Appendix 1: Advantages and Disadvantages of Timber Frame Construction

Table A1.1

Advantages of Timber Frame Construction	Potential Problems with Timber Frame Construction
▪ Quick erection times ▪ Reduced site labour ▪ Reduced time to weather the structure ▪ Earlier introduction of following trades ▪ Low embodied energy if constructed in local timber ▪ Recyclable ▪ Reduced construction waste through efficient controlled manufacturing ▪ Low volume of waste on site requiring removal ▪ Can be built to exceed 60-year design life ▪ Energy efficient when constructed to current standards ▪ Fast heating due to low thermal mass ▪ Reduced time on site reduces environmental nuisance and disruption to local residents ▪ Engineered product ▪ Factory controlled quality assurance in fabrication ▪ Efficient use of material due to controlled engineering and fabrication ▪ Reduced construction time translates into reduced risk exposure	▪ Traditional procurement process ▪ Additional design and engineering time ▪ Modification of general arrangement drawings if based on masonry construction ▪ Lack of experienced builders and erection crews ▪ Lack of experience of following trades ▪ Transportation and carriage access ▪ Exposure to weather before enclosed ▪ Work of following trades ▪ Deficiency of site quality control ▪ Combustibility of timber requires vigilant quality control to achieve required fire rating of separating and compartment walls ▪ Susceptibility to decay of timber when exposed to excessive moisture

Advantages of Timber Frame Construction

Quick Erection Times

The timber frame structure of a typical 2 storey semi-detached house (Generic House Type 2, Appendix 5) can be constructed in approximately 1 week. Quick erection times can allow the work of other trades to proceed earlier in the construction programme. Quick erection times are offset by additional period required to facilitate the tendering, longer detail design lead in times and manufacture of the timber frame. These factors reduce the overall benefits of reduction in construction time on site in context of the overall development process. See Table A1.2.

Table A1.2

Lead in Times vs. Construction Times		
	Lead in Times	**Construction Time**
Masonry structure	2 weeks	6-8 weeks
Timber frame structure	8 weeks	1 week
Steel structure	8-10 weeks	2 weeks

The TFHC assessed the construction programme implications for House Type 2 of the Generic House Type models in Appendix 5 and concluded that when benchmarked against other forms of construction the overall development times where broadly similar.

The TFHC's assessment on the overall saving of time on site is based on an overview of the generic house types in Appendix 5 and subsequently reviewed with timber frame manufacturers and further benchmarked against other forms of construction for housing. The above times are indicative and may vary based on project-specific issues such as:

- Number of residential units in the scheme
- Mix of units (detached, semi-detached, terraced)
- Phasing of development
- Availability of resources
- Regional industrial relations issues
- Capacity at particular points within respective supply industries

Reduced Site Labour

The timber frame erection crew for the typical two storey semi-detached house will consist of three carpenters and one crane operator.

Reduced Risk

Commercial institutions and lenders view construction risk as a critical factor in the overall approval of schemes and reflect this in different financing arrangements. The TFHC believe that construction risk is linked to the period of time set aside for construction. The longer the period, the greater the risk in terms of industrial relations issues, inclement weather, and availability of resources and consequently it is our view that the benefit in terms of time saving on site manifests itself as a saving in construction risk.

Quality

Industrialised prefabrication of engineered products is believed by the TFHC to provide consistent quality assurance when compared to works on sited. Buying prefabricated building systems, e.g. bathroom pods, kitchen units, architectural pre-cast concrete panels, etc. is seen by builders, developers and design professionals as a means of achieving expected quality. The timber frame manufacturers interviewed during the course of this study all had well organised quality control procedures in place and the research by the TFHC has shown that most of the defects occurring in timber frame construction in Ireland were site related.

Environmental Sustainability

The majority of structural timber used in Ireland comes from managed forests and is a renewable and sustainable material. The growing of timber benefits the environment, and its harvesting, production and transport are seen to produce less CO_2 than other construction materials such as concrete and steel. The environmental benefits of timber frame construction are reduced when timber is imported from sources outside non local and requiring substantial fuel consumption in transportation. Most of the solid structural timber used in Ireland is sourced in Scandinavia and North America.

Potential Problems with Timber Frame Construction

Design

There are some residual reservations about timber frame among architects, engineers, builders, administrative bodies, financial institutions and insurance companies as well as with end users.

