



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 15, 2026 – 02:07 AM UTC

PDB ID : 1HQA / pdb_00001hqa
Title : ALKALINE PHOSPHATASE (H412Q)
Authors : Ma, L.; Kantrowitz, E.R.
Deposited on : 1995-11-30
Resolution : 2.25 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4-5-2 with Phenix2.0
Xtriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

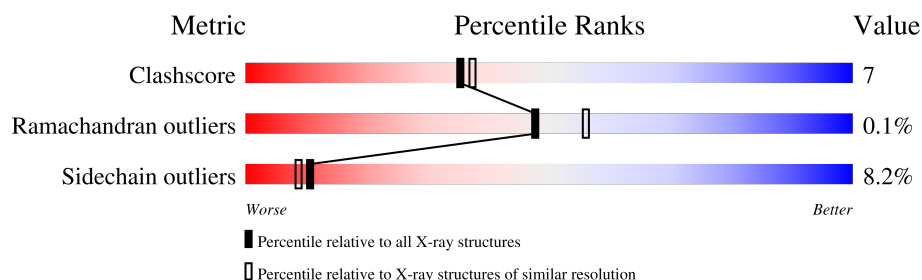
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.25 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	190562	2005 (2.26-2.26)
Ramachandran outliers	187476	1965 (2.26-2.26)
Sidechain outliers	187428	1966 (2.26-2.26)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	449	 78% 19% ..
1	B	449	 75% 21% ..

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 6959 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called ALKALINE PHOSPHATASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	446	Total	C	N	O	S	0	0	0
			3280	2027	577	664	12			
1	B	446	Total	C	N	O	S	0	0	0
			3280	2027	577	664	12			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	412	GLN	HIS	engineered mutation	UNP P00634
B	412	GLN	HIS	engineered mutation	UNP P00634

- Molecule 2 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	3	Total	Zn	0	0
			3	3		
2	B	3	Total	Zn	0	0
			3	3		

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	222	Total	O	0	0
			222	222		
3	B	171	Total	O	0	0
			171	171		

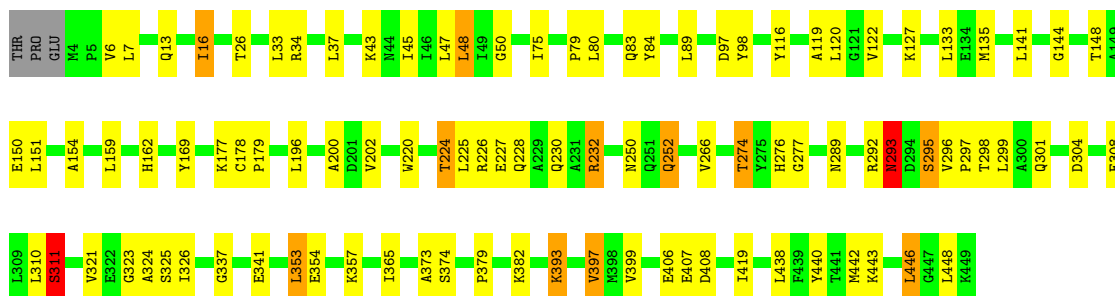
3 Residue-property plots

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

Note EDS was not executed.

