HISTORICAL PERSPECTIVE

The history of extensive green roofs, more commonly referred to as turf or sod roofs, spans over five millennia and at least two continents. Sod has been used extensively in the Northern Hemisphere, especially in regions with cold climates and/or limited resources. As a



building material, sod historically consisted of the surface strata of soil and the live roots and rhizomes that occupy it, and give it strength. While both sod and turf are similarly defined as containing a dense growth of grasses, the

2.1 The image shows a wispy layer of short-grass prairie plants and the overhanging soil held together by their root systems (Websteaders 1998, Sod Houses).

composition of this surface layer varied from region to region. On the Great Plains of North America, building

sod derived from "mixed and short-grass prairies that began to develop in Miocene times" (figure 2.1) (Oliver 1997, 215).

Details about many early forms of sod construction remain either sketchy or non-existent. In Scandinavia squares of pasture were laid over birch bark to form the roof. As seasons passed, the roots intertwined between sods, creating a contiguous whole. In North America, reminiscences and photographs depicting the latter part of the nineteenth century detail the use of sod blocks. Strips of sod, 7-10 cm (3-4 in) thick and typically 30-45 cm (12-18 in) wide, were sliced

parallel with the soil surface using special ploughs, or

2.2 Sod was cut with a variety of plows. There were basic versions, like the battered old plow shown here, as well as fancy wheeled plows available (Websteaders 1998, Sod Houses).

by hand, with an axe and/or shovel (figure 2.2). The ploughs would turn the sod onto its top in an unbroken slab. The sod would then be cut into varying lengths, 1 m (3 ft) being the longest. These blocks were "laid in masonry fashion, grass side down, to form walls and then thinner blocks used to cover the wood framed roof" (Oliver 1997, 1877). Sod roofs were widespread both temporally and spatially, and proved an invaluable building material in areas with limited sources of wood and/or cold winters.

FROM NEOLITHIC PEOPLE TO THE IRON AGE

Archaeologists believe that a number of the earliest dwellings in both Europe and North America were constructed of limited amounts of wood, stone, and a good amount of sod. The Orkney Isles of Scotland posses some of the oldest houses in Europe. The southernmost of the



2.3 Knap of Hower, Orkney. Earliest standing house in Northern Europe (Stone Pages 1998).

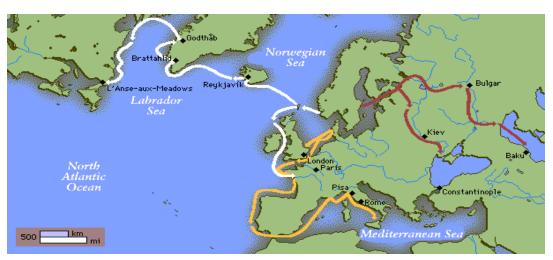
two archipelagos that form the northern isles of Scotland, the Orkneys are virtually treeless and the geological base, mainly sandstone. The now roofless, but otherwise intact masonry walls of ancient houses, dated from 3600 to 2500 B.C., have been excavated at a number of sites (figure 2.3).

Later dwellings suggest that the roofs of these structures were thatched with straw or turf, held in place with simmons (straw or heather rope) and weighted with flagstone at the eves (Oliver 1997, 1393).

Tobias Faber writes that in Denmark during the Iron Age (500 B.C.-800 A.D.) roofs consisted of rafters, supported on a row of posts up the centre or by two parallel rows of posts along the walls, covered with a framework of branches or light thatch, and a layer of turf or peat.

THE VIKINGS AND THE NORTHERN ATLANTIC

The Norsemen of Scandinavia cut turf in several shapes and sizes from pastures and sedge marshes with special tools and used it extensively in the construction of their settlements



2.4 Viking explorations. The white line designates the route taken by the Norwegian Vikings through the Northern Atlantic islands and across to Iceland, Greenland and Newfoundland (Microsoft 1997).

as they began to expand into Europe and explore the Northern Atlantic from the end of the Iron Age (700 A.D.) and into the Viking Age (800-1000 A.D.) (figure 2.4) (Donnelly 1992, 20).

