

DOWN HOUSE, BROMLEY

*Notes on the Original Heating System Installed in
Darwin's Greenhouse*

by

Richard Lea

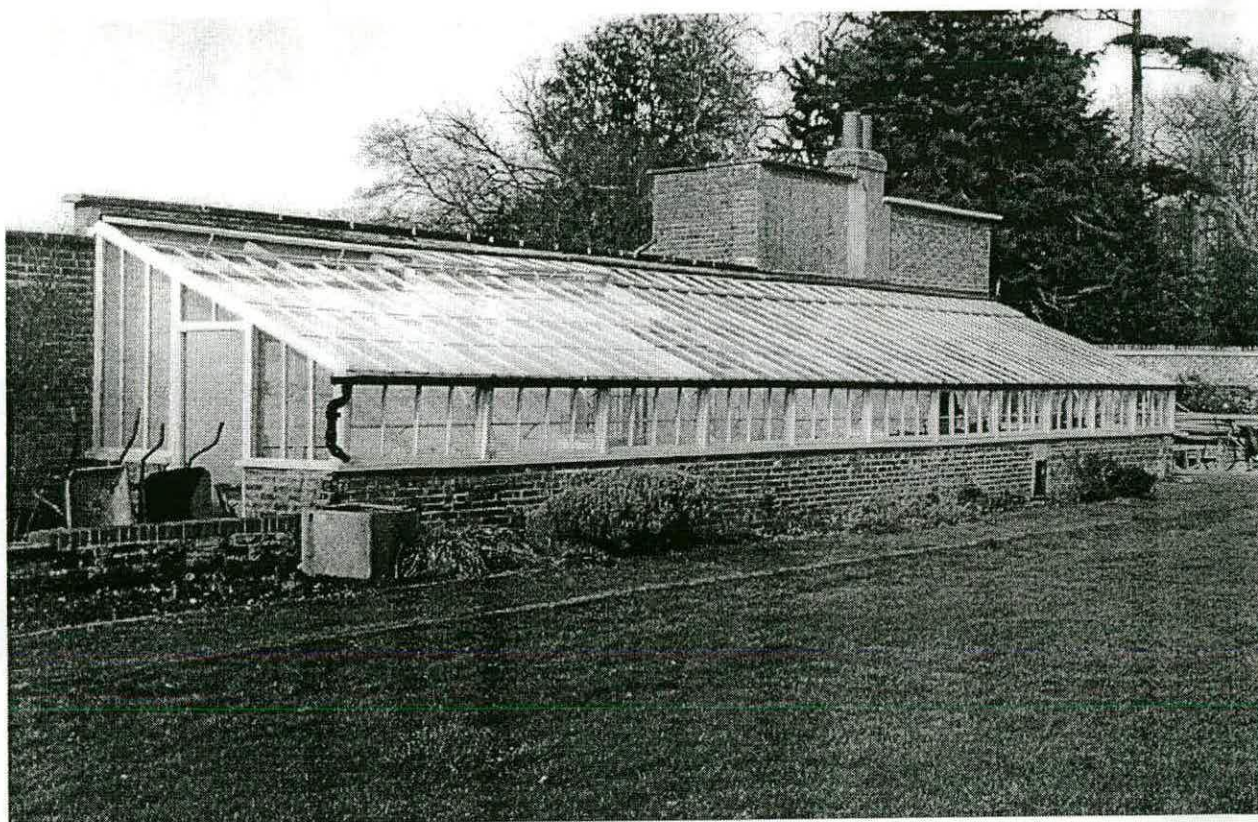
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Down House Bromley Kent

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Historical Analysis and Research
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Introduction

The following report was written in response to a request for advice from Tracy Thursfield, General Manager at Down House and Nick Biddle, Gardens Curator, Historic Properties, London. The request followed works in the greenhouse associated with the installation of a new heating system, during which the historic heating system was exposed. I visited the site on 12 and 19 March 1998.

In July 1996, I drafted a preliminary report on the greenhouse complex, in which I established a broad phasing sequence for the structure.¹ This was refined and expanded by Keystone in February 1997.² They also provided a date for the reduction in the overall size of the greenhouse in 1898 and its reroofing in 1899.