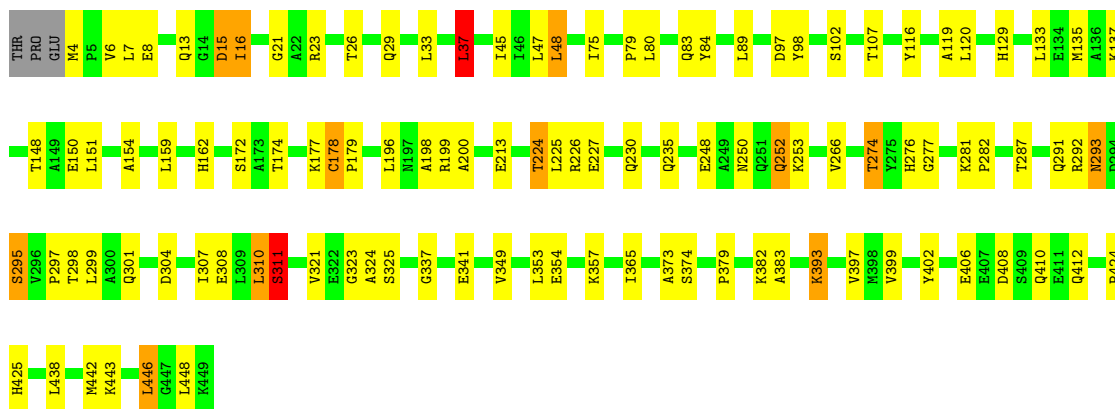
• Molecule 1: ALKALINE PHOSPHATASE

Chain A: 



• Molecule 1: ALKALINE PHOSPHATASE

Chain B: 



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α , β , γ	194.90 Å 167.00 Å 76.80 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	8.00 – 2.25	Depositor
% Data completeness (in resolution range)	(Not available) (8.00-2.25)	Depositor
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	X-PLOR 3.1	Depositor
R, R_{free}	0.161 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	6959	wwPDB-VP
Average B, all atoms (Å ²)	21.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: ZN

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z > 5$	RMSZ	$\# Z > 5$
1	A	0.99	0/3333	1.24	23/4523 (0.5%)
1	B	0.96	1/3333 (0.0%)	1.21	26/4523 (0.6%)
All	All	0.98	1/6666 (0.0%)	1.22	49/9046 (0.5%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	4	MET	SD-CE	6.83	1.96	1.79

All (49) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	324	ALA	N-CA-C	10.91	123.25	111.36
1	B	324	ALA	N-CA-C	9.97	122.23	111.36
1	B	293	ASN	N-CA-C	7.97	127.77	110.80
1	A	293	ASN	N-CA-C	7.90	127.63	110.80
1	A	373	ALA	N-CA-C	7.49	120.90	111.69
1	B	200	ALA	N-CA-C	-7.48	100.66	110.53
1	B	98	TYR	N-CA-C	7.38	121.38	112.38
1	B	79	PRO	N-CA-C	7.01	123.93	114.18
1	A	98	TYR	N-CA-C	6.90	120.80	112.38
1	B	224	THR	N-CA-C	-6.55	101.71	110.55
1	A	79	PRO	N-CA-C	6.51	123.23	114.18
1	A	75	ILE	N-CA-C	6.43	117.95	110.62
1	B	323	GLY	N-CA-C	-6.34	98.14	113.18
1	B	373	ALA	N-CA-C	6.29	119.43	111.69
1	A	178	CYS	CA-C-N	6.25	126.44	119.32
1	A	178	CYS	C-N-CA	6.25	126.44	119.32
1	B	75	ILE	N-CA-C	6.20	117.69	110.62
1	A	150	GLU	N-CA-C	-6.05	101.33	110.28

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	311	SER	N-CA-C	6.00	117.82	111.28
1	A	43	LYS	N-CA-C	-5.83	105.27	112.90
1	B	325	SER	N-CA-C	5.82	120.24	113.20
1	B	37	LEU	N-CA-C	5.80	117.75	108.41
1	B	178	CYS	CA-C-N	5.69	125.16	119.24
1	B	178	CYS	C-N-CA	5.69	125.16	119.24
1	A	97	ASP	N-CA-C	-5.67	98.10	108.02
1	A	326	ILE	N-CA-C	-5.66	104.98	110.42
1	A	200	ALA	N-CA-C	-5.60	103.14	110.53
1	B	97	ASP	N-CA-C	-5.57	98.27	108.02
1	B	15	ASP	CA-C-N	5.56	128.37	120.53
1	B	15	ASP	C-N-CA	5.56	128.37	120.53
1	A	6	VAL	N-CA-C	-5.54	100.64	109.17
1	A	374	SER	N-CA-C	5.53	118.34	110.10
1	B	172	SER	N-CA-C	5.51	116.96	111.07
1	B	383	ALA	CA-C-N	5.44	125.05	119.56
1	B	383	ALA	C-N-CA	5.44	125.05	119.56
1	A	419	ILE	N-CA-C	-5.43	100.25	108.17
1	B	6	VAL	N-CA-C	-5.38	100.63	108.97
1	A	224	THR	N-CA-C	-5.33	103.36	110.55
1	B	150	GLU	N-CA-C	-5.30	102.44	110.28
1	A	50	GLY	N-CA-C	-5.24	100.77	113.18
1	A	323	GLY	N-CA-C	-5.21	100.82	113.18
1	A	154	ALA	N-CA-C	5.21	119.97	111.37
1	A	169	TYR	N-CA-C	5.17	116.61	110.97
1	A	325	SER	N-CA-C	5.17	119.45	113.20
1	B	154	ALA	N-CA-C	5.13	119.83	111.37
1	B	374	SER	N-CA-C	5.12	117.72	110.10
1	B	235	GLN	N-CA-C	-5.03	100.53	108.73
1	B	311	SER	N-CA-C	5.01	118.16	111.75
1	B	199	ARG	N-CA-C	5.00	118.22	111.17