Perceived problems with timber frame construction in the housing market from both the end users and local authorities would include a perceived greater risk of fire, issues of sound attenuation in a timber structure and the impact such a structure might have on the security of the end user.

Procurement and Detail Design

A timber frame solution is at a disadvantage in a procurement process where a prescriptive design and specification is tendered which is specific to a masonry cavity wall construction. Acceptance of a comparable timber frame solution, which would require review, takes time to prepare. The time allowed may be insufficient or unavailable in the current tender process.

Deficiency in On-Site Quality

Familiarisation with the timber frame construction methods is often lacking in both the construction crew and any architects or site managers who should be ensuring on-site quality is achieved. Training courses are run by manufacturing companies or the timber industry to ensure that there is an acceptable level of know-how.

Critical Setting Out of Ground Works

Timber frames are designed and manufactured to tight tolerance and require accurate setting out of ground works and other adjoining construction such as chimneys, rising walls and block construction. As a result, these works need to be set out with a high degree of accuracy. Problems arise on a site if agreed tolerance between the required dimensions and the built dimensions are not followed.

Procedures for verifying that the ground works comply with the setting out for the timber frame must be in place as part of the builder's quality control procedure.

Timber Frame Erection Skills

The provision of skilled labour and trades on site, knowledgeable in the particular construction method used, is fundamental to the proper completion of any building. The use of inexperienced labour can result in assembly problems and defects in critical details such as fire stopping, moisture protection and structural integrity. Timber frame construction in Ireland is erected either by the timber frame manufacturer's own erection crews, accredited erection crews, or the house-builder/developer's own carpenters. When the builder or developer uses their own crews they should either be accredited experienced crews or trained in timber frame techniques. The manufacturers interviewed by the TFHC provide training seminars, usually consisting of two days for contractors erection crews prior to the construction of the timber frames.

Education

Timber frame construction is less prevalent in Ireland than other forms of construction. As a result, there are fewer builders, design professionals and developers experienced in timber frame construction. It is self-evident that as its use becomes more prevalent, so will the knowledge of timber frame systems. Timber frame manufacturers use in-house designers, architects and technicians to convert architectural drawings to manufacturing plans. The full advantages of timber frame technology will be experienced only when professionals themselves become more familiar with it through education.

Storage of panels On Site

Protection of the timber panels on site is critical to ensuring timber components are not subjected to excessive moisture content. Panels should be stacked on a flat surface so that warping or buckling does not occur. Proper on-site practices and coordination of deliveries can address this issue.

Flooding

Where housing is proposed in areas at risk of flooding, the proposed construction methods undertaken need to be reviewed in order to assess the potential risks or implications should flooding occur.

According to a report issued by the Department for Transport, Local Government and the Regions (UK) on 'Preparing for Floods', there are a few permanent measures that can be taken to improve the flood resistance of timber framed buildings. Where the external cladding material is of masonry, tiles, plastic or metal sheeting, damage to cladding is believed to be limited. In the case where timber-cladding boards are used, replacement of warped or buckled boards will be required.

TRADA's experience in the UK's southeast is that timber frame homes subjected to flood damage require removal of internal linings and insulation, drying out of the structure and installation of new insulation and linings. The drying out time is shorter than that of masonry homes and they are therefore habitable sooner.

Structurally, the timber frame wall is unlikely to be adversely affected by flooding if it is dried out within a matter of weeks. Should it be left wet for any longer, decay may occur. However, plywood or OSB sheathing which provides racking resistance to the wall may become weakened due to absorption of water as a result of flooding. Should this occur, it too would need to be replaced.

Combustibility

Timber is a combustible material. Fire resistance is achieved by protective enclosure in non-combustible materials or by the thickness of the timber section, which provides a degree of protection, by the charred surface of the structural timber element. The fire protection of timber structures can be compromised if not detailed correctly and not constructed in accordance with the details and product manufacturer's instructions.

Transportation and Site Access

Transportation of the finished wall panels imposes limitations on the sizes that can be achieved. An indication of the size restraints would be:

- 12 to 13 metres for the wall panel lengths
- 3 metres for the highest panel

These sizes are dictated by the size of truck normally used for transportation and traffic restrictions.

Transportation, site access and accessibility for cranage of the prefabricated panels are considerations in choosing a construction system consisting of timber frame construction.

