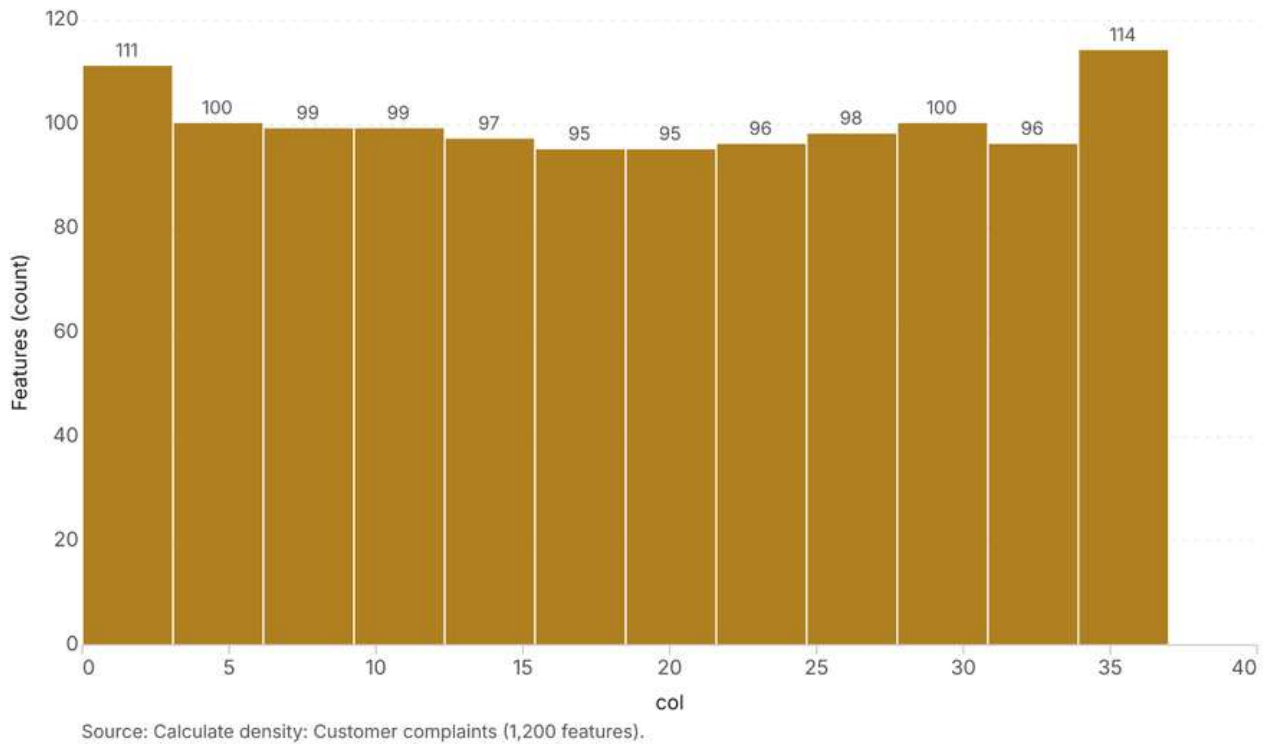
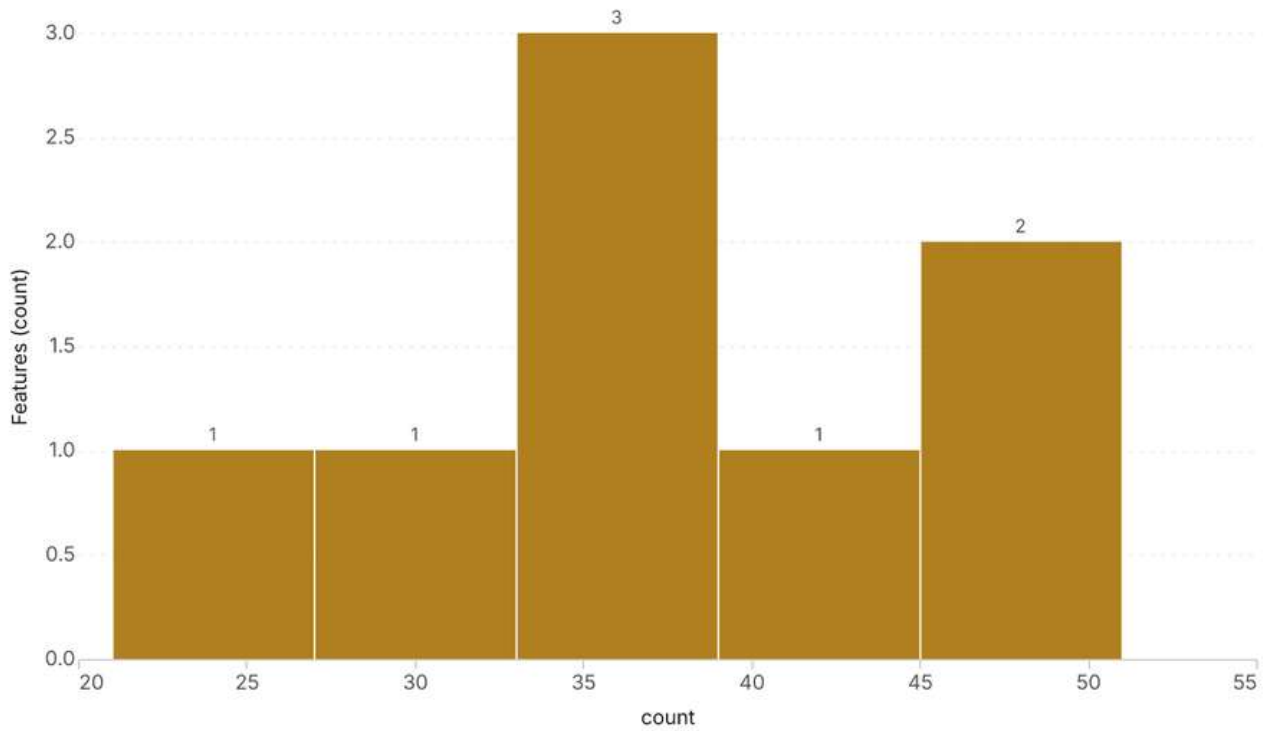


Figure 36. Calculate density: Customer complaints [83]. Source: Calculate density: Customer complaints (1,200 features). The data is in the appendix.

Distribution of count

8 values in 5 bins

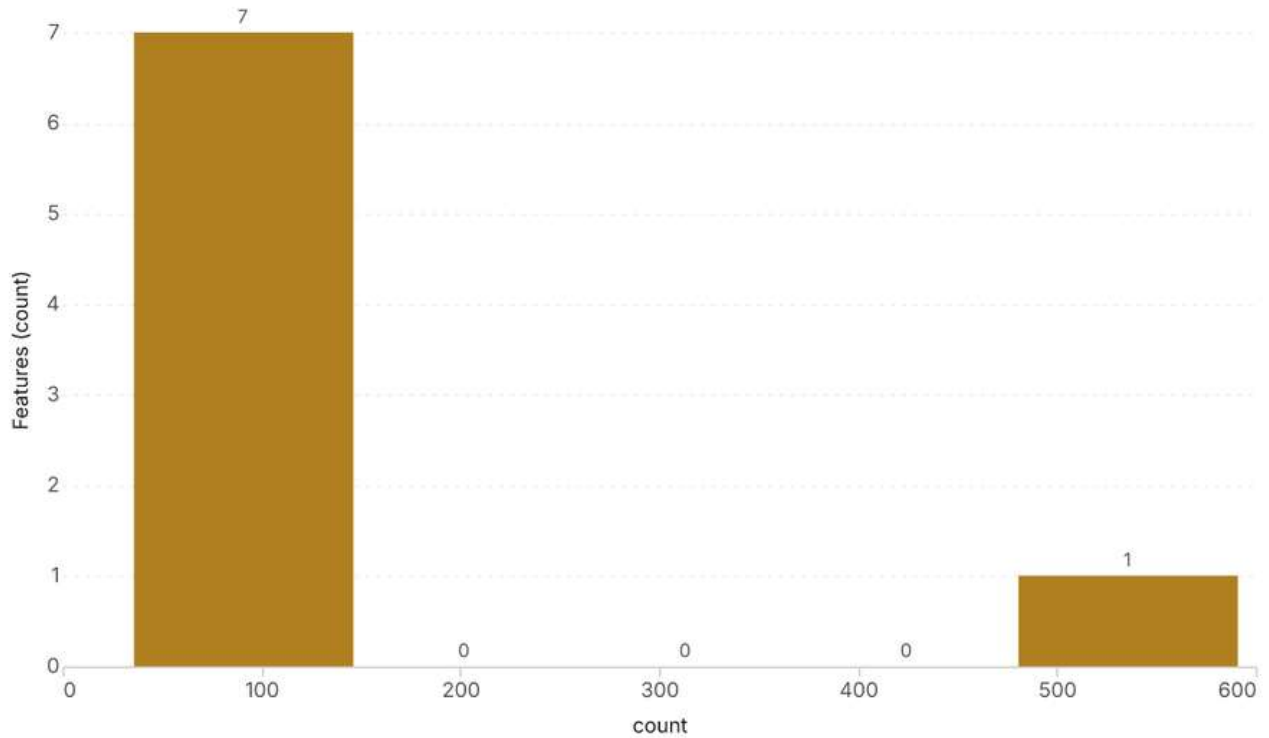


Source: Summarize within: Pressure zones (8 features).

Figure 37. Summarize within: Pressure zones [84]. Source: Summarize within: Pressure zones (8 features). The data is in the appendix.

Distribution of count

8 values in 5 bins

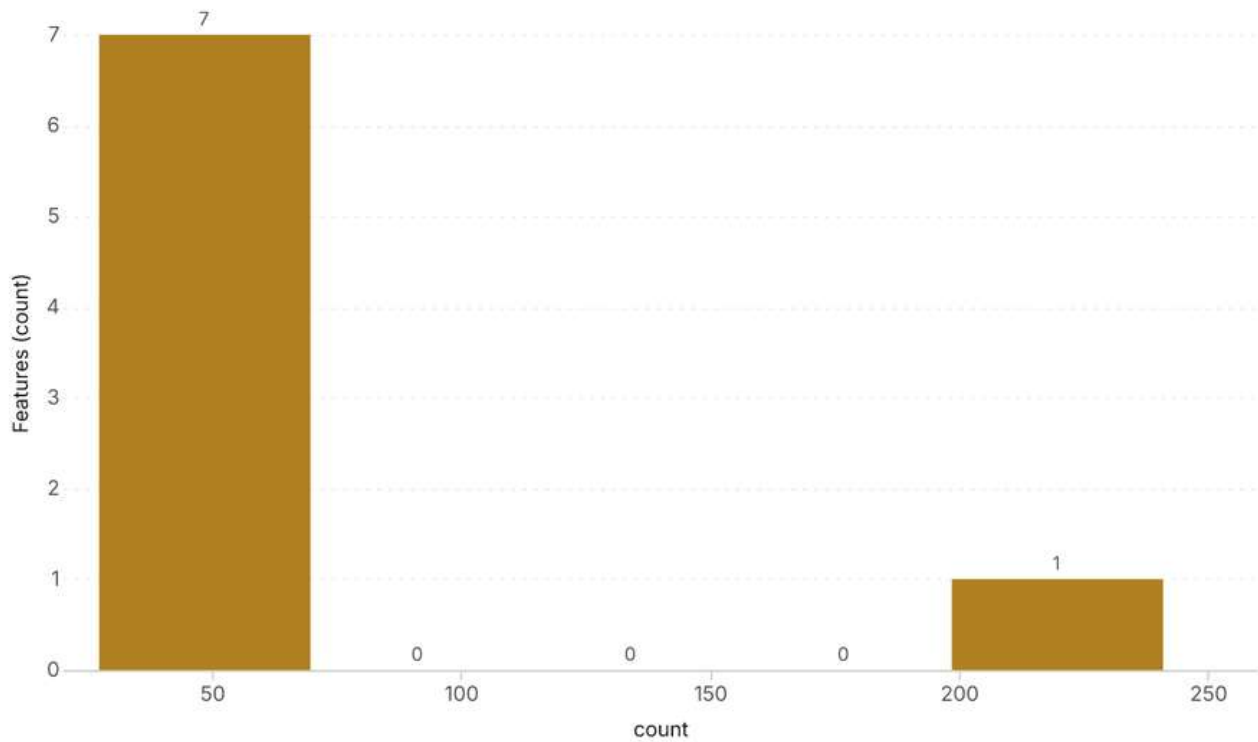


Source: Summarize within: Pressure zones (8 features).