On the Orkney Isles, the Vikings used flagstone and/or simmons to form a sloped roofing deck, which was then "thatched with straw or turf, held in place with yet more closely spaced simmons weighted with flagstone at the eaves" (Oliver 1997, 1394). Similar techniques were used on the Shetlands Isles around the seventh century and the Faeroe Islands in the late ninth century. Even as wood construction began to replace the old traditional house, most of the

stave-built outbuildings on the Faeroes, that form part of the house or farm, had roofs covered with turf. Timber-lined buildings faced externally with turf could be found on the Shetlands as late as the twentieth century. In his 1966 book, *The Historic Architecture of Scotland*, John Dunbar wrote that the practice of "pegging squared turf roots upwards to the rafters as a sole covering has been recorded in Shetland within the past generation or so" (232).

From the time the Vikings arrived in Iceland in the late-ninth century, until the late-nine teenth century, the primary construction materials in this bare land were stone, wood, and turf. Icelandic turf buildings were "wooden buildings surrounded by protective walls and roofs of turf and stone" (Oliver 1997, 1389-90). The timber used in construction came in the way of driftwood and later imported timber. As late as the early 1900's more than half the population of Iceland lived in turf farmhouses. While the majority of these structures were replaced soon thereafter with wood, and then concrete, in some places, people continued to live in them even after World War II (Oliver 1997, 1389).



2.5 Vidmyri Church, Iceland (Velazquez 1999).

The most common roof construction used in Iceland was the *sperruthak* or spar-construction (A-frame couples). "The roof, protected with turf on the outside, is covered in two different ways: *helluthak* which has flat stone pieces laid on the rafters on which are placed earth and then turf with the grass facing out; or *tródthak* which has

brushwood instead of flat stones laid on the rafters with first turf, then earth and finally turf with the grass facing outwards, placed on top" (Oliver 1997, 1390).

Later periods saw

primarily two kinds of turf

buildings. One involved a

structure built entirely of turf

blocks (slabs), laid to form domed

or barrel-vaulted roofs (figure



2.6 Holar Farmhouse, Iceland (Velazquez 1999).

2.5). The other was a wooden dwelling, where the front was panelled with wood, and the roof and walls were made of turf (figure 2.6) (Donnelly 1992, 235). The latter is still associated with Iceland, and is a popular subject for picturesque postcards.

The Vikings went on to use similar roof and wall construction in their short-lived settlements on the icy landscape of Greenland in the late tenth century and on the North Atlantic coast of Canada in the twelfth century (figure 2.7) (Kalman 1994, 12).



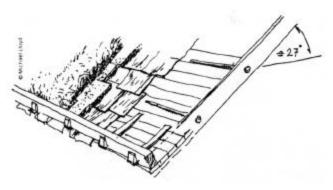
2.7 L'Anse aux Meadows, Newfoundland. Reconstruction of the Viking village known as Vineland (Parks Canada 2000).

SCANDINAVIA

Turf roofs were used extensively in the medieval period on farm buildings throughout Scandinavia. While wood was plentiful and sod was heavy, turf roofs possessed good insulation qualities compared to other roofing materials in use at the time. These roofs had to be renewed

regularly when the turf degenerated or when small branches sprouted. Lifespan estimates, though, ranged from 20 years to 40 or more.

The roofs generally consisted of a layer of robust boarding, one or more layer(s) of birchbark, with all the pieces generously overlapping, a network of birch twigs, a thin layer of gravel, and then finally two courses of turf, the first upside down (figure 2.8). While it was



2.8 Cross-section of typical Scandinavian turf roof (Oliver 1997, 360).

possible to omit the twigs and gravel, the roof did not perform as well or last as long without them. A later variation of this construction used a corrugated waterproof layer of tough plastic in lieu of the birchbark. The eaves at the bottom of the roof were finished by a solid board held in place with

hooks that extended some distance up the roof under the birchbark. The birchbark/waterproof layer had to "continue under the eaves board and form a water drip nosing clear of the roof boarding." A substantial piece of timber, a form of bargeboard, "held in place by long wooden pins bored through the board and dug well into the turf," was often used on the gabled eaves (Oliver 1997, 360). The roof had to have a pitch that allowed it to drain well, where the turf could be held in place, and where snow could settle in the winter; this was often around 27 degrees (Oliver 1997, 359). There is little written on how well these roofs kept out the elements. The above roofs were intended to be permanent, and their multi-layered construction, sometimes involving up to seven layers of birchbark, does suggest they were effective barriers against the rain and the cold.