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts ⓘ

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3280	0	3226	53	0
1	B	3280	0	3226	53	0
2	A	3	0	0	0	0
2	B	3	0	0	0	0
3	A	222	0	0	4	0
3	B	171	0	0	8	0
All	All	6959	0	6452	96	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 7.

All (96) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:16:ILE:HG21	3:B:555:HOH:O	1.76	0.85
1:A:135:MET:HE1	1:A:443:LYS:HD2	1.63	0.80
1:A:34:ARG:HD3	3:A:556:HOH:O	1.85	0.75
1:B:224:THR:OG1	1:B:227:GLU:HG3	1.89	0.73
1:A:224:THR:OG1	1:A:227:GLU:HG3	1.92	0.70
1:B:135:MET:HE1	1:B:443:LYS:HD2	1.72	0.70
1:A:16:ILE:CG2	1:B:89:LEU:HD21	2.23	0.69
1:A:220:TRP:CZ2	1:A:232:ARG:HD2	2.30	0.67
1:B:250:ASN:OD1	1:B:252:GLN:HG2	1.97	0.65
1:A:289:ASN:O	1:A:292:ARG:HG2	1.97	0.64
1:A:48:LEU:HD13	1:A:321:VAL:HB	1.80	0.64
1:A:16:ILE:HG22	1:B:89:LEU:HD21	1.81	0.63
1:A:276:HIS:HE1	1:B:406:GLU:OE1	1.83	0.62
1:A:89:LEU:HD21	1:B:16:ILE:HG22	1.82	0.60
1:B:48:LEU:HD13	1:B:321:VAL:HB	1.82	0.60
1:B:45:ILE:HD12	1:B:446:LEU:HD22	1.85	0.58
1:A:89:LEU:HD21	1:B:16:ILE:CG2	2.34	0.58
1:B:354:GLU:HA	1:B:357:LYS:HE3	1.87	0.57
1:A:298:THR:OG1	1:A:301:GLN:HG3	2.05	0.56
1:B:379:PRO:HA	1:B:399:VAL:HG21	1.86	0.56
1:A:393:LYS:O	1:A:393:LYS:HG3	2.04	0.56
1:A:45:ILE:HD12	1:A:446:LEU:HD22	1.87	0.56
1:A:354:GLU:HA	1:A:357:LYS:HE3	1.88	0.56
1:A:407:GLU:HB3	3:A:672:HOH:O	2.06	0.56
1:B:297:PRO:HA	1:B:301:GLN:OE1	2.07	0.55
1:B:337:GLY:O	1:B:341:GLU:HG2	2.07	0.55
1:A:308:GLU:O	1:A:311:SER:HB2	2.07	0.54
1:A:250:ASN:OD1	1:A:252:GLN:HG2	2.08	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:226:ARG:O	1:A:230:GLN:HG3	2.08	0.53
1:B:120:LEU:O	1:B:162:HIS:HA	2.08	0.53
1:B:393:LYS:O	1:B:393:LYS:HG3	2.07	0.53
1:A:274:THR:HG22	1:A:277:GLY:HA3	1.91	0.52
1:A:120:LEU:O	1:A:162:HIS:HA	2.09	0.52
1:B:293:ASN:OD1	1:B:295:SER:HB2	2.10	0.52
1:A:34:ARG:HG2	1:B:37:LEU:HD23	1.92	0.52
1:A:379:PRO:HA	1:A:399:VAL:HG21	1.90	0.52
3:A:523:HOH:O	1:B:29:GLN:HG3	2.09	0.52
1:A:293:ASN:OD1	1:A:295:SER:HB2	2.09	0.52
1:A:122:VAL:HA	1:A:127:LYS:O	2.10	0.51
1:B:227:GLU:HA	1:B:230:GLN:HE21	1.76	0.50
1:A:406:GLU:OE1	1:B:276:HIS:HE1	1.94	0.50
1:A:297:PRO:HA	1:A:301:GLN:OE1	2.12	0.49
1:A:116:TYR:CZ	1:A:119:ALA:HB2	2.47	0.49
1:B:48:LEU:HG	1:B:349:VAL:HG22	1.95	0.49
1:B:298:THR:OG1	1:B:301:GLN:HG3	2.12	0.49
1:A:227:GLU:HA	1:A:230:GLN:HE21	1.78	0.49