Figure 38. Summarize within: Pressure zones [85]. Source: Summarize within: Pressure zones (8 features). The data is in the appendix.

Distribution of count

8 values in 5 bins



Source: Summarize within: Pressure zones (8 features).

Figure 39. Summarize within: Pressure zones [86]. Source: Summarize within: Pressure zones (8 features). The data is in the appendix.

Cluster sizes

11 clusters over 300 features

cluster	features	share
Noise	114	38.0%
1	66	22.0%
0	30	10.0%
4	26	8.7%
3	11	3.7%
2	10	3.3%
8	10	3.3%
6	9	3.0%
10	8	2.7%
7	8	2.7%
5	5	1.7%
9	3	1.0%

Source: Find point clusters: Valves (300 features).

Figure 40. Find point clusters: Valves [87]. Source: Find point clusters: Valves (300 features). The data is in the appendix.

Cluster sizes

11 clusters over 11 features

cluster	features	share
0	1	9.1%
1	1	9.1%
10	1	9.1%
2	1	9.1%
3	1	9.1%
4	1	9.1%
5	1	9.1%
6	1	9.1%
7	1	9.1%
8	1	9.1%
9	1	9.1%

Source: Find point clusters: cluster hulls (11 features).

Figure 41. Find point clusters: cluster hulls [88]. Source: Find point clusters: cluster hulls (11 features). The data is in the appendix.

Cluster sizes

3 clusters over 950 features

cluster	features	share
Noise	830	87.4%
1	56	5.9%
0	38	4.0%
2	26	2.7%

Period: 2023-10-01 to 2026-09-30 (reported_at). Source: Find point clusters: Leak and burst ...

Figure 42. Find point clusters: Leak and burst repairs [89]. Period: 2023-10-01 to 2026-09-30 (reported_at). Source: Find point clusters: Leak and burst repairs (950 features). The data is in the appendix.

Cluster sizes

3 clusters over 3 features

cluster	features	share
0	1	33.3%
1	1	33.3%
2	1	33.3%

Source: Find point clusters: cluster hulls (3 features).

Figure 43. Find point clusters: cluster hulls [90]. Source: Find point clusters: cluster hulls (3 features). The data is in the appendix.

Cluster sizes

3 clusters over 520 features

cluster	features	share
0	289	55.6%
Noise	196	37.7%
1	21	4.0%
2	14	2.7%

Period: 2025-10-01 to 2026-09-29 (date). Source: Find point clusters: Customer complaints (...)

Figure 44. Find point clusters: Customer complaints [91]. Period: 2025-10-01 to 2026-09-29 (date). Source: Find point clusters: Customer complaints (520 features). The data is in the appendix.

Cluster sizes

3 clusters over 3 features

cluster	features	share
0	1	33.3%
1	1	33.3%
2	1	33.3%

Source: Find point clusters: cluster hulls (3 features).

Figure 45. Find point clusters: cluster hulls [92]. Source: Find point clusters: cluster hulls (3 features). The data is in the appendix.

Count per month by reported_at and type

Per month: 36 months from 2023-10-01 to 2026-09-01; trend +0.466 per month; first half 406, second half 544 (+34.0%)

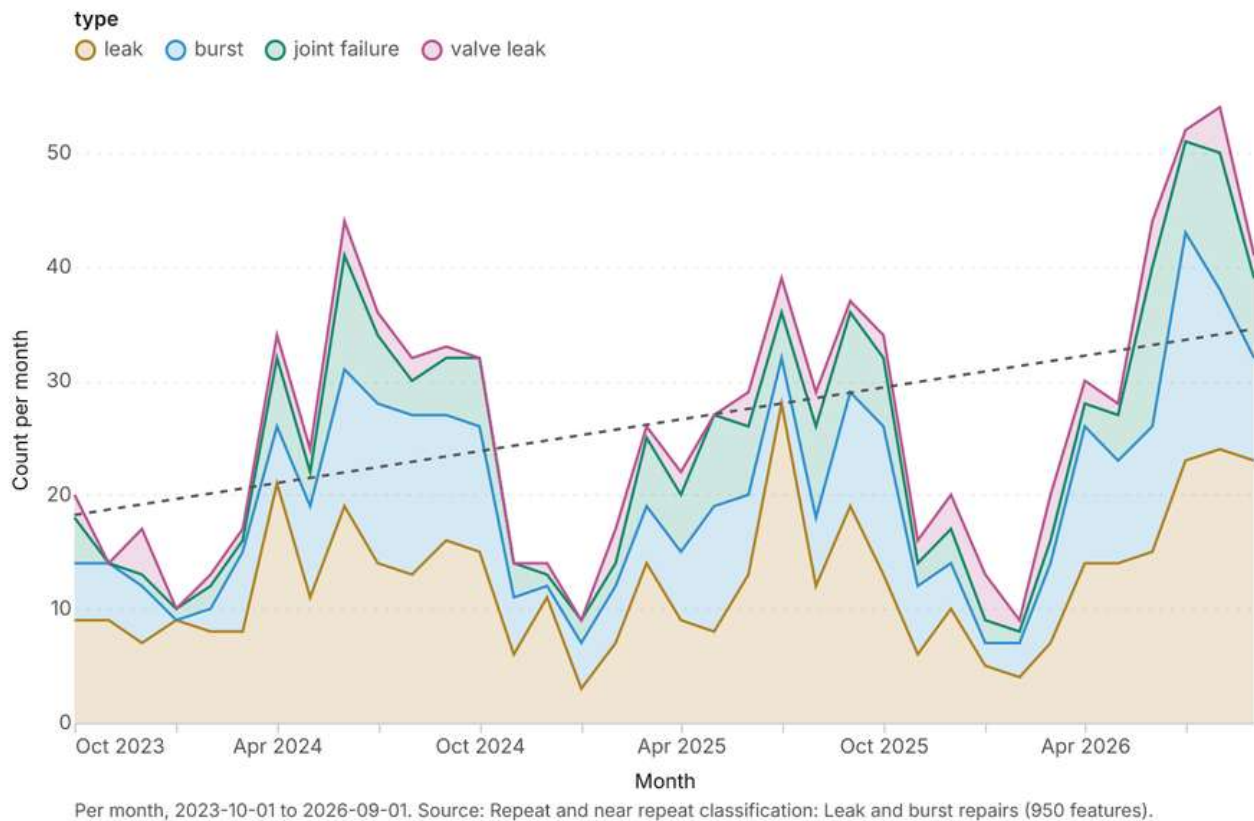


Figure 46. Repeat and near repeat classification: Leak and burst repairs over time [93]. Per month, 2023-10-01 to 2026-09-01. Source: Repeat and near repeat classification: Leak and burst repairs (950 features). The data is in the appendix.

Count per week by date and issue

Per week: 53 weeks from 2025-09-29 to 2026-09-28; trend +0.172 per week; first half 164, second half 344 (+109.8%)

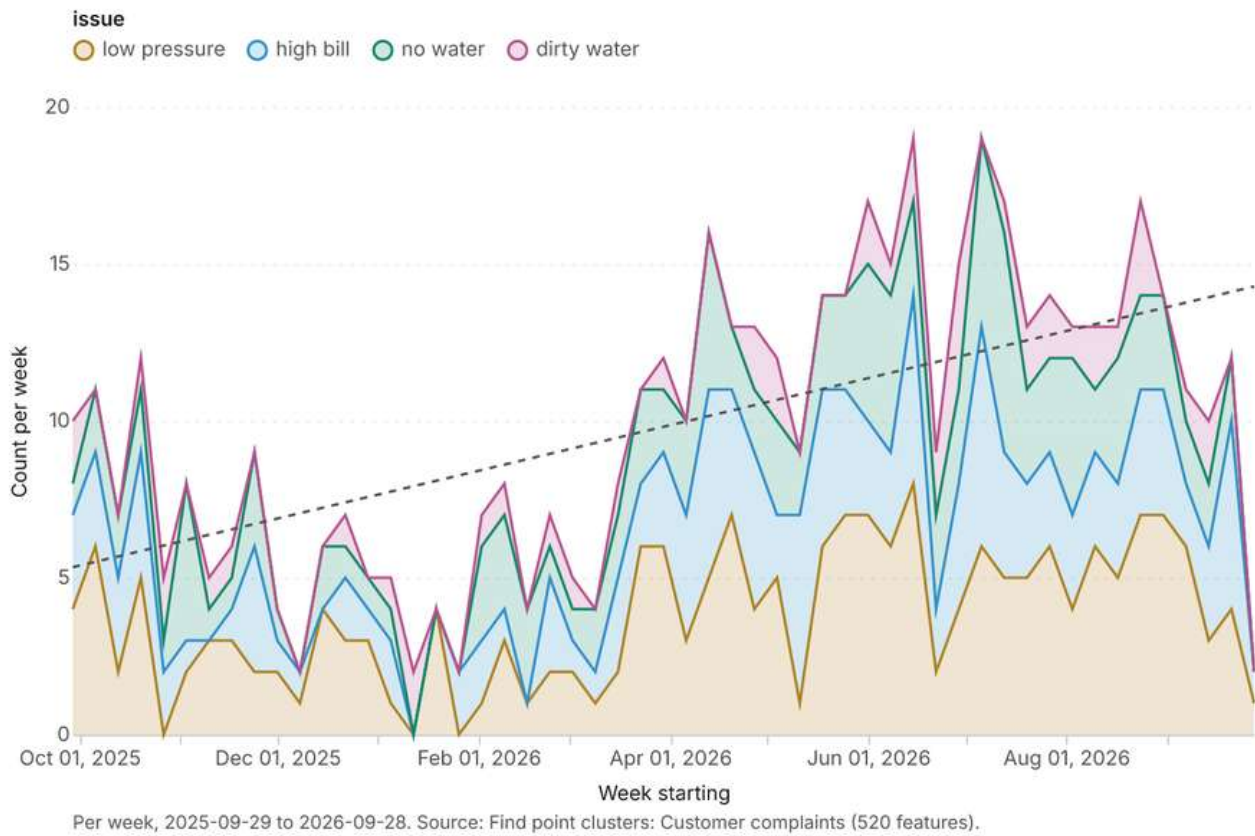


Figure 47. Find point clusters: Customer complaints over time [94]. Per week, 2025-09-29 to 2026-09-28. Source: Find point clusters: Customer complaints (520 features). The data is in the appendix.