Impact of Irish Climate on Timber Frame Construction

Moisture can cause damage to timber frame construction where it has not been properly designed, fabricated or constructed for the specific conditions of use. Appendix 3 lists some international case studies of failures in regions with similarly wet climates and that were attributed to moisture intrusion and particular types of cladding.

The Irish climate is characterised by frequent rainfall, high humidity and high winds with conditions across Ireland varying dramatically. Meteorological data shows that e.g. Co. Sligo (west coast) experiences over 54% more annual rain than Co. Dublin (east coast). The higher wind speeds in conjunction with rain, categorise the west coast of Ireland as severely exposed to wind-driven rain. These climatic conditions suggest that external cladding must be suitably robust and fit for the purpose to resist the elements while also satisfying the requirements of moisture protection of the internal structure of the building. The timber frame structure must also resist the forces created by wind while supporting the cladding without excessive movement which could cause failure of sealants and the cladding itself. Where the frame is unable to resist the forces of wind, the cladding or other external elements such as windows and doors may fail.

Table A1.3 Temperature, relative humidity and precipitation of the world.
Air Ministry Meteorological Office, HMSO 1958.

Location	Average daily temp. (Celsius)		Absolute temp. (Celsius)		Relative humidity		Rainfall (mm)	
	Max	Min	Max	Min	AM	PM	Annual Rainfall	Max fall in 24hrs
Ireland								
Cork	14	7	30	-10	85	-	1032	77
Dublin	13	7	30	-10	83	-	742	67
Shannon Airport	14	8	30	-11	90	81	912	62.5
Sligo*	13	6.7	28.7	-8.1	87	78	1139	67.8
Malin Head*	12	7	27	-6.2	82	78		
UK								
Belfast	13	6	30	-10	-	-	955	57
Aberdeen	11	5	31	-11	83	75	825	62
Braemar	11	3	29	-16	76	-	910	110
Stornaway	11	7	29	-12	89	81	1227	82
St. Ann's Head	11	8	30	-7	89	84	930	60
Oxford	14	6	35	-16	79	82	635	72
USA								
Atlanta	22	12	40	-22	78	59	1215	185
Charleston	23	15	40	-14	79	64	1190	265
Key West	28	22	38	5	78	70	952	337
Los Angeles	23	12	43	-2	77	51	375	185
Canada								
Vancouver	14	6	33	-14	90	73	1435	110
Victoria	14	7	35	-18	91	70	680	75
New Zealand								
Auckland	19	12	32	-1	76	67	1227	160
Christchurch	17	7	36	-7	75	66	627	117
Dunedin	15	7	34	-5	73	71	922	170

Note: * 30 year average figures – 1960 to 1990.

The data in Table 3.2 suggest that in terms of humidity, rainfall and temperature, other regions of the world experience similar conditions to those found in Ireland. The TFHC investigated timber frame construction in some of the regions with similar climatic conditions and assessed the performance of timber frame construction. These investigations resulted in the TFHC finding instances of reported defects that were attributed to cladding failures leading to water intrusion and damage to timber frame housing. See Appendix 3: International and National Case Studies.

The Irish weather also impacts on the construction industry in relation to site conditions. The timber frame manufacturers express their view that erecting of the basic structure can be done in a number of days after delivery of the timber frame kit on site. Speed of erection is thought to limit exposure to weather and to provide an enclosed environment for the follow-on trades and internal fit out. This is seen as an advantage of timber frame construction.

The Consortium has conducted extensive investigative research on timber frame housing construction in both Ireland and other countries. Initial findings suggested that environmental factors such as wind-driven rain, humidity and drying times were important factors in the performance of timber frame construction in countries with similar meteorological conditions. This initial study lead to the Consortium's assessment of performance failures in countries with similar environmental factors to those found in Ireland.

Assessment of these (incidents) failures leads to the conclusion that damage to timber frame buildings was caused by water intrusion beyond new cladding systems. These new cladding systems, which were widely implemented overseas, were directly applied to the timber frame structure and utilised materials that were relatively moisture and vapour impermeable. A high degree of reported failures were attributed to three factors: the cladding system used; poor quality control during the installation of moisture protection elements within the wall, floors and roof construction; and regions frequented by wind-driven rainfall, high humidity and a low percentage of dry days. This combination of factors leads to fungal decay of timber frame buildings. Detailed assessment can be found in Chapter 5 and Appendix 3.