1:A:337:GLY:O	1:A:341:GLU:HG2	2.13	0.49
1:A:353:LEU:O	1:A:357:LYS:HB2	2.12	0.49
1:A:177:LYS:C	1:A:179:PRO:HD3	2.39	0.48
1:B:307:ILE:O	1:B:311:SER:HB2	2.12	0.48
1:A:397:VAL:HG12	3:A:457:HOH:O	2.14	0.47
1:A:148:THR:HG23	1:A:299:LEU:HD13	1.95	0.47
1:B:402:TYR:HB3	1:B:410:GLN:HG3	1.97	0.47
1:B:177:LYS:C	1:B:179:PRO:HD3	2.40	0.47
1:B:133:LEU:C	1:B:133:LEU:HD23	2.40	0.46
1:B:274:THR:HG22	1:B:277:GLY:HA3	1.96	0.46
1:B:438:LEU:HG	1:B:442:MET:HE2	1.97	0.46
1:B:379:PRO:HA	1:B:399:VAL:CG2	2.45	0.46
1:A:16:ILE:HG13	3:B:555:HOH:O	2.16	0.46
1:B:102:SER:HB3	3:B:547:HOH:O	2.16	0.46
1:B:116:TYR:CZ	1:B:119:ALA:HB2	2.50	0.46
1:A:135:MET:HE1	1:A:443:LYS:CD	2.41	0.46
1:A:276:HIS:CE1	1:B:406:GLU:OE1	2.66	0.45
1:B:213:GLU:O	1:B:224:THR:HA	2.16	0.45
1:B:287:THR:HG22	3:B:529:HOH:O	2.14	0.45
1:B:365:ILE:HD13	1:B:438:LEU:HD11	1.97	0.45
1:B:137:LYS:NZ	1:B:198:ALA:O	2.47	0.45
1:A:13:GLN:HG3	1:A:26:THR:HG22	1.99	0.45
1:B:248:GLU:OE2	1:B:253:LYS:HE2	2.17	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:281:LYS:HB3	1:B:282:PRO:HD2	1.98	0.45
1:A:83:GLN:HE21	1:B:83:GLN:HE21	1.66	0.44
1:B:137:LYS:HG3	3:B:503:HOH:O	2.17	0.44
1:B:15:ASP:O	1:B:21:GLY:HA3	2.18	0.43
1:A:144:GLY:HA2	1:A:202:VAL:O	2.18	0.43
1:A:438:LEU:HG	1:A:442:MET:HE2	2.01	0.43
1:A:365:ILE:HD13	1:A:438:LEU:HD11	2.01	0.42
1:A:133:LEU:HD23	1:A:133:LEU:C	2.44	0.42
1:B:424:PRO:O	1:B:425:HIS:HB2	2.19	0.42
1:A:16:ILE:CB	3:B:555:HOH:O	2.68	0.42
1:B:107:THR:HA	3:B:588:HOH:O	2.20	0.42
1:B:226:ARG:O	1:B:230:GLN:HG3	2.20	0.42
1:A:379:PRO:HA	1:A:399:VAL:CG2	2.49	0.42
1:B:310:LEU:HD12	1:B:310:LEU:HA	1.87	0.42
1:B:13:GLN:HG3	1:B:26:THR:HG22	2.01	0.42
1:B:148:THR:HG23	1:B:299:LEU:HD13	2.02	0.41
1:B:308:GLU:O	1:B:311:SER:HB2	2.19	0.41
1:A:141:LEU:HD12	1:A:141:LEU:N	2.35	0.41
1:A:220:TRP:CH2	1:A:232:ARG:HD2	2.54	0.41
1:A:228:GLN:OE1	1:A:232:ARG:NH1	2.49	0.41
1:A:357:LYS:HE3	1:A:357:LYS:HB3	1.85	0.41
1:A:440:TYR:CE2	1:B:23:ARG:HD2	2.55	0.41
1:A:16:ILE:CG1	3:B:555:HOH:O	2.69	0.41
1:A:293:ASN:HB3	1:A:296:VAL:HG23	2.02	0.41
1:B:291:GLN:O	1:B:292:ARG:C	2.62	0.41
1:B:129:HIS:O	1:B:162:HIS:HE1	2.04	0.40
1:B:174:THR:HG23	1:B:178:CYS:HB2	2.03	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	444/449 (99%)	438 (99%)	5 (1%)	1 (0%)	43	50
1	B	444/449 (99%)	437 (98%)	7 (2%)	0	100	100
All	All	888/898 (99%)	875 (98%)	12 (1%)	1 (0%)	48	56