Count per month by reported_at and type

Per month: 36 months from 2023-10-01 to 2026-09-01; trend +0.466 per month; first half 406, second half 544 (+34.0%)

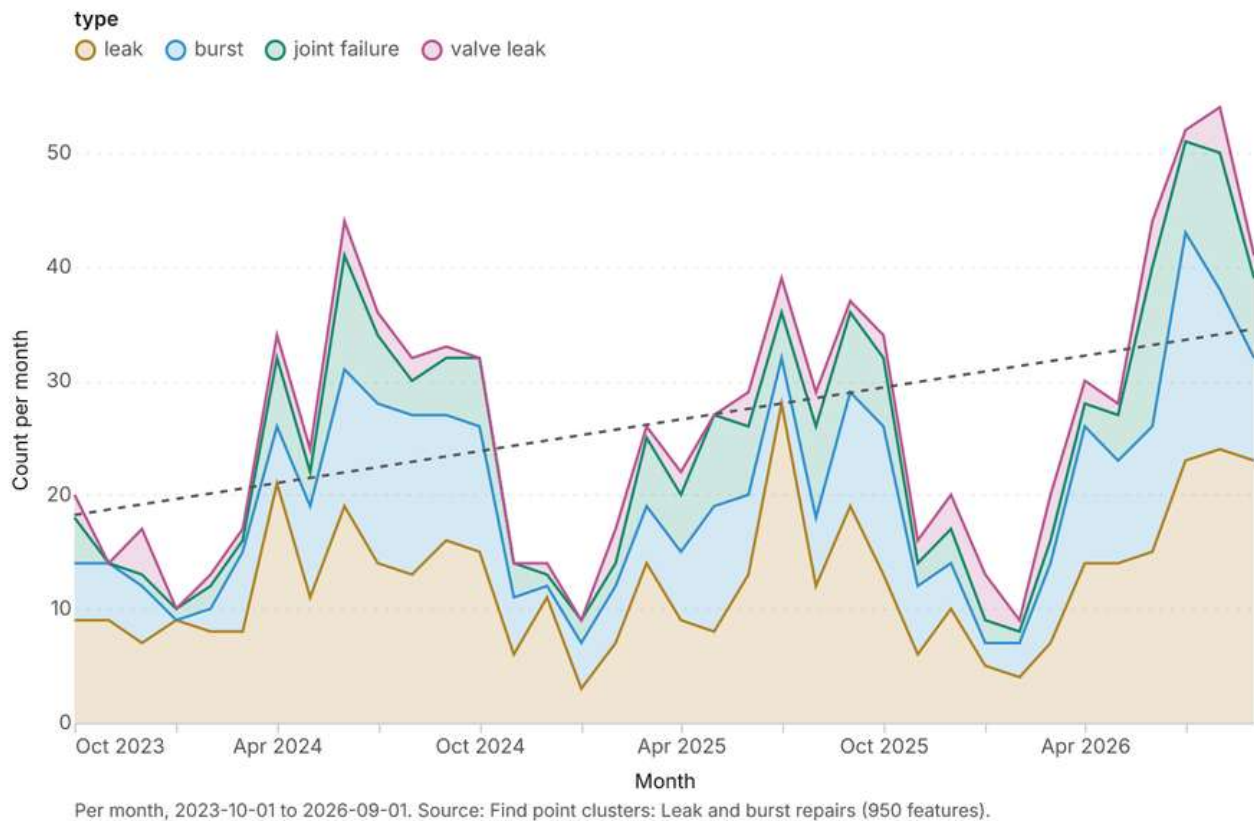


Figure 48. Find point clusters: Leak and burst repairs over time [95]. Per month, 2023-10-01 to 2026-09-01. Source: Find point clusters: Leak and burst repairs (950 features). The data is in the appendix.

Changes since the last run

This is the first report of this project.

Sources

- [1] Rendering: Chart: Timeline: events per month by dataset. 108 rows (id 94a93c16-67b9-41a4-8ed2-808fbfbf2754f)
- [2] Dataset: Leak and burst repairs. vector, 950 rows (id 3f198310-8d97-42f8-b03b-813a838bc233)
- [3] Dataset: Customer complaints. vector, 520 rows (id 57e4c410-eab9-4da0-8287-b2acf2ce16ca)
- [4] Dataset: Zone meter readings by month. table, 192 rows (id 56bef21a-7861-4acc-b024-b65a14052a40)
- [5] Catalog: Emerging hot spots (operation catalog, gp_space_time_hot_spots). Where hot spots are new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating or historical over time. ArcGIS: Emerging Hot Spot Analysis, Create Space Time Cube. (id gp_space_time_hot_spots)
- [6] Plan: Space time hot spots of Leak and burst repairs (the Start plan's candidate c_6d3c49125c9a). Leak and burst repairs carry dates in 'reported_at': emerging hot spot analysis finds new, intensifying and fading hot spots per month. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_6d3c49125c9a)
- [7] Tool result: gp_space_time_hot_spots, step 0. Emerging hot spots: 1 layer saved: Emerging hot spots: Leak and burst repairs (71 features). (id 8c251b5b-c068-49c2-83e1-3ea333425a96:0)
- [8] Layer: Leak and burst repairs. 950 features (id 7e6cb18c-a956-4aa0-b060-b927e53b2106)
- [9] Plan: Space time hot spots of Customer complaints (the Start plan's candidate c_8348225de6d1). Customer complaints carry dates in 'date': emerging hot spot analysis finds new, intensifying and fading hot spots per week. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_8348225de6d1)
- [10] Tool result: gp_space_time_hot_spots, step 1. Emerging hot spots: 1 layer saved: Emerging hot spots: Customer complaints (75 features). (id 8c251b5b-c068-49c2-83e1-3ea333425a96:1)
- [11] Layer: Customer complaints. 520 features (id 56e8a858-22c0-49f4-ad9c-220e4d9d9989)

[12] Catalog: Hot spot analysis (operation catalog, gp_hot_spots). Getis-Ord Gi* hot and cold spots with z-scores, p-values and confidence bins. ArcGIS: Find Hot Spots, Hot Spot Analysis (Getis-Ord Gi*). QGIS: qgis:hotspot (plugin). (id gp_hot_spots)

[13] Plan: Hot spots of Valves (the Start plan's candidate c_73fb2acb1b6a). 300 points: Getis-Ord Gi* tests whether the concentrations in Valves are statistically significant. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_73fb2acb1b6a)

[14] Tool result: gp_hot_spots, step 0. Hot spot analysis: 1 layer saved: Hot spot analysis: Valves (53 features). (id 5758135c-54d5-4daf-a6ef-b217938623cb:0)

[15] Layer: Valves. 300 features (id c6aeca7-984d-4e15-9197-a69b622b052f)

[16] Plan: Hot spots of Leak and burst repairs (the Start plan's candidate c_580c09db1123). 950 points: Getis-Ord Gi* tests whether the concentrations in Leak and burst repairs are statistically significant. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_580c09db1123)

[17] Tool result: gp_hot_spots, step 1. Hot spot analysis: 1 layer saved: Hot spot analysis: Leak and burst repairs (184 features). (id 5758135c-54d5-4daf-a6ef-b217938623cb:1)

[18] Plan: Hot spots of Customer complaints (the Start plan's candidate c_00d8b144d9af). 520 points: Getis-Ord Gi* tests whether the concentrations in Customer complaints are statistically significant. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_00d8b144d9af)

[19] Tool result: gp_hot_spots, step 2. Hot spot analysis: 1 layer saved: Hot spot analysis: Customer complaints (185 features). (id 5758135c-54d5-4daf-a6ef-b217938623cb:2)

[20] Catalog: Calculate density (operation catalog, gp_calculate_density). Kernel density per square kilometer on a grid. ArcGIS: Calculate Density, Kernel Density. QGIS: native:heatmapkerneldensityestimation. (id gp_calculate_density)

[21] Plan: Kernel density of Valves (the Start plan's candidate c_d636e5cd662d). 300 points in Valves: a density surface shows where they concentrate. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_d636e5cd662d)

[22] Tool result: gp_calculate_density, step 0. Calculate density: 1 layer saved: Calculate density: Valves (257 features). (id 15ea63ce-83f8-46f4-930b-a1531b369666:0)

[23] Plan: Kernel density of Leak and burst repairs (the Start plan's candidate c_ab36517e4e0c). 950 points in Leak and burst repairs: a density surface shows where they concentrate. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_ab36517e4e0c)

[24] Tool result: gp_calculate_density, step 1. Calculate density: 1 layer saved: Calculate density: Leak and burst repairs (1220 features). (id 15ea63ce-83f8-46f4-930b-a1531b369666:1)

[25] Plan: Kernel density of Customer complaints (the Start plan's candidate c_be075c3460ae). 520 points in Customer complaints: a density surface shows where they concentrate. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_be075c3460ae)

[26] Tool result: gp_calculate_density, step 2. Calculate density: 1 layer saved: Calculate density: Customer complaints (1200 features). (id 15ea63ce-83f8-46f4-930b-a1531b369666:2)

[27] Catalog: Summarize within (operation catalog, gp_summarize_within). Count and aggregate the features inside each polygon (or bin), proportionally for lines and polygons. ArcGIS: Summarize Within, Aggregate Points. QGIS: native:countpointsinpolygon, native:sumlinelengths. (id gp_summarize_within)

[28] Plan: Valves per feature of Pressure zones (the Start plan's candidate c_5c2b4f19804e). Count Valves inside each feature of Pressure zones by type; the counts map as a choropleth (natural breaks, sequential colors). (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_5c2b4f19804e)

[29] Tool result: gp_summarize_within, step 0. Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features). (id 7fbce9f6-226d-43c9-b187-49e18e2f3a63:0)

[30] Layer: Pressure zones. 8 features (id a4c55d18-97e0-4d48-82c0-0a14b5ad5659)

[31] Tool result: gp_summarize_within, step 1. Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features). (id 7fbce9f6-226d-43c9-b187-49e18e2f3a63:1)

[32] Tool result: gp_summarize_within, step 2. Summarize within: 1 layer saved: Summarize within: Pressure zones (8 features). (id 7fbce9f6-226d-43c9-b187-49e18e2f3a63:2)

[33] Catalog: Find point clusters (operation catalog, gp_find_point_clusters). Density-based clusters (DBSCAN, HDBSCAN or OPTICS, optionally space-time) with hulls and noise. ArcGIS: Find Point Clusters, Density-based Clustering. QGIS: native:dbscanclustering, native:stdbscanclustering. (id gp_find_point_clusters)