However, the phasing sequence for the greenhouse complex outlined in my report and by Keystone in 1997 had to be revised following advice from Janet Browne at the Darwin Letters Project, that Darwin's first green house at Down was built in the winter of 1855-6.³ Although this advice does not alter the sequence of construction identified in those reports, it does change the date ascribed to each phase. It also significantly alters our understanding of the design and function of the various phases of building.

The revised sequence for the development of the greenhouse complex set out in the following table is now illustrated in **Figure 3** to **Figure 21**.

PHASE	DESCRIPTION	DATE	FIGURE
Phase 1	The kitchen garden walls and associated structures	before 1845	Figure 1
Phase 2	The construction of the first greenhouse	winter 1855-6	Figure 3
Phase 3	The construction of the hothouse	winter 1863	Figure 5
Phase 4	Extension of the hothouse/greenhouse	Spring 1864	Figure 13
Phase 5	Final addition at the west end and construction of laboratory	after 1868-9, probably 1881	Figure 18
Phase 8	Reduction in length of greenhouse and re-roofing	1898-9	Figure 21

The cast iron pipes exposed on 12/3/98 appear to date from the construction of the hothouse in 1863, its extension in 1864 and alterations around 1881. The heating system appears to have been abandoned in the overhaul of 1898-9.

¹ Lea R, 1996

² Keystone Historic Buildings Consultancy, 1997

³ Janet Browne's advice is based on a note by Dr J R Topham of the Darwin Letters Project dated 26/2/97 and reproduced in this report as an appendix

1 The kitchen garden walls and associated structures, 1845

The structures shown in **Figure 1** include the north orchard wall which enclosed land purchased by Darwin in 1845. Since there was no property boundary included on this line on the Tithe Map of 1840, the north orchard wall presumably dates from 1845. The lean-to structure against the east wall of the kitchen garden is of unknown date and purpose. It was shown on the 1868-9 OS map as a roofed building.

2 The construction of the first greenhouse, 1855-6

In a letter to Joseph Dalton Hooker of 19 April [1855] (*Correspondence vol.5*) Darwin said that he did not have a greenhouse. However, this soon changed. An entry in his Classed Account Book (Down House Ms) for 1 February 1856 indicates that he paid £67 to John Strudwick, a builder from Westerham, to build a greenhouse.⁴

The earliest structure in the building sequence for the greenhouse appears to be that at the east end of the present building, although it was reroofed in 1898. Its construction differs from the later work, in that the bricks are laid on edge as rat trap bond. This first greenhouse appears to have been unheated, **Figure 3**.

3 The first hothouse built in the winter of 1862/3

The first addition to the greenhouse, built in 1863, was described by Darwin in his correspondence as a 'hothouse.' This new building was explicitly designed for 'experimental purposes' (see *Correspondence, vol. 11*, letter to Thomas Rivers, 15 January [1863]). It was built at the suggestion, and under the superintendence, of John Horwood, gardener to Darwin's neighbour, George Henry Turnbull.⁵ Horwood had charge of the hothouses at his master's house, of which Darwin had 'free use' while preparing his book on orchids in 1861 and 1862.⁶ The hothouse was built in January and February 1863, and cost a total of £75 15s. 3d.⁶

The hothouse was built with a raised bed on the south side of the walkway. It was heated by a loop of 4" cast iron pipes set against the side of the bed. Hot water for the pipes was provided by a cast iron jacket set in the exterior face of the south wall. The 4" pipes simply returned through the east end of the raised bed into the back of the jacket. It was a sealed system without a header tank. The water circulated by convection. There was a drainage tap hole at the bottom of the front of the jacket. In 1997, the tap had been removed. There were small holes in the 4" pipe at the far end of the loop and in the lower pipe where it returned through the bed. These presumably allowed air to escape when the system was filled or topped up. The water jacket probably incorporated a brazier-like front and was fed with coal. It would have been important to prevent the fumes from the jacket from entering the hothouse.

The 4" diameter iron pipes were cast in 9' lengths. At 3' intervals, the annulus was formed as part of the casting around the pipe. A sleeve joint with two annular rings formed part of the casting at one end of each length of pipe. It is not clear whether the purpose of these rings was decorative or functional. Their inclusion in the design may have eased the casting process. Joints between pipes

⁴ Topham, 1997

⁵ According to Desmond and Moore, Horwood was Lubbock's gardener at Nine Elms. Also according to Atkins, 1974, page 29, in a letter now in the Down House collection, Darwin wrote to Sir John Lubbock thanking him for 'allowing Horwood to superintend the erection' of the hothouse

⁶ Topham, 1997

were made watertight by the insertion of the plain end of one pipe into the sleeve of another and sealed with lime putty.