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	293	ASN

5.3.2 Protein sidechains ⓘ

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	337/340 (99%)	310 (92%)	27 (8%)	11	9
1	B	337/340 (99%)	309 (92%)	28 (8%)	10	8
All	All	674/680 (99%)	619 (92%)	55 (8%)	10	9

All (55) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7	LEU
1	A	16	ILE
1	A	33	LEU
1	A	37	LEU
1	A	47	LEU
1	A	48	LEU
1	A	80	LEU
1	A	84	TYR
1	A	151	LEU
1	A	159	LEU
1	A	196	LEU
1	A	225	LEU
1	A	232	ARG
1	A	252	GLN
1	A	266	VAL

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Mol	Chain	Res	Type
1	A	274	THR
1	A	295	SER
1	A	304	ASP
1	A	310	LEU
1	A	311	SER
1	A	353	LEU
1	A	382	LYS
1	A	393	LYS
1	A	397	VAL
1	A	408	ASP
1	A	446	LEU
1	A	448	LEU
1	B	7	LEU
1	B	8	GLU
1	B	16	ILE
1	B	33	LEU
1	B	37	LEU
1	B	47	LEU
1	B	48	LEU
1	B	80	LEU
1	B	84	TYR
1	B	151	LEU
1	B	159	LEU
1	B	196	LEU
1	B	225	LEU
1	B	252	GLN
1	B	266	VAL
1	B	274	THR
1	B	295	SER
1	B	304	ASP
1	B	310	LEU
1	B	311	SER
1	B	353	LEU
1	B	382	LYS
1	B	393	LYS
1	B	397	VAL
1	B	408	ASP
1	B	412	GLN
1	B	446	LEU
1	B	448	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (19) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	13	GLN
1	A	230	GLN
1	A	244	ASN
1	A	276	HIS
1	A	329	GLN
1	A	388	GLN
1	A	391	ASN
1	A	410	GLN
1	A	425	HIS
1	B	9	ASN
1	B	13	GLN
1	B	29	GLN
1	B	83	GLN
1	B	125	HIS
1	B	230	GLN
1	B	244	ASN
1	B	276	HIS
1	B	388	GLN
1	B	391	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 6 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers

There are no such residues in this entry.

5.8 Polymer linkage issues

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.