[34] Plan: Cluster points of Valves (the Start plan's candidate c_5a8770e11140). DBSCAN finds dense groups of Valves and separates noise. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_5a8770e11140)

[35] Tool result: gp_find_point_clusters, step 0. Find point clusters: 2 layers saved: Find point clusters: Valves (300 features); Find point clusters: cluster hulls (11 features). (id d14409c4-ceb7-40bf-8118-b4f183221686:0)

[36] Plan: Cluster points of Leak and burst repairs (the Start plan's candidate c_fcbb370f7b11). DBSCAN finds dense groups of Leak and burst repairs and separates noise. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_fcbb370f7b11)

[37] Tool result: gp_find_point_clusters, step 1. Find point clusters: 2 layers saved: Find point clusters: Leak and burst repairs (950 features); Find point clusters: cluster hulls (3 features). (id d14409c4-ceb7-40bf-8118-b4f183221686:1)

[38] Plan: Cluster points of Customer complaints (the Start plan's candidate c_ffd68e523286). DBSCAN finds dense groups of Customer complaints and separates noise. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_ffd68e523286)

[39] Tool result: gp_find_point_clusters, step 2. Find point clusters: 2 layers saved: Find point clusters: Customer complaints (520 features); Find point clusters: cluster hulls (3 features). (id d14409c4-ceb7-40bf-8118-b4f183221686:2)

[40] Catalog: Find outliers (operation catalog, gp_outliers). Anselin local Moran's I: HH, LL clusters and HL, LH outliers. ArcGIS: Find Outliers, Cluster and Outlier Analysis (Anselin Local Moran's I). (id gp_outliers)

[41] Plan: Local morans i of Pressure zones (the Start plan's candidate c_d6bf59d0b92b). Local Moran's I maps clusters and outliers of 'connections'. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_d6bf59d0b92b)

[42] Tool result: gp_outliers, step 0. Find outliers: 1 layer saved: Find outliers: Pressure zones (8 features). (id d51ffd20-8b3f-40ae-b231-4aaceda6ee41:0)

[43] Catalog: Spatial autocorrelation (operation catalog, gp_spatial_autocorrelation). Global Moran's I: is the pattern clustered, dispersed or random. ArcGIS: Spatial Autocorrelation (Global Moran's I). (id gp_spatial_autocorrelation)

[44] Plan: Global morans i of Pressure zones (the Start plan's candidate c_6ddd928b3a6c). Global Moran's I says whether similar values of 'connections' sit next to each other. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_6ddd928b3a6c)

[45] Tool result: gp_spatial_autocorrelation, step 1. Spatial autocorrelation: done; no map output. (id d51ffd20-8b3f-40ae-b231-4aaceda6ee41:1)

[46] Catalog: Repeat and near repeat classification (operation catalog, gp_near_repeat). Classify incidents as originators, repeats (same place) or near repeats within a distance and time window, with a Knox test table. ArcGIS: Repeat and Near Repeat Classification, Near Repeat Calculator. (id gp_near_repeat)

[47] Plan: Near repeat of Leak and burst repairs (the Start plan's candidate c_31a838496880). Near repeat analysis tests whether Leak and burst repairs close in space also follow each other within 30 days. (id 4f377cd3-7339-41df-845b-392c7e4b6b94:c_31a838496880)

[48] Tool result: gp_near_repeat, step 0. Repeat and near repeat classification: 1 layer saved: Repeat and near repeat classification: Leak and burst repairs (950 features). (id 49d484f0-691d-49a8-9795-a8bae9950aef:0)

[49] Rendering: Map: Emerging hot spots: Leak and burst repairs (id 3f3bb028-17f1-44d1-9de6-44fc0a9fc721)

[50] Rendering: Map: Emerging hot spots: Customer complaints (id 9509ddaa-4c98-4096-9c90-32c7d0128ded)

[51] Rendering: Map: Hot spot analysis: Valves (id d9873c2c-3566-4d27-8fb1-3136201c8204)

[52] Rendering: Map: Hot spot analysis: Leak and burst repairs (id cdaff975-dab2-424f-adfa-2274328ed591)

[53] Rendering: Map: Hot spot analysis: Customer complaints (id a6899e22-c5e5-420f-b266-3bc1126baba6)

[54] Rendering: Map: Calculate density: Valves (id ceb559c1-f678-4874-aea2-b7d563cf1fef)

[55] Rendering: Map: Calculate density: Leak and burst repairs (id 8c99a9da-4d30-49f5-a977-12f556499841)

[56] Rendering: Map: Calculate density: Customer complaints (id b9ce5771-f68b-494b-ae0f-5e0d4969f781)

[57] Rendering: Map: Summarize within: Pressure zones (id fd78fee3-ac8d-4b2b-b5ed-f7f57f068c3f)

[58] Rendering: Map: Summarize within: Pressure zones (id e6e4e8f2-04db-41fd-9da6-5906d1ba4b30)

[59] Rendering: Map: Summarize within: Pressure zones (id a4dbb3eb-6f59-462f-b3a9-d07bb0313663)

[60] Rendering: Map: Find point clusters: Valves (id db8344db-3a76-4085-aeb4-dd38135e8607)

[61] Rendering: Map: Find point clusters: cluster hulls (id 49a3caba-0eac-49c0-a96c-a416fb8cffcc)

[62] Rendering: Map: Find point clusters: Leak and burst repairs (id 2ad72120-f06f-49cc-bcfe-1d1f0f3704d0)

[63] Rendering: Map: Find point clusters: cluster hulls (id 1a6807c6-9e63-44e0-b47a-9cfd06d92860)

[64] Rendering: Map: Find point clusters: Customer complaints (id 6cdef5e4-9d12-42ff-9772-03d4ae9d2a31)

[65] Rendering: Map: Find point clusters: cluster hulls (id 0a4f53e6-e3e8-4a99-86a4-49c237e7d264)

[66] Rendering: Map: Pressure zones by connections (id a91f1b3f-c237-43d7-ba64-33ecbd256f0a)

[67] Rendering: Map: Find outliers: Pressure zones (id 44cdd90e-0c9c-4cf3-93b9-7b1f48c5e306)

[68] Rendering: Map: Repeat and near repeat classification: Leak and burst repairs (id 5f3c5bb5-4c59-4d70-a046-4429e3906db9)

[69] Rendering: Chart: Water mains over time (install_year). 13 rows (id 02627da8-8e62-4e80-9719-72a7e2f55e57)

[70] Rendering: Chart: Leak and burst repairs over time (reported_at). 144 rows (id c494397c-b48a-49fb-afa7-7a5504c99947)

[71] Rendering: Chart: Valves over time (exercised_year). 10 rows (id dcd28c89-a9a3-4182-881a-28e358a8b5a7)

[72] Rendering: Chart: Fire hydrants over time (last_test_year). 9 rows (id 9501bf0d-1118-4646-9011-1d6607707f6d)

[73] Rendering: Chart: Customer complaints over time (date). 212 rows (id 7b3d1156-e7a8-493d-9083-daeb182a4c85)

[74] Rendering: Chart: Zone meter readings by month over time (month). 24 rows (id 2ab22dd9-e4bb-48ba-8c04-bc7babef5d0b)

[75] Rendering: Chart: Pipe replacement plan over time (planned_year). 9 rows (id 177c5fda-dc15-4abc-a44e-4ee15d594e8b)

[76] Rendering: Chart: Emerging hot spots: Leak and burst repairs. 8 rows (id 595a0dc9-9c95-4ae1-b0ca-4e5d14d12396)

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- [77] Rendering: Chart: Emerging hot spots: Customer complaints. 8 rows (id 49549103-57d2-486d-8bd4-4431013cb1b3)
- [78] Rendering: Chart: Hot spot analysis: Valves. 10 rows (id 5e1fa7b3-4f72-4f37-b847-44ccfd91b8d8)
- [79] Rendering: Chart: Hot spot analysis: Leak and burst repairs. 13 rows (id 4cefd833-0e50-4578-9d0a-70931ac2bf5a)
- [80] Rendering: Chart: Hot spot analysis: Customer complaints. 11 rows (id 86d35ebf-41a8-48e6-b171-41a261df419b)
- [81] Rendering: Chart: Calculate density: Valves. 10 rows (id 27f5c03d-412f-4e4d-822d-a1df30a1c49a)
- [82] Rendering: Chart: Calculate density: Leak and burst repairs. 12 rows (id 4666369b-bfa5-4f04-901c-ec29c5b49d6c)
- [83] Rendering: Chart: Calculate density: Customer complaints. 12 rows (id aa86d4c3-c625-4f70-a661-51f8126e6af8)
- [84] Rendering: Chart: Summarize within: Pressure zones. 5 rows (id 0d45df48-f878-4529-8914-7b9c943ea003)
- [85] Rendering: Chart: Summarize within: Pressure zones. 5 rows (id 502ad046-ea5a-4ca6-9f48-484b32739196)
- [86] Rendering: Chart: Summarize within: Pressure zones. 5 rows (id 949001f2-9fc6-4ae2-909c-4b238ba0916e)
- [87] Rendering: Chart: Find point clusters: Valves. 12 rows (id 868093f7-066c-469b-baa7-f20941a2f40e)
- [88] Rendering: Chart: Find point clusters: cluster hulls. 11 rows (id 84119cbe-b098-4105-bce7-8ddc860ad22d)
- [89] Rendering: Chart: Find point clusters: Leak and burst repairs. 4 rows (id 1b45df1b-a05d-4531-ae0d-49c2224a2551)
- [90] Rendering: Chart: Find point clusters: cluster hulls. 3 rows (id 5a127efb-1998-463d-8956-bee898322fc9)
- [91] Rendering: Chart: Find point clusters: Customer complaints. 4 rows (id ae5b32b2-383a-4be8-bf14-6c6f8449b0b1)
- [92] Rendering: Chart: Find point clusters: cluster hulls. 3 rows (id 2b12b071-0f4d-46c7-abc8-69c6b190d0d6)
- [93] Rendering: Chart: Repeat and near repeat classification: Leak and burst repairs over time. 144 rows (id 3fc856ce-5d0d-407f-ad64-e3c0cc964288)
- [94] Rendering: Chart: Find point clusters: Customer complaints over time. 212 rows (id 1e06545d-de8b-4037-b0da-2de0f7f334fe)
- [95] Rendering: Chart: Find point clusters: Leak and burst repairs over time. 144 rows (id b893e1bc-7a5d-4622-8b2d-a1fc99d79142)
- [96] Dataset: Pressure zones. vector, 8 rows (id 8e552b2b-0ef5-4c0c-821c-708e0de62375)
- [97] Dataset: Water mains. vector, 2130 rows (id b6d4651b-de72-426b-b18e-081f92a20090)
- [98] Dataset: Reservoirs. vector, 4 rows (id a4ba7898-6adb-4a62-b4b3-2baa51710fd7)
- [99] Dataset: Valves. vector, 300 rows (id 2f9d6af4-8dbc-4919-9c2e-358009680d94)
- [100] Dataset: Fire hydrants. vector, 250 rows (id 5c702260-a660-41d8-8aac-adc95c8d4329)
- [101] Dataset: Pipe replacement plan. table, 220 rows (id c062d67a-c643-4dbc-bddd-b13a8c563a9e)
- [102] Dataset: Non-revenue water briefing. document, ? rows (id 0a3aab36-0977-4c51-a725-7886eccfb7f7)
- [103] Record: Sample: Water utility, Cape Town (id 0f6d1895-598a-4c17-a195-fc538533c4a3)
- [104] Layer: Emerging hot spots: Leak and burst repairs. 71 features (id fcb15038-1ce5-4dfe-bef3-37f0d0710660)
- [105] Layer: Emerging hot spots: Customer complaints. 75 features (id 6cd4cdee-eaed-4536-97a3-8cfccea991a)
- [106] Layer: Hot spot analysis: Valves. 53 features (id e6e46379-bab5-4be3-b731-f573fbaeaa2b)
- [107] Layer: Hot spot analysis: Leak and burst repairs. 184 features (id 1b8c7972-3a5f-43cb-9c04-79be94f68fa2)
- [108] Layer: Hot spot analysis: Customer complaints. 185 features (id cc6c04aa-9769-4c55-bffd-23f14fc19e22)
- [109] Layer: Calculate density: Valves. 257 features (id 7c69e54b-2611-4108-a8f1-7edbf9681ff2)
- [110] Layer: Calculate density: Leak and burst repairs. 1,220 features (id 10a45b3b-e980-47be-9cf9-6b191e7fa957)
- [111] Layer: Calculate density: Customer complaints. 1,200 features (id 36b7f8be-2e78-4f25-add1-4c5b63fade60)
- [112] Layer: Summarize within: Pressure zones. 8 features (id e1b22dd3-e0d4-4c9f-a4dd-6460b011a8f0)
- [113] Layer: Summarize within: Pressure zones. 8 features (id 2c26882f-372c-4dd1-9856-1556ecf83503)
- [114] Layer: Summarize within: Pressure zones. 8 features (id 8d6f5fe5-afba-45d0-8676-09532976c3ba)
- [115] Layer: Find point clusters: Valves. 300 features (id 4058852d-d252-42dd-b715-c4555264de96)
- [116] Layer: Find point clusters: cluster hulls. 11 features (id 01ccf49b-1072-42db-8660-3b6bfa50a885)
- [117] Layer: Find point clusters: Leak and burst repairs. 950 features (id 2ace68cb-dd6a-44c4-9784-ec90079bfd14)
- [118] Layer: Find point clusters: cluster hulls. 3 features (id cee4dd63-1a39-434b-86a5-dbf42ae6477)
- [119] Layer: Find point clusters: Customer complaints. 520 features (id 7c106e45-1ddc-48c3-bc26-ae9c11c94028)
- [120] Layer: Find point clusters: cluster hulls. 3 features (id 5dfd2c79-c5e3-4675-8539-b2fa77d08d7a)