The 4" pipes attached to the side of the raised beds in the middle section of the greenhouse appear in the view by Alfred Parsons, drawn in the summer of 1882 and published in the *Century Magazine* in 1883.

4 The extending of the hothouse/greenhouse in the spring of 1864

In a letter of 26[--7] March 1864 (*Correspondence vol. 12*), Darwin told Hooker, 'I am so magnificent that I am thinking of building a large greenhouse & turning the present greenhouse into a cool stove.' His *Classed Account Book* (Down House Ms) record that on 14 April 1864 he paid Horwood £14 for "Iron Pipes for Hothouse." On 30 June and 9 July he paid out a total of £112 10s. for a new greenhouse, mostly to William Ledger, a builder of Hayes, Bromley, but also a small sum to Horwood, apparently again for "Iron Pipes."⁷ The extended greenhouse was recorded on the OS map of 1868-9.

The heating system for the extended greenhouse was entirely independent of the earlier hothouse system although it did include a loop of 4" pipes set inside the raised bed of the hothouse. It is not clear whether both systems were used or if the earlier stem was abandoned with the introduction of the second.

On the north side of the hothouse and in the eastern greenhouse, 2" pipes were set below floor level in a channel formed by reused floor slabs set on edge. The pipes were supported within the channel by cross walls of brick set at intervals of approximately 900mm. There were no traces of the original covering of this channel. It might have been covered either with an iron grille or with floor flags. The absence of any evidence for an iron frame, however, suggests that stone is more likely than iron.

The pipes were laid in pairs. The lower pipe rises from the east, indicating that the boiler was located to the east of the first greenhouse. At the east end of the hothouse, the 2" pipes branch south and continue westwards. The southern branch presumably links up with the 4" pipes to heat the hothouse and the first greenhouse. The westward branch presumably heated the extension to the hothouse. The loop, in what was then the westernmost section of the greenhouse, appears to have been replaced in 1881 (see below).

The 2" pipes matched the 4" pipes in style and construction and employed the same system of jointing. They were cast in 6' lengths. Additional castings employed in the system include a 'T' joint in the 2" pipe, a stop valve with a copper alloy lever in 2" pipe, a stop valve cast with a short length of conical pipe converting 2" to 4" pipe, a large 'L' bend converting 2" to 4" pipe, 'L' and 'U' bends in 4" pipe.

This system was much larger than the original hothouse system. It would have required a much larger heat source.

The greenhouse in this phase is shown on the OS map of 1868/9.

⁷ Topham, 1997

5 The final addition to the hothouse/greenhouse and the construction of the laboratory, 1881

The date of the construction of the laboratory and the final addition to the greenhouse which appears to have been executed in the same brickwork is not documented. However, the land on which the laboratory was built did not come into Darwin's possession until 1881. This therefore seems to be the most likely date for this last phase of additions.

The original hothouse heating system was extended to heat the west section of the present greenhouse and its final western addition. The extension to the plumbing consisted of 2" pipes in 6' lengths with bolted cast joints sealed with bitumen. The pipes were cast without the annular rings which characterise the earlier system. The extension also included a loop which provided heat for the small lean-to structure on the north side of the garden wall which appears to belong to the same phase.

In the eastern section of the greenhouse, the original return pipe appears to have been altered or repaired using bolted joint types sealed with bitumen which belong to this phase.

6 The reduction in the size of the hothouse/greenhouse and the disuse of the heating system, 1898

In 1898 the greenhouse was reduced in overall length and reroofed with a mechanism for operating the opening and closing of the windows. The parts were stamped with the name Boulton and Paul of Norwich. They probably also supplied the timber and glass for the roof structure.⁸

The greenhouse was reduced in size when the western half of the greenhouse was abandoned. Although the brick walls were left standing and still survive today, only the eastern half was reroofed with equipment supplied by Boulton and Paul of Norwich. The pipe for the abandoned half of the green house was left in-situ. There were no signs that any attempt had been made to contain the water in the eastern half of the greenhouse. This indicates that the heating system was no longer in use when the greenhouse was reduced in size.