In the province of Telemark, in southern Norway, where the main building material was timber, walls would be constructed with logs, and the roof topped with turf. During the eighteenth and up to the mid-nineteenth century, on the eastern coast of Sweden and on Gotland Island, the corner-timbered dwellings had pitched roofs covered with turf, straw, reed, or split

logs. It wasn't until the late-nineteenth century that these were replaced with increasingly popular tiles (Oliver 1997, 1395). The national open-air folk museums of Norway, Denmark and Sweden all include a number of turf-roofed structures dated between the seventeenth and nineteenth century (figure 2.9) (Donnelly 1992, 220-225).



2.9 Sod roofed house in the Mallhaugen Open Air Museum, Lillehammer, Norway (Dodd).

THE ARCTIC

Indigenous Peoples—Winter House

Archaeological analysis suggests that the history of Arctic architecture stretches back some 25,000 years (Easton and Nobokov 1989, 191). Clear evidence of early dwellings begins

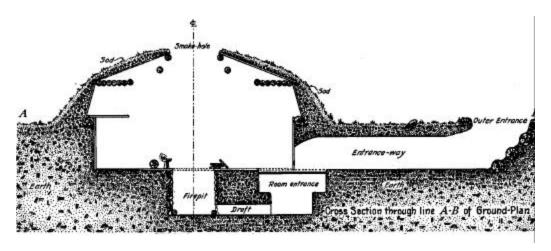


2.10 Thule Inuit, turf-covered stone dwelling in northern Greenland, photographed ca. 1909 (Easton and Nobokov 1989, 192).

with the Dorset Culture
around 800 B.C. The Thule,
the direct ancestors of
today's Inuit, began to
spread their remarkably
uniform culture from the

Pacific Coast in the eleventh century, reaching Greenland in the thirteenth century. While snow-blocked igloos come to mind as the typical winter Inuit dwellings, this form was probably limited to the Central Arctic. Far more common across the thousands of miles of tundra were winter structures framed with whatever materials could be found—rocks, driftwood, animal skeletons—and insulated with layers of dirt, skins, packed snow or sod (figure 2.10) (Easton and Nabokov 189-190).

From the Inuit on St. Lawrence Island, with their semi-subterranean *ningloos*, to the extraordinarily wide Eastern Greenland winter houses, turf played an important role in the construction and insulation of Inuit winter dwellings. While variations in building material



2.11 Section of a sod covered Inuit dwelling (Easton and Nobokov 1989, 203).

resources and local customs dictated the various shapes and sizes of dwellings, the construction involved several basics: excavating the site to some degree, creating a frame using the materials available, and then covering the frame with sod (figure 2.11). The North Eastern Greenland Polar Inuit constructed their roofs of corbelled sandstone slabs supported by interior driftwood or bone uprights, over which sod, earth, and then more sod was laid (Easton and Nobokov 1989, 192).

The inhabitants of the Aleutian Islands built some of the largest native homes of the Arctic. Called *barabaras*, these buildings sometimes measured up to 60 m (180 ft) long. The thatched roof, sealed over with grassy turf, made these communal buildings blend into the terrain. In fact, after the introduction of cattle, it was not unusual for a grazing cow to tumble through the sod into the group's living space (Easton and Nobokov 1989, 205).

In parts of the western Arctic and Alaska, where timber was more readily available, sod-covered houses were wood-framed (figure 2.12). The greatest variety of wood-framed winter

houses existed along the
North Alaskan coast. In
the southernmost portion
of the Alaskan territory,
the influence of the First
Nation architecture of
the Northwest Coast,



2.12 Sod-roofed winter houses of Nunivak Inuit. Photographed at Hooper Bay, Alaska, ca. 1928 (Easton and Nobokov 1989, 190).

resulted in Inuit groups using sod-covered gabled structures built on a rectangular plan, similar to the plank buildings of the Tlingit (Easton and Nabokov 1989, 193).