[121] Layer: Find outliers: Pressure zones. 8 features (id e61c7a42-8b9f-473a-8310-bc15178693a5)

[122] Layer: Repeat and near repeat classification: Leak and burst repairs. 950 features (id 9bbadc15-5868-46e4-9005-946ec8a2298c)

Appendix: the data behind the charts

Figure 1. Timeline: events per month by dataset [1]

period	series	value
2023-10-01	Leak and burst repairs	20
2023-10-01	Customer complaints	0
2023-10-01	Zone meter readings by month	0
2023-11-01	Leak and burst repairs	14
2023-11-01	Customer complaints	0
2023-11-01	Zone meter readings by month	0
2023-12-01	Leak and burst repairs	17
2023-12-01	Customer complaints	0
2023-12-01	Zone meter readings by month	0
2024-01-01	Leak and burst repairs	10
2024-01-01	Customer complaints	0
2024-01-01	Zone meter readings by month	0
2024-02-01	Leak and burst repairs	13
2024-02-01	Customer complaints	0
2024-02-01	Zone meter readings by month	0
2024-03-01	Leak and burst repairs	17
2024-03-01	Customer complaints	0
2024-03-01	Zone meter readings by month	0
2024-04-01	Leak and burst repairs	34
2024-04-01	Customer complaints	0
2024-04-01	Zone meter readings by month	0
2024-05-01	Leak and burst repairs	24
2024-05-01	Customer complaints	0
2024-05-01	Zone meter readings by month	0
2024-06-01	Leak and burst repairs	44
2024-06-01	Customer complaints	0
2024-06-01	Zone meter readings by month	0
2024-07-01	Leak and burst repairs	36
2024-07-01	Customer complaints	0
2024-07-01	Zone meter readings by month	0
2024-08-01	Leak and burst repairs	32
2024-08-01	Customer complaints	0
2024-08-01	Zone meter readings by month	0
2024-09-01	Leak and burst repairs	33
2024-09-01	Customer complaints	0
2024-09-01	Zone meter readings by month	0
2024-10-01	Leak and burst repairs	32
2024-10-01	Customer complaints	0
2024-10-01	Zone meter readings by month	8

period	series	value
2024-11-01	Leak and burst repairs	14
2024-11-01	Customer complaints	0
2024-11-01	Zone meter readings by month	8
2024-12-01	Leak and burst repairs	14
2024-12-01	Customer complaints	0
2024-12-01	Zone meter readings by month	8
2025-01-01	Leak and burst repairs	9
2025-01-01	Customer complaints	0
2025-01-01	Zone meter readings by month	8
2025-02-01	Leak and burst repairs	17
2025-02-01	Customer complaints	0
2025-02-01	Zone meter readings by month	8
2025-03-01	Leak and burst repairs	26
2025-03-01	Customer complaints	0
2025-03-01	Zone meter readings by month	8
2025-04-01	Leak and burst repairs	22
2025-04-01	Customer complaints	0
2025-04-01	Zone meter readings by month	8
2025-05-01	Leak and burst repairs	27
2025-05-01	Customer complaints	0
2025-05-01	Zone meter readings by month	8
2025-06-01	Leak and burst repairs	29
2025-06-01	Customer complaints	0
2025-06-01	Zone meter readings by month	8
2025-07-01	Leak and burst repairs	39
2025-07-01	Customer complaints	0
2025-07-01	Zone meter readings by month	8
2025-08-01	Leak and burst repairs	29
2025-08-01	Customer complaints	0
2025-08-01	Zone meter readings by month	8
2025-09-01	Leak and burst repairs	37
2025-09-01	Customer complaints	0
2025-09-01	Zone meter readings by month	8
2025-10-01	Leak and burst repairs	34
2025-10-01	Customer complaints	43
2025-10-01	Zone meter readings by month	8
2025-11-01	Leak and burst repairs	16
2025-11-01	Customer complaints	30
2025-11-01	Zone meter readings by month	8
2025-12-01	Leak and burst repairs	20
2025-12-01	Customer complaints	21
2025-12-01	Zone meter readings by month	8
2026-01-01	Leak and burst repairs	13

period	series	value
2026-01-01	Customer complaints	16
2026-01-01	Zone meter readings by month	8
2026-02-01	Leak and burst repairs	9
2026-02-01	Customer complaints	25
2026-02-01	Zone meter readings by month	8
2026-03-01	Leak and burst repairs	20
2026-03-01	Customer complaints	34
2026-03-01	Zone meter readings by month	8
2026-04-01	Leak and burst repairs	30
2026-04-01	Customer complaints	48
2026-04-01	Zone meter readings by month	8
2026-05-01	Leak and burst repairs	28
2026-05-01	Customer complaints	60
2026-05-01	Zone meter readings by month	8
2026-06-01	Leak and burst repairs	44
2026-06-01	Customer complaints	64
2026-06-01	Zone meter readings by month	8
2026-07-01	Leak and burst repairs	52
2026-07-01	Customer complaints	70
2026-07-01	Zone meter readings by month	8
2026-08-01	Leak and burst repairs	54
2026-08-01	Customer complaints	64
2026-08-01	Zone meter readings by month	8
2026-09-01	Leak and burst repairs	41
2026-09-01	Customer complaints	45
2026-09-01	Zone meter readings by month	8

Figure 22. Water mains over time (install_year) [69]

bin_start	bin_end	count
75	84.62	417
84.62	94.23	0
94.23	103.8	396
103.8	113.5	393
113.5	123.1	0
123.1	132.7	0
132.7	142.3	0
142.3	151.9	0
151.9	161.5	377
161.5	171.2	0
171.2	180.8	0
180.8	190.4	0
190.4	200	547

Figure 23. Leak and burst repairs over time (reported_at) [70]

period	series	value
2023-10-01	leak	9
2023-10-01	burst	5
2023-10-01	joint failure	4
2023-10-01	valve leak	2
2023-11-01	leak	9
2023-11-01	burst	5
2023-11-01	joint failure	0
2023-11-01	valve leak	0
2023-12-01	leak	7
2023-12-01	burst	5
2023-12-01	joint failure	1
2023-12-01	valve leak	4
2024-01-01	leak	9
2024-01-01	burst	0
2024-01-01	joint failure	1
2024-01-01	valve leak	0
2024-02-01	leak	8
2024-02-01	burst	2
2024-02-01	joint failure	2
2024-02-01	valve leak	1
2024-03-01	leak	8
2024-03-01	burst	7
2024-03-01	joint failure	1
2024-03-01	valve leak	1
2024-04-01	leak	21
2024-04-01	burst	5
2024-04-01	joint failure	6
2024-04-01	valve leak	2
2024-05-01	leak	11
2024-05-01	burst	8
2024-05-01	joint failure	3
2024-05-01	valve leak	2
2024-06-01	leak	19
2024-06-01	burst	12
2024-06-01	joint failure	10
2024-06-01	valve leak	3
2024-07-01	leak	14
2024-07-01	burst	14
2024-07-01	joint failure	6
2024-07-01	valve leak	2
2024-08-01	leak	13
2024-08-01	burst	14
2024-08-01	joint failure	3

period	series	value
2024-08-01	valve leak	2
2024-09-01	leak	16
2024-09-01	burst	11
2024-09-01	joint failure	5
2024-09-01	valve leak	1
2024-10-01	leak	15
2024-10-01	burst	11
2024-10-01	joint failure	6
2024-10-01	valve leak	0
2024-11-01	leak	6
2024-11-01	burst	5
2024-11-01	joint failure	3
2024-11-01	valve leak	0
2024-12-01	leak	11
2024-12-01	burst	1
2024-12-01	joint failure	1
2024-12-01	valve leak	1
2025-01-01	leak	3
2025-01-01	burst	4
2025-01-01	joint failure	2
2025-01-01	valve leak	0
2025-02-01	leak	7
2025-02-01	burst	5
2025-02-01	joint failure	2
2025-02-01	valve leak	3
2025-03-01	leak	14
2025-03-01	burst	5
2025-03-01	joint failure	6
2025-03-01	valve leak	1
2025-04-01	leak	9
2025-04-01	burst	6
2025-04-01	joint failure	5
2025-04-01	valve leak	2
2025-05-01	leak	8
2025-05-01	burst	11
2025-05-01	joint failure	8
2025-05-01	valve leak	0
2025-06-01	leak	13
2025-06-01	burst	7
2025-06-01	joint failure	6
2025-06-01	valve leak	3
2025-07-01	leak	28
2025-07-01	burst	4

period	series	value
2025-07-01	joint failure	4
2025-07-01	valve leak	3
2025-08-01	leak	12
2025-08-01	burst	6
2025-08-01	joint failure	8
2025-08-01	valve leak	3
2025-09-01	leak	19
2025-09-01	burst	10
2025-09-01	joint failure	7
2025-09-01	valve leak	1
2025-10-01	leak	13
2025-10-01	burst	13
2025-10-01	joint failure	6
2025-10-01	valve leak	2
2025-11-01	leak	6
2025-11-01	burst	6
2025-11-01	joint failure	2
2025-11-01	valve leak	2
2025-12-01	leak	10
2025-12-01	burst	4
2025-12-01	joint failure	3
2025-12-01	valve leak	3
2026-01-01	leak	5
2026-01-01	burst	2
2026-01-01	joint failure	2
2026-01-01	valve leak	4
2026-02-01	leak	4
2026-02-01	burst	3
2026-02-01	joint failure	1
2026-02-01	valve leak	1
2026-03-01	leak	7
2026-03-01	burst	7
2026-03-01	joint failure	2
2026-03-01	valve leak	4
2026-04-01	leak	14
2026-04-01	burst	12
2026-04-01	joint failure	2
2026-04-01	valve leak	2
2026-05-01	leak	14
2026-05-01	burst	9
2026-05-01	joint failure	4
2026-05-01	valve leak	1
2026-06-01	leak	15

period	series	value
2026-06-01	burst	11
2026-06-01	joint failure	14
2026-06-01	valve leak	4
2026-07-01	leak	23
2026-07-01	burst	20
2026-07-01	joint failure	8
2026-07-01	valve leak	1
2026-08-01	leak	24
2026-08-01	burst	14
2026-08-01	joint failure	12
2026-08-01	valve leak	4
2026-09-01	leak	23
2026-09-01	burst	9
2026-09-01	joint failure	7
2026-09-01	valve leak	2

Figure 24. Valves over time (exercised_year) [71]

bin_start	bin_end	count
2,008	2,010	41
2,010	2,012	22
2,012	2,013	27
2,013	2,015	30
2,015	2,017	13
2,017	2,019	29
2,019	2,021	34
2,021	2,022	35
2,022	2,024	38
2,024	2,026	31

Figure 25. Fire hydrants over time (last_test_year) [72]

bin_start	bin_end	count
8	11.56	35
11.56	15.11	23
15.11	18.67	31
18.67	22.22	32
22.22	25.78	20
25.78	29.33	24
29.33	32.89	20
32.89	36.44	28
36.44	40	37

Figure 26. Customer complaints over time (date) [73]

period	series	value
2025-09-29	low pressure	4
2025-09-29	high bill	3

period	series	value
2025-09-29	no water	1
2025-09-29	dirty water	2
2025-10-06	low pressure	6
2025-10-06	high bill	3
2025-10-06	no water	2
2025-10-06	dirty water	0
2025-10-13	low pressure	2
2025-10-13	high bill	3
2025-10-13	no water	2
2025-10-13	dirty water	0
2025-10-20	low pressure	5
2025-10-20	high bill	4
2025-10-20	no water	2
2025-10-20	dirty water	1
2025-10-27	low pressure	0
2025-10-27	high bill	2
2025-10-27	no water	1
2025-10-27	dirty water	2
2025-11-03	low pressure	2
2025-11-03	high bill	1
2025-11-03	no water	5
2025-11-03	dirty water	0
2025-11-10	low pressure	3
2025-11-10	high bill	0
2025-11-10	no water	1
2025-11-10	dirty water	1
2025-11-17	low pressure	3
2025-11-17	high bill	1
2025-11-17	no water	1
2025-11-17	dirty water	1
2025-11-24	low pressure	2
2025-11-24	high bill	4
2025-11-24	no water	3
2025-11-24	dirty water	0
2025-12-01	low pressure	2
2025-12-01	high bill	1
2025-12-01	no water	1
2025-12-01	dirty water	0
2025-12-08	low pressure	1
2025-12-08	high bill	1
2025-12-08	no water	0
2025-12-08	dirty water	0
2025-12-15	low pressure	4

period	series	value
2025-12-15	high bill	0
2025-12-15	no water	2
2025-12-15	dirty water	0
2025-12-22	low pressure	3
2025-12-22	high bill	2
2025-12-22	no water	1
2025-12-22	dirty water	1
2025-12-29	low pressure	3
2025-12-29	high bill	1
2025-12-29	no water	1
2025-12-29	dirty water	0
2026-01-05	low pressure	1
2026-01-05	high bill	2
2026-01-05	no water	1
2026-01-05	dirty water	1
2026-01-12	low pressure	0
2026-01-12	high bill	0
2026-01-12	no water	0
2026-01-12	dirty water	2
2026-01-19	low pressure	4
2026-01-19	high bill	0
2026-01-19	no water	0
2026-01-19	dirty water	0
2026-01-26	low pressure	0
2026-01-26	high bill	2
2026-01-26	no water	0
2026-01-26	dirty water	0
2026-02-02	low pressure	1
2026-02-02	high bill	2
2026-02-02	no water	3
2026-02-02	dirty water	1
2026-02-09	low pressure	3
2026-02-09	high bill	1
2026-02-09	no water	3
2026-02-09	dirty water	1
2026-02-16	low pressure	1
2026-02-16	high bill	0
2026-02-16	no water	3
2026-02-16	dirty water	0
2026-02-23	low pressure	2
2026-02-23	high bill	3
2026-02-23	no water	1
2026-02-23	dirty water	1

period	series	value
2026-03-02	low pressure	2
2026-03-02	high bill	1
2026-03-02	no water	1
2026-03-02	dirty water	1
2026-03-09	low pressure	1
2026-03-09	high bill	1
2026-03-09	no water	2
2026-03-09	dirty water	0
2026-03-16	low pressure	2
2026-03-16	high bill	3
2026-03-16	no water	2
2026-03-16	dirty water	1
2026-03-23	low pressure	6
2026-03-23	high bill	2
2026-03-23	no water	3
2026-03-23	dirty water	0
2026-03-30	low pressure	6
2026-03-30	high bill	3
2026-03-30	no water	2
2026-03-30	dirty water	1
2026-04-06	low pressure	3
2026-04-06	high bill	4
2026-04-06	no water	3
2026-04-06	dirty water	0
2026-04-13	low pressure	5
2026-04-13	high bill	6
2026-04-13	no water	5
2026-04-13	dirty water	0
2026-04-20	low pressure	7
2026-04-20	high bill	4
2026-04-20	no water	2
2026-04-20	dirty water	0
2026-04-27	low pressure	4
2026-04-27	high bill	5
2026-04-27	no water	2
2026-04-27	dirty water	2
2026-05-04	low pressure	5
2026-05-04	high bill	2
2026-05-04	no water	3
2026-05-04	dirty water	2
2026-05-11	low pressure	1
2026-05-11	high bill	6
2026-05-11	no water	2

period	series	value
2026-05-11	dirty water	0
2026-05-18	low pressure	6
2026-05-18	high bill	5
2026-05-18	no water	3
2026-05-18	dirty water	0
2026-05-25	low pressure	7
2026-05-25	high bill	4
2026-05-25	no water	3
2026-05-25	dirty water	0
2026-06-01	low pressure	7
2026-06-01	high bill	3
2026-06-01	no water	5
2026-06-01	dirty water	2
2026-06-08	low pressure	6
2026-06-08	high bill	3
2026-06-08	no water	5
2026-06-08	dirty water	1
2026-06-15	low pressure	8
2026-06-15	high bill	6
2026-06-15	no water	3
2026-06-15	dirty water	2
2026-06-22	low pressure	2
2026-06-22	high bill	2
2026-06-22	no water	3
2026-06-22	dirty water	2
2026-06-29	low pressure	4
2026-06-29	high bill	4
2026-06-29	no water	3
2026-06-29	dirty water	4
2026-07-06	low pressure	6
2026-07-06	high bill	7
2026-07-06	no water	6
2026-07-06	dirty water	0
2026-07-13	low pressure	5
2026-07-13	high bill	4
2026-07-13	no water	7
2026-07-13	dirty water	1
2026-07-20	low pressure	5
2026-07-20	high bill	3
2026-07-20	no water	3
2026-07-20	dirty water	2
2026-07-27	low pressure	6
2026-07-27	high bill	3

period	series	value
2026-07-27	no water	3
2026-07-27	dirty water	2
2026-08-03	low pressure	4
2026-08-03	high bill	3
2026-08-03	no water	5
2026-08-03	dirty water	1
2026-08-10	low pressure	6
2026-08-10	high bill	3
2026-08-10	no water	2
2026-08-10	dirty water	2
2026-08-17	low pressure	5
2026-08-17	high bill	3
2026-08-17	no water	4
2026-08-17	dirty water	1
2026-08-24	low pressure	7
2026-08-24	high bill	4
2026-08-24	no water	3
2026-08-24	dirty water	3
2026-08-31	low pressure	7
2026-08-31	high bill	4
2026-08-31	no water	3
2026-08-31	dirty water	0
2026-09-07	low pressure	6
2026-09-07	high bill	2
2026-09-07	no water	2
2026-09-07	dirty water	1
2026-09-14	low pressure	3
2026-09-14	high bill	3
2026-09-14	no water	2
2026-09-14	dirty water	2
2026-09-21	low pressure	4
2026-09-21	high bill	6
2026-09-21	no water	2
2026-09-21	dirty water	0
2026-09-28	low pressure	1
2026-09-28	high bill	1
2026-09-28	no water	0
2026-09-28	dirty water	0

Figure 27. Zone meter readings by month over time (month) [74]

period	value
2024-10-01	8
2024-11-01	8
2024-12-01	8

period	value
2025-01-01	8
2025-02-01	8
2025-03-01	8
2025-04-01	8
2025-05-01	8
2025-06-01	8
2025-07-01	8
2025-08-01	8
2025-09-01	8
2025-10-01	8
2025-11-01	8
2025-12-01	8
2026-01-01	8
2026-02-01	8
2026-03-01	8
2026-04-01	8
2026-05-01	8
2026-06-01	8
2026-07-01	8
2026-08-01	8
2026-09-01	8

Figure 28. Pipe replacement plan over time (planned_year) [75]

bin_start	bin_end	count
1	1.333	60
1.333	1.667	0
1.667	2	0
2	2.333	60
2.333	2.667	0
2.667	3	0
3	3.333	60
3.333	3.667	0
3.667	4	40

Figure 29. Emerging hot spots: Leak and burst repairs [76]

bin_start	bin_end	count
-0.961	0.1214	35
0.1214	1.204	9
1.204	2.286	10
2.286	3.369	5
3.369	4.451	2
4.451	5.533	8
5.533	6.616	0
6.616	7.698	2

Figure 30. Emerging hot spots: Customer complaints [77]

bin_start	bin_end	count
-0.737	-0.5961	55
-0.5961	-0.4552	0
-0.4552	-0.3144	0
-0.3144	-0.1735	0
-0.1735	-0.03263	0
-0.03263	0.1082	0
0.1082	0.2491	0
0.2491	0.39	20