Settlers

Trappers, adventurers, miners, and settlers of the North also took advantage of the insulating properties of sod. In 1897, the gold rush to the Klondike increased the number of Caucasians in the region by five times in just one decade. These new arrivals tended to construct cabins of a temporary nature, built of round logs laid horizontally, often not even peeled of their bark. "The gable roof was constructed of thin poles laid perpendicularly to the ridge-pole, then

covered with 30 cm of sod or moss for insulation" (Oliver 1997, 1794). Over time the sod might have been covered with flattened fuel cans, forming metal shingles.

Following European contact, a number of native peoples in Alaska began to construct sod-covered log houses, in lieu of their traditional dwellings. The last manifestation of the Aleutian *barabara*, mentioned earlier, was a gable-roofed, double-walled plank house with an external skin of sod bricks (Easton and Nobokov 1989, 205).

THE GREAT PLAINS

The Great Plains cover an expansive area that extends from southern Saskatchewan and Manitoba in Canada to Mexico (figure 2.13). The flat terrain of the Plains was for the most part a treeless landscape with an immense sky. Early explorers called the Prairie Plains the "Great American Desert," as much of the vast region they encountered was largely waterless, treeless, and

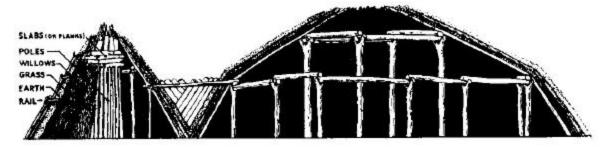


featureless (Oliver 1997, 1874). Although the home to primarily nomadic hunters, a small number of early farming cultures, semi nomadic people, were known for their circular earthlodge villages. The settlements of the Mandan, in what is the present day Dakotas, became renowned centres of trade by the 1780's (Easton and Nobokov 1989, 126).

Indigenous Peoples—Earthlodge

Earthlodges first appeared on the North American Plains around 700 A.D.

Archaeological work suggests that the earliest earthlodges were rectangular and their successors circular. Tribes constructed their earthlodges in more or less the same fashion. Building entailed



2.14 Cross-section of an earthlodge (Easton and Nobokov 1989, 131).

constructing a wooden frame to hold the earthen walls and to support the heavy roof. The roof included a layer of smaller sticks overlaid with brush or grass, followed by a thick layer of sod or loose earth (figure 2.14). A typical earthlodge measured up to 20 m (60 ft) across and 30 m (90 ft) wide. Although limited resources inspired these sod-covered designs, a number of indigenous people continued to use them even after wood became readily available. It wasn't until the late nineteenth century when the government forced them to live in log cabins or wooden frame houses, did they finally abandon this traditional dwelling (Easton and Nobokov 1989, 123-143).

North American Settlers—Dugouts and 'Soddies'

To prospective settlers the seemingly limitless sea of grass exerted an irresistible attraction. Many U.S. Civil War survivors saw the opportunity to raise beef for the growing demands of the Midwest cities, and the government began to encourage the immigration of the 'huddled masses' of Europe 'yearning to breathe free'. Hailing largely from the Germanic and Nordic countries, the Baltic, and central and eastern Europe, many were familiar with extremes

in temperature and bitter winds, yet few could have anticipated countryside so bare and bereft of cover, protection, and more importantly building materials.

With treeless grassland stretching for miles, lumber had to be transported by wagon at an exorbitant cost. Settlers with slim financial resources depended on improvisation, ingenuity, and the materials at hand, to build their underground or semi-underground dugouts and later sod houses, barns and schools. Popular in the southern plains, dugouts involved digging a room into



the ground or a hillside, and then covering it with a roof of planks that might rest on a low wall of fieldstone or timber wall plate. Upon this would be laid brush, earth and sod (figure 2.15) (Oliver 1997, 1875-77).

2.15 Dugout, Fur Trading Post (Websteaders 1998, Pioneer Dugouts).

Father north in Oklahoma, Kansas, Nebraska, Wyoming and Montana, settlers built early 'soddies' into a hill or partially underground, with sod walls rising above the excavation.

'Soddies' were considered temporary dwellings that would provide basic shelter until there was time and/or money to build a more permanent frame house with board and batten. A simple roof consisted of forked posts to hold up the roof-ridge and freighted in poles to form the rafters.