Figure 31. Hot spot analysis: Valves [78]

bin_start	bin_end	band	band_label	count
-2	-1.5	not_significant	Not significant	5
-1.5	-1	not_significant	Not significant	2
-1	-0.5	not_significant	Not significant	10
-0.5	0	not_significant	Not significant	8
0	0.5	not_significant	Not significant	12
0.5	1	not_significant	Not significant	7
1	1.5	not_significant	Not significant	4
1.5	2	hot_90	Hot spot, 90% confidence	2
1.5	2	hot_95	Hot spot, 95% confidence	2
2	2.5	hot_95	Hot spot, 95% confidence	1

Figure 32. Hot spot analysis: Leak and burst repairs [79]

bin_start	bin_end	band	band_label	count
-1	-0.5	not_significant	Not significant	45
-0.5	0	not_significant	Not significant	104
0	0.5	not_significant	Not significant	4
0.5	1	not_significant	Not significant	3
1	1.5	not_significant	Not significant	11
1.5	2	hot_90	Hot spot, 90% confidence	1
1.5	2	hot_95	Hot spot, 95% confidence	2
1.5	2	not_significant	Not significant	1
2	2.5	hot_95	Hot spot, 95% confidence	5
2.5	3	hot_95	Hot spot, 95% confidence	1
2.5	3	hot_99	Hot spot, 99% confidence	2
3	3.5	hot_99	Hot spot, 99% confidence	3
4	4.5	hot_99	Hot spot, 99% confidence	2

Figure 33. Hot spot analysis: Customer complaints [80]

bin_start	bin_end	band	band_label	count
-1	-0.5	not_significant	Not significant	74
-0.5	0	not_significant	Not significant	37
0	0.5	not_significant	Not significant	40
0.5	1	not_significant	Not significant	8
1	1.5	not_significant	Not significant	10
1.5	2	hot_90	Hot spot, 90% confidence	4
2	2.5	hot_95	Hot spot, 95% confidence	5
2.5	3	hot_95	Hot spot, 95% confidence	3
2.5	3	hot_99	Hot spot, 99% confidence	2
3.5	4	hot_99	Hot spot, 99% confidence	1
4.5	5	hot_99	Hot spot, 99% confidence	1

Figure 34. Calculate density: Valves [81]

bin_start	bin_end	count
0	1.7	21
1.7	3.4	31
3.4	5.1	32
5.1	6.8	16
6.8	8.5	29
8.5	10.2	30
10.2	11.9	15
11.9	13.6	31
13.6	15.3	28
15.3	17	24

Figure 35. Calculate density: Leak and burst repairs [82]

bin_start	bin_end	count
0	3.25	95
3.25	6.5	99
6.5	9.75	99
9.75	13	95
13	16.25	128
16.25	19.5	95
19.5	22.75	98
22.75	26	95
26	29.25	135
29.25	32.5	94
32.5	35.75	98
35.75	39	89

Figure 36. Calculate density: Customer complaints [83]

bin_start	bin_end	count
0	3.083	111
3.083	6.167	100
6.167	9.25	99
9.25	12.33	99
12.33	15.42	97
15.42	18.5	95
18.5	21.58	95
21.58	24.67	96
24.67	27.75	98
27.75	30.83	100
30.83	33.92	96
33.92	37	114

Figure 37. Summarize within: Pressure zones [84]

bin_start	bin_end	count
21	27	1
27	33	1
33	39	3
39	45	1
45	51	2

Figure 38. Summarize within: Pressure zones [85]

bin_start	bin_end	count
35	146.2	7
146.2	257.4	0
257.4	368.6	0
368.6	479.8	0
479.8	591	1

Figure 39. Summarize within: Pressure zones [86]

bin_start	bin_end	count
27	69.8	7
69.8	112.6	0
112.6	155.4	0
155.4	198.2	0
198.2	241	1

Figure 40. Find point clusters: Valves [87]

cluster	features	fraction	share
Noise	114	0.38	38.0%
1	66	0.22	22.0%
0	30	0.1	10.0%
4	26	0.08667	8.7%
3	11	0.03667	3.7%
2	10	0.03333	3.3%

cluster	features	fraction	share
8	10	0.03333	3.3%
6	9	0.03	3.0%
10	8	0.02667	2.7%
7	8	0.02667	2.7%
5	5	0.01667	1.7%
9	3	0.01	1.0%

Figure 41. Find point clusters: cluster hulls [88]

cluster	features	fraction	share
0	1	0.09091	9.1%
1	1	0.09091	9.1%
10	1	0.09091	9.1%
2	1	0.09091	9.1%
3	1	0.09091	9.1%
4	1	0.09091	9.1%
5	1	0.09091	9.1%
6	1	0.09091	9.1%
7	1	0.09091	9.1%
8	1	0.09091	9.1%
9	1	0.09091	9.1%

Figure 42. Find point clusters: Leak and burst repairs [89]

cluster	features	fraction	share
Noise	830	0.8737	87.4%
1	56	0.05895	5.9%
0	38	0.04	4.0%
2	26	0.02737	2.7%

Figure 43. Find point clusters: cluster hulls [90]

cluster	features	fraction	share
0	1	0.3333	33.3%
1	1	0.3333	33.3%
2	1	0.3333	33.3%

Figure 44. Find point clusters: Customer complaints [91]

cluster	features	fraction	share
0	289	0.5558	55.6%
Noise	196	0.3769	37.7%
1	21	0.04038	4.0%
2	14	0.02692	2.7%

Figure 45. Find point clusters: cluster hulls [92]

cluster	features	fraction	share
0	1	0.3333	33.3%
1	1	0.3333	33.3%
2	1	0.3333	33.3%

Figure 46. Repeat and near repeat classification: Leak and burst repairs over time [93]

period	series	value
2023-10-01	leak	9
2023-10-01	burst	5
2023-10-01	joint failure	4
2023-10-01	valve leak	2
2023-11-01	leak	9
2023-11-01	burst	5
2023-11-01	joint failure	0
2023-11-01	valve leak	0
2023-12-01	leak	7
2023-12-01	burst	5
2023-12-01	joint failure	1
2023-12-01	valve leak	4
2024-01-01	leak	9
2024-01-01	burst	0
2024-01-01	joint failure	1
2024-01-01	valve leak	0
2024-02-01	leak	8
2024-02-01	burst	2
2024-02-01	joint failure	2
2024-02-01	valve leak	1
2024-03-01	leak	8
2024-03-01	burst	7
2024-03-01	joint failure	1
2024-03-01	valve leak	1
2024-04-01	leak	21
2024-04-01	burst	5
2024-04-01	joint failure	6
2024-04-01	valve leak	2
2024-05-01	leak	11
2024-05-01	burst	8
2024-05-01	joint failure	3
2024-05-01	valve leak	2
2024-06-01	leak	19
2024-06-01	burst	12
2024-06-01	joint failure	10
2024-06-01	valve leak	3
2024-07-01	leak	14
2024-07-01	burst	14
2024-07-01	joint failure	6
2024-07-01	valve leak	2
2024-08-01	leak	13
2024-08-01	burst	14
2024-08-01	joint failure	3

period	series	value
2024-08-01	valve leak	2
2024-09-01	leak	16
2024-09-01	burst	11
2024-09-01	joint failure	5
2024-09-01	valve leak	1
2024-10-01	leak	15
2024-10-01	burst	11
2024-10-01	joint failure	6
2024-10-01	valve leak	0
2024-11-01	leak	6
2024-11-01	burst	5
2024-11-01	joint failure	3
2024-11-01	valve leak	0
2024-12-01	leak	11
2024-12-01	burst	1
2024-12-01	joint failure	1
2024-12-01	valve leak	1
2025-01-01	leak	3
2025-01-01	burst	4
2025-01-01	joint failure	2
2025-01-01	valve leak	0
2025-02-01	leak	7
2025-02-01	burst	5
2025-02-01	joint failure	2
2025-02-01	valve leak	3
2025-03-01	leak	14
2025-03-01	burst	5
2025-03-01	joint failure	6
2025-03-01	valve leak	1
2025-04-01	leak	9
2025-04-01	burst	6
2025-04-01	joint failure	5
2025-04-01	valve leak	2
2025-05-01	leak	8
2025-05-01	burst	11
2025-05-01	joint failure	8
2025-05-01	valve leak	0
2025-06-01	leak	13
2025-06-01	burst	7
2025-06-01	joint failure	6
2025-06-01	valve leak	3
2025-07-01	leak	28
2025-07-01	burst	4

period	series	value
2025-07-01	joint failure	4
2025-07-01	valve leak	3
2025-08-01	leak	12
2025-08-01	burst	6
2025-08-01	joint failure	8
2025-08-01	valve leak	3
2025-09-01	leak	19
2025-09-01	burst	10
2025-09-01	joint failure	7
2025-09-01	valve leak	1
2025-10-01	leak	13
2025-10-01	burst	13
2025-10-01	joint failure	6
2025-10-01	valve leak	2
2025-11-01	leak	6
2025-11-01	burst	6
2025-11-01	joint failure	2
2025-11-01	valve leak	2
2025-12-01	leak	10
2025-12-01	burst	4
2025-12-01	joint failure	3
2025-12-01	valve leak	3
2026-01-01	leak	5
2026-01-01	burst	2
2026-01-01	joint failure	2
2026-01-01	valve leak	4
2026-02-01	leak	4
2026-02-01	burst	3
2026-02-01	joint failure	1
2026-02-01	valve leak	1
2026-03-01	leak	7
2026-03-01	burst	7
2026-03-01	joint failure	2
2026-03-01	valve leak	4
2026-04-01	leak	14
2026-04-01	burst	12
2026-04-01	joint failure	2
2026-04-01	valve leak	2
2026-05-01	leak	14
2026-05-01	burst	9
2026-05-01	joint failure	4
2026-05-01	valve leak	1
2026-06-01	leak	15

period	series	value
2026-06-01	burst	11
2026-06-01	joint failure	14
2026-06-01	valve leak	4
2026-07-01	leak	23
2026-07-01	burst	20
2026-07-01	joint failure	8
2026-07-01	valve leak	1
2026-08-01	leak	24
2026-08-01	burst	14
2026-08-01	joint failure	12
2026-08-01	valve leak	4
2026-09-01	leak	23
2026-09-01	burst	9
2026-09-01	joint failure	7
2026-09-01	valve leak	2