Builders finished the roof with a layer of brush, a layer of prairie grass, and finally with sod 'bricks', either grass side up, or grass side down. The latter version was more desirable, as less dirt would drop from the ceiling.

Later 'soddies' were freestanding structures built with sod blocks (figure 2.16). If settlers could afford the lumber they would construct a frame roof, cover it with sheeting and tarpaper and finish with blocks of sod (Oliver 1997, 1877). The sod acted to both weatherproof

the roof and ballast the tarpaper.

The roof planks were either,
rabbeted and lapped, or butted
together with strips of lath at the
joints in order to discourage
leaking (Gulliford 1986, 56).

Unfortunately, as the sod
covering dried and the earth



2.16 Sod house in Kansas (Wichita State University, Special Collections).

cracked from the sun, the planks warped and leaked at the joints. It was a common saying that with a sod roof, if it rained one day outside it rained two days inside (Shepherd 1977, 45). The weight of saturated soil (15 cm [6 in] of sod weighs approximately 244 kg/m² [50 psf]) coupled with the usually inadequate frames, on occasion, also caused the roof to buckle and collapse after a soaking spring rain.

Over one million sod buildings were in use on the plains of Canada and the U.S. from 1903 to 1913 (Shepherd 1977, 45). Immigrants, from a number of different ethnic groups across Alberta, Saskatchewan, and Manitoba used sod in the construction of their buildings. Mennonite settlers in Alberta and Manitoba built *semlins*, sod houses that housed both family and livestock under one roof, in the late 1800's (Roe 1970, 1; Kalman 1994, 349). In 1899, Russian Doukhobor immigrants, given three large areas to settle in Saskatchewan, built substantial log houses where good timber was available, and soddies where it was scarce. In both cases, though, the roofs were pitched low and generally covered with prairie sod.

NORTHWEST PLATEAU REGION

While the architectural history of the Northwest region remains unclear, most tribal traditions suggest that the oldest house form was the pit house (figure 2.17). The shape and construction of pit houses varied throughout the Plateau region. While similar in construction to the earthlodges of the plains, pit houses were considerably smaller and sunken three to four feet into the ground, before being covered with the earth and



2.17 The Northwest Plateau Region (Easton and Nobokov 1989, 174).



2.18 Winter pit-house in the Nicola Valley (British Columbia Archives).

then sometimes sod (figure 2.18). Families moved into these underground houses in the late fall, and stayed until the spring.

Settlers and trappers also used pit
houses in the interior regions of British
Columbia, but considered them temporary
dwellings. After clearing their site, pioneers

would erect a more permanent notched log house. The roofs of these permanent buildings were sometimes covered with a thick layer of turf for insulation (Dangelmaier 1989, 16). The small, short-lived community of Wallahachin, located on a 'bench' above the Thompson River, had several shallow-pitched roofs covered with bark and turf (Oliver 1997, 1813).

THE DECLINE OF SOD

From Neolithic times to the mid-nineteenth century, sod represented an important material for a number of people in resource scare regions, and as a form of insulation in many northern latitudes. Growing means of transportation and changing social standards in the mid-nineteenth and early twentieth century eventually pushed sod into the history books. In North America, the spread of the railroad dramatically increased options for builders across the Plains. Small sawmills sprang up throughout the 1850's and 1860's as more and more people sought lumber to build their houses. Sawed pine boards and machine-made wire nails, cut to standard sizes, and ready-made products such as doors, windows and trim became widely available. People could order entire prefabricated buildings of all types from catalogues. The increased availability of building materials coupled with publications about building encouraged people to adopt new methods of construction (Kansas State Historical Society 1998).

Settlers across North America welcomed materials that allowed them to build homes of more permanence and in the tradition of their respective ethnic groups. For many indigenous people, though, this transition came rather abruptly, as the government began forcing them to give up their traditional dwellings and life style. The use of sod and turf roofs did continue sporadically in a number of rural areas, particularly in Europe, for many years though. It also became an attractive option to many North American "back-to-the-land" enthusiasts in the 1960's. However, it was not until the 1980's that green roofs began their return as a viable roofing option.