Figure 47. Find point clusters: Customer complaints over time [94]

period	series	value
2025-09-29	low pressure	4
2025-09-29	high bill	3
2025-09-29	no water	1
2025-09-29	dirty water	2
2025-10-06	low pressure	6
2025-10-06	high bill	3
2025-10-06	no water	2
2025-10-06	dirty water	0
2025-10-13	low pressure	2
2025-10-13	high bill	3
2025-10-13	no water	2
2025-10-13	dirty water	0
2025-10-20	low pressure	5
2025-10-20	high bill	4
2025-10-20	no water	2
2025-10-20	dirty water	1
2025-10-27	low pressure	0
2025-10-27	high bill	2
2025-10-27	no water	1
2025-10-27	dirty water	2
2025-11-03	low pressure	2
2025-11-03	high bill	1
2025-11-03	no water	5
2025-11-03	dirty water	0
2025-11-10	low pressure	3
2025-11-10	high bill	0

period	series	value
2025-11-10	no water	1
2025-11-10	dirty water	1
2025-11-17	low pressure	3
2025-11-17	high bill	1
2025-11-17	no water	1
2025-11-17	dirty water	1
2025-11-24	low pressure	2
2025-11-24	high bill	4
2025-11-24	no water	3
2025-11-24	dirty water	0
2025-12-01	low pressure	2
2025-12-01	high bill	1
2025-12-01	no water	1
2025-12-01	dirty water	0
2025-12-08	low pressure	1
2025-12-08	high bill	1
2025-12-08	no water	0
2025-12-08	dirty water	0
2025-12-15	low pressure	4
2025-12-15	high bill	0
2025-12-15	no water	2
2025-12-15	dirty water	0
2025-12-22	low pressure	3
2025-12-22	high bill	2
2025-12-22	no water	1
2025-12-22	dirty water	1
2025-12-29	low pressure	3
2025-12-29	high bill	1
2025-12-29	no water	1
2025-12-29	dirty water	0
2026-01-05	low pressure	1
2026-01-05	high bill	2
2026-01-05	no water	1
2026-01-05	dirty water	1
2026-01-12	low pressure	0
2026-01-12	high bill	0
2026-01-12	no water	0
2026-01-12	dirty water	2
2026-01-19	low pressure	4
2026-01-19	high bill	0
2026-01-19	no water	0
2026-01-19	dirty water	0
2026-01-26	low pressure	0

period	series	value
2026-01-26	high bill	2
2026-01-26	no water	0
2026-01-26	dirty water	0
2026-02-02	low pressure	1
2026-02-02	high bill	2
2026-02-02	no water	3
2026-02-02	dirty water	1
2026-02-09	low pressure	3
2026-02-09	high bill	1
2026-02-09	no water	3
2026-02-09	dirty water	1
2026-02-16	low pressure	1
2026-02-16	high bill	0
2026-02-16	no water	3
2026-02-16	dirty water	0
2026-02-23	low pressure	2
2026-02-23	high bill	3
2026-02-23	no water	1
2026-02-23	dirty water	1
2026-03-02	low pressure	2
2026-03-02	high bill	1
2026-03-02	no water	1
2026-03-02	dirty water	1
2026-03-09	low pressure	1
2026-03-09	high bill	1
2026-03-09	no water	2
2026-03-09	dirty water	0
2026-03-16	low pressure	2
2026-03-16	high bill	3
2026-03-16	no water	2
2026-03-16	dirty water	1
2026-03-23	low pressure	6
2026-03-23	high bill	2
2026-03-23	no water	3
2026-03-23	dirty water	0
2026-03-30	low pressure	6
2026-03-30	high bill	3
2026-03-30	no water	2
2026-03-30	dirty water	1
2026-04-06	low pressure	3
2026-04-06	high bill	4
2026-04-06	no water	3
2026-04-06	dirty water	0

period	series	value
2026-04-13	low pressure	5
2026-04-13	high bill	6
2026-04-13	no water	5
2026-04-13	dirty water	0
2026-04-20	low pressure	7
2026-04-20	high bill	4
2026-04-20	no water	2
2026-04-20	dirty water	0
2026-04-27	low pressure	4
2026-04-27	high bill	5
2026-04-27	no water	2
2026-04-27	dirty water	2
2026-05-04	low pressure	5
2026-05-04	high bill	2
2026-05-04	no water	3
2026-05-04	dirty water	2
2026-05-11	low pressure	1
2026-05-11	high bill	6
2026-05-11	no water	2
2026-05-11	dirty water	0
2026-05-18	low pressure	6
2026-05-18	high bill	5
2026-05-18	no water	3
2026-05-18	dirty water	0
2026-05-25	low pressure	7
2026-05-25	high bill	4
2026-05-25	no water	3
2026-05-25	dirty water	0
2026-06-01	low pressure	7
2026-06-01	high bill	3
2026-06-01	no water	5
2026-06-01	dirty water	2
2026-06-08	low pressure	6
2026-06-08	high bill	3
2026-06-08	no water	5
2026-06-08	dirty water	1
2026-06-15	low pressure	8
2026-06-15	high bill	6
2026-06-15	no water	3
2026-06-15	dirty water	2
2026-06-22	low pressure	2
2026-06-22	high bill	2
2026-06-22	no water	3

period	series	value
2026-06-22	dirty water	2
2026-06-29	low pressure	4
2026-06-29	high bill	4
2026-06-29	no water	3
2026-06-29	dirty water	4
2026-07-06	low pressure	6
2026-07-06	high bill	7
2026-07-06	no water	6
2026-07-06	dirty water	0
2026-07-13	low pressure	5
2026-07-13	high bill	4
2026-07-13	no water	7
2026-07-13	dirty water	1
2026-07-20	low pressure	5
2026-07-20	high bill	3
2026-07-20	no water	3
2026-07-20	dirty water	2
2026-07-27	low pressure	6
2026-07-27	high bill	3
2026-07-27	no water	3
2026-07-27	dirty water	2
2026-08-03	low pressure	4
2026-08-03	high bill	3
2026-08-03	no water	5
2026-08-03	dirty water	1
2026-08-10	low pressure	6
2026-08-10	high bill	3
2026-08-10	no water	2
2026-08-10	dirty water	2
2026-08-17	low pressure	5
2026-08-17	high bill	3
2026-08-17	no water	4
2026-08-17	dirty water	1
2026-08-24	low pressure	7
2026-08-24	high bill	4
2026-08-24	no water	3
2026-08-24	dirty water	3
2026-08-31	low pressure	7
2026-08-31	high bill	4
2026-08-31	no water	3
2026-08-31	dirty water	0
2026-09-07	low pressure	6
2026-09-07	high bill	2

period	series	value
2026-09-07	no water	2
2026-09-07	dirty water	1
2026-09-14	low pressure	3
2026-09-14	high bill	3
2026-09-14	no water	2
2026-09-14	dirty water	2
2026-09-21	low pressure	4
2026-09-21	high bill	6
2026-09-21	no water	2
2026-09-21	dirty water	0
2026-09-28	low pressure	1
2026-09-28	high bill	1
2026-09-28	no water	0
2026-09-28	dirty water	0

Figure 48. Find point clusters: Leak and burst repairs over time [95]

period	series	value
2023-10-01	leak	9
2023-10-01	burst	5
2023-10-01	joint failure	4
2023-10-01	valve leak	2
2023-11-01	leak	9
2023-11-01	burst	5
2023-11-01	joint failure	0
2023-11-01	valve leak	0
2023-12-01	leak	7
2023-12-01	burst	5
2023-12-01	joint failure	1
2023-12-01	valve leak	4
2024-01-01	leak	9
2024-01-01	burst	0
2024-01-01	joint failure	1
2024-01-01	valve leak	0
2024-02-01	leak	8
2024-02-01	burst	2
2024-02-01	joint failure	2
2024-02-01	valve leak	1
2024-03-01	leak	8
2024-03-01	burst	7
2024-03-01	joint failure	1
2024-03-01	valve leak	1
2024-04-01	leak	21
2024-04-01	burst	5
2024-04-01	joint failure	6

period	series	value
2024-04-01	valve leak	2
2024-05-01	leak	11
2024-05-01	burst	8
2024-05-01	joint failure	3
2024-05-01	valve leak	2
2024-06-01	leak	19
2024-06-01	burst	12
2024-06-01	joint failure	10
2024-06-01	valve leak	3
2024-07-01	leak	14
2024-07-01	burst	14
2024-07-01	joint failure	6
2024-07-01	valve leak	2
2024-08-01	leak	13
2024-08-01	burst	14
2024-08-01	joint failure	3
2024-08-01	valve leak	2
2024-09-01	leak	16
2024-09-01	burst	11
2024-09-01	joint failure	5
2024-09-01	valve leak	1
2024-10-01	leak	15
2024-10-01	burst	11
2024-10-01	joint failure	6
2024-10-01	valve leak	0
2024-11-01	leak	6
2024-11-01	burst	5
2024-11-01	joint failure	3
2024-11-01	valve leak	0
2024-12-01	leak	11
2024-12-01	burst	1
2024-12-01	joint failure	1
2024-12-01	valve leak	1
2025-01-01	leak	3
2025-01-01	burst	4
2025-01-01	joint failure	2
2025-01-01	valve leak	0
2025-02-01	leak	7
2025-02-01	burst	5
2025-02-01	joint failure	2
2025-02-01	valve leak	3
2025-03-01	leak	14
2025-03-01	burst	5

period	series	value
2025-03-01	joint failure	6
2025-03-01	valve leak	1
2025-04-01	leak	9
2025-04-01	burst	6
2025-04-01	joint failure	5
2025-04-01	valve leak	2
2025-05-01	leak	8
2025-05-01	burst	11
2025-05-01	joint failure	8
2025-05-01	valve leak	0
2025-06-01	leak	13
2025-06-01	burst	7
2025-06-01	joint failure	6
2025-06-01	valve leak	3
2025-07-01	leak	28
2025-07-01	burst	4
2025-07-01	joint failure	4
2025-07-01	valve leak	3
2025-08-01	leak	12
2025-08-01	burst	6
2025-08-01	joint failure	8
2025-08-01	valve leak	3
2025-09-01	leak	19
2025-09-01	burst	10
2025-09-01	joint failure	7
2025-09-01	valve leak	1
2025-10-01	leak	13
2025-10-01	burst	13
2025-10-01	joint failure	6
2025-10-01	valve leak	2
2025-11-01	leak	6
2025-11-01	burst	6
2025-11-01	joint failure	2
2025-11-01	valve leak	2
2025-12-01	leak	10
2025-12-01	burst	4
2025-12-01	joint failure	3
2025-12-01	valve leak	3
2026-01-01	leak	5
2026-01-01	burst	2
2026-01-01	joint failure	2
2026-01-01	valve leak	4
2026-02-01	leak	4

period	series	value
2026-02-01	burst	3
2026-02-01	joint failure	1
2026-02-01	valve leak	1
2026-03-01	leak	7
2026-03-01	burst	7
2026-03-01	joint failure	2
2026-03-01	valve leak	4
2026-04-01	leak	14
2026-04-01	burst	12
2026-04-01	joint failure	2
2026-04-01	valve leak	2
2026-05-01	leak	14
2026-05-01	burst	9
2026-05-01	joint failure	4
2026-05-01	valve leak	1
2026-06-01	leak	15
2026-06-01	burst	11
2026-06-01	joint failure	14
2026-06-01	valve leak	4
2026-07-01	leak	23
2026-07-01	burst	20
2026-07-01	joint failure	8
2026-07-01	valve leak	1
2026-08-01	leak	24
2026-08-01	burst	14
2026-08-01	joint failure	12
2026-08-01	valve leak	4
2026-09-01	leak	23
2026-09-01	burst	9
2026-09-01	joint failure	7
2026-09-01	valve leak	2