⁸ Keystone, 1997

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Lea R, *Down House Bromley Kent, Notes on the historic development of the greenhouse and laboratory complex in the gardens of Down House*, July 1996

Topham J R, *Hothouses at Down House: some history* Notes for the Darwin Letters Project, 26/2/97
(attached here as an appendix)

Figure 1 An axonometric sketch reconstruction of Phase 1, the kitchen garden walls and associated structures

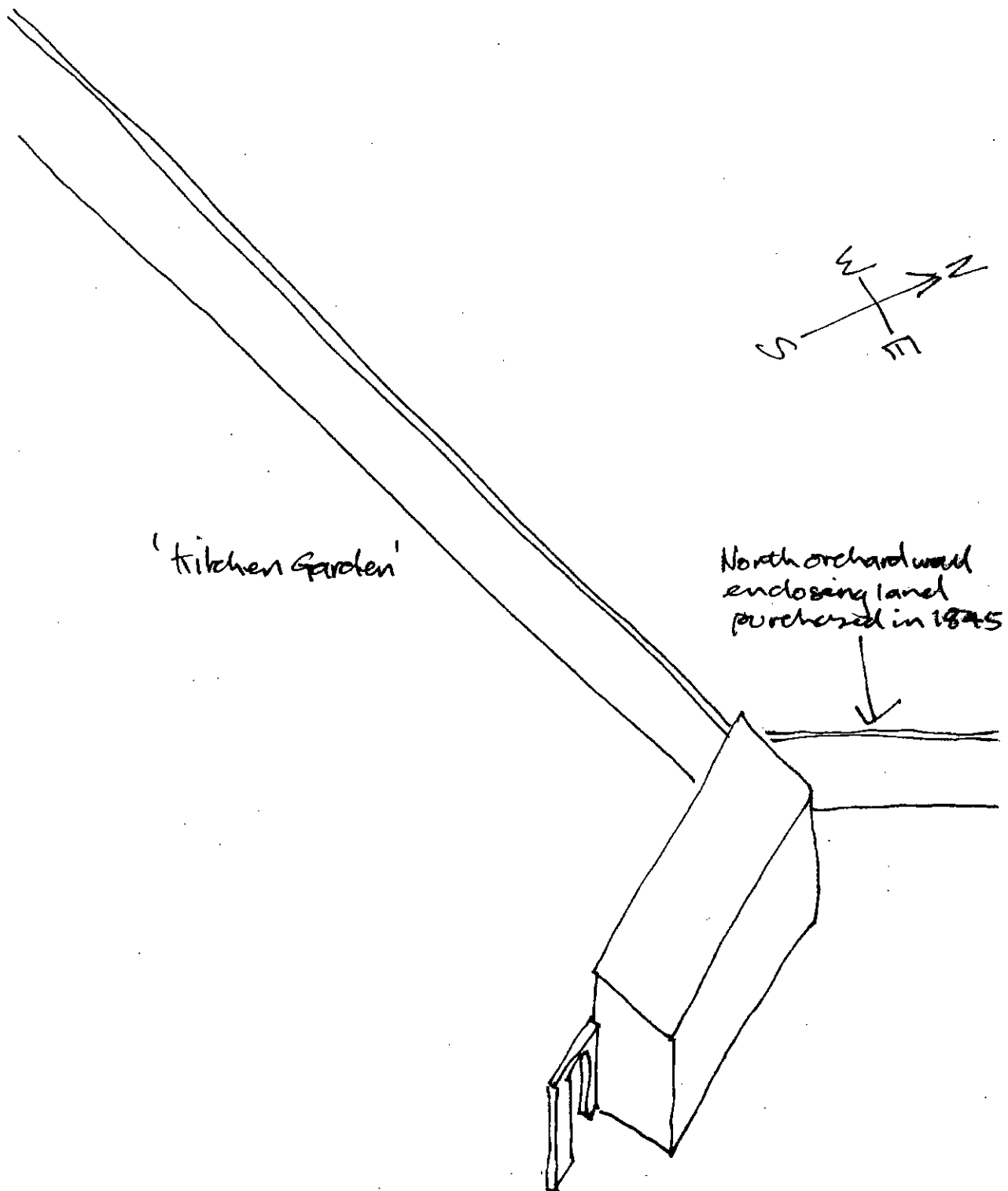


Figure 2 Simplified plan of the garden wall and greenhouse built in 1856

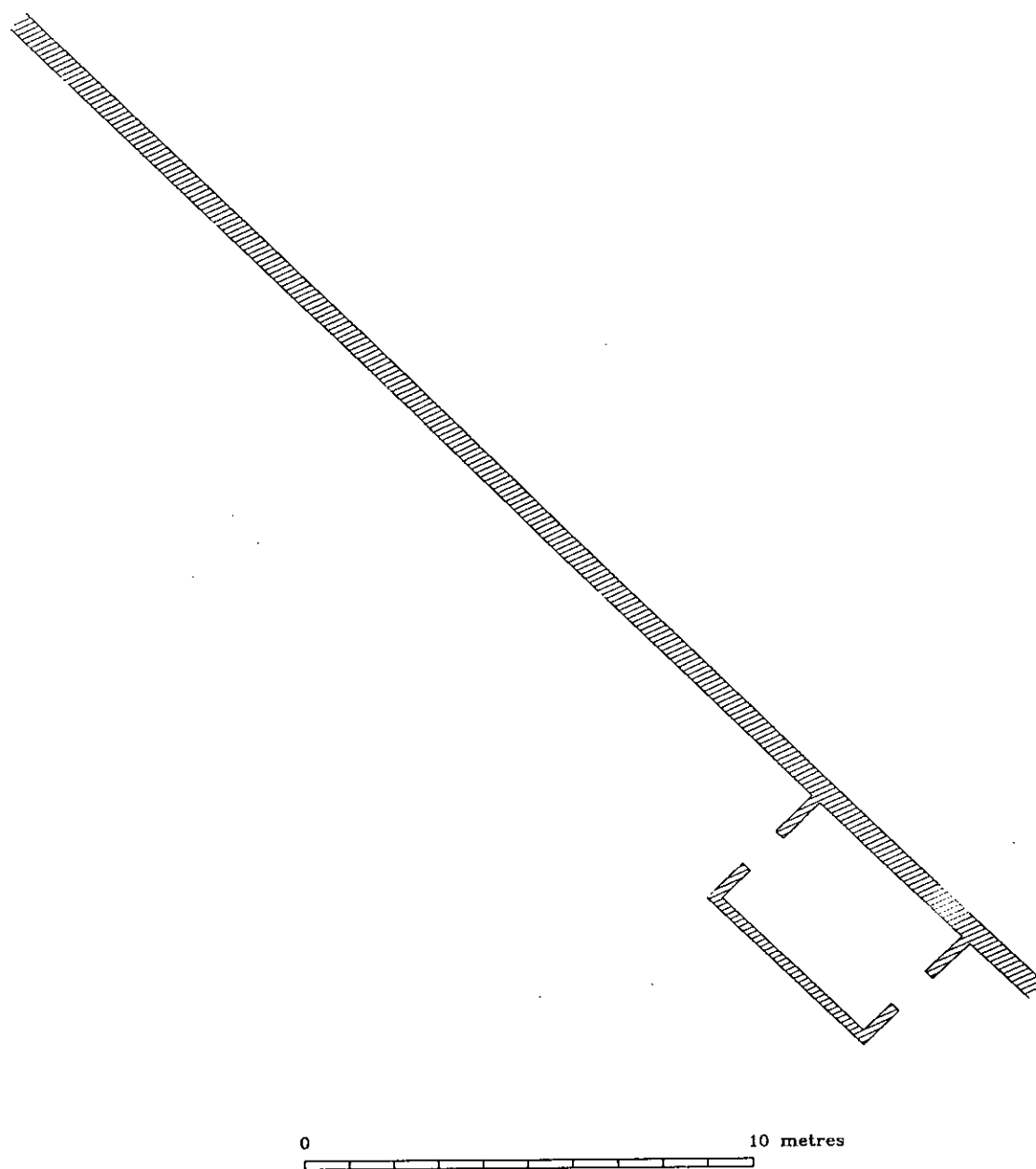


Figure 3 An axonometric sketch reconstruction of Phase 2, the construction of the first greenhouse in the winter of 1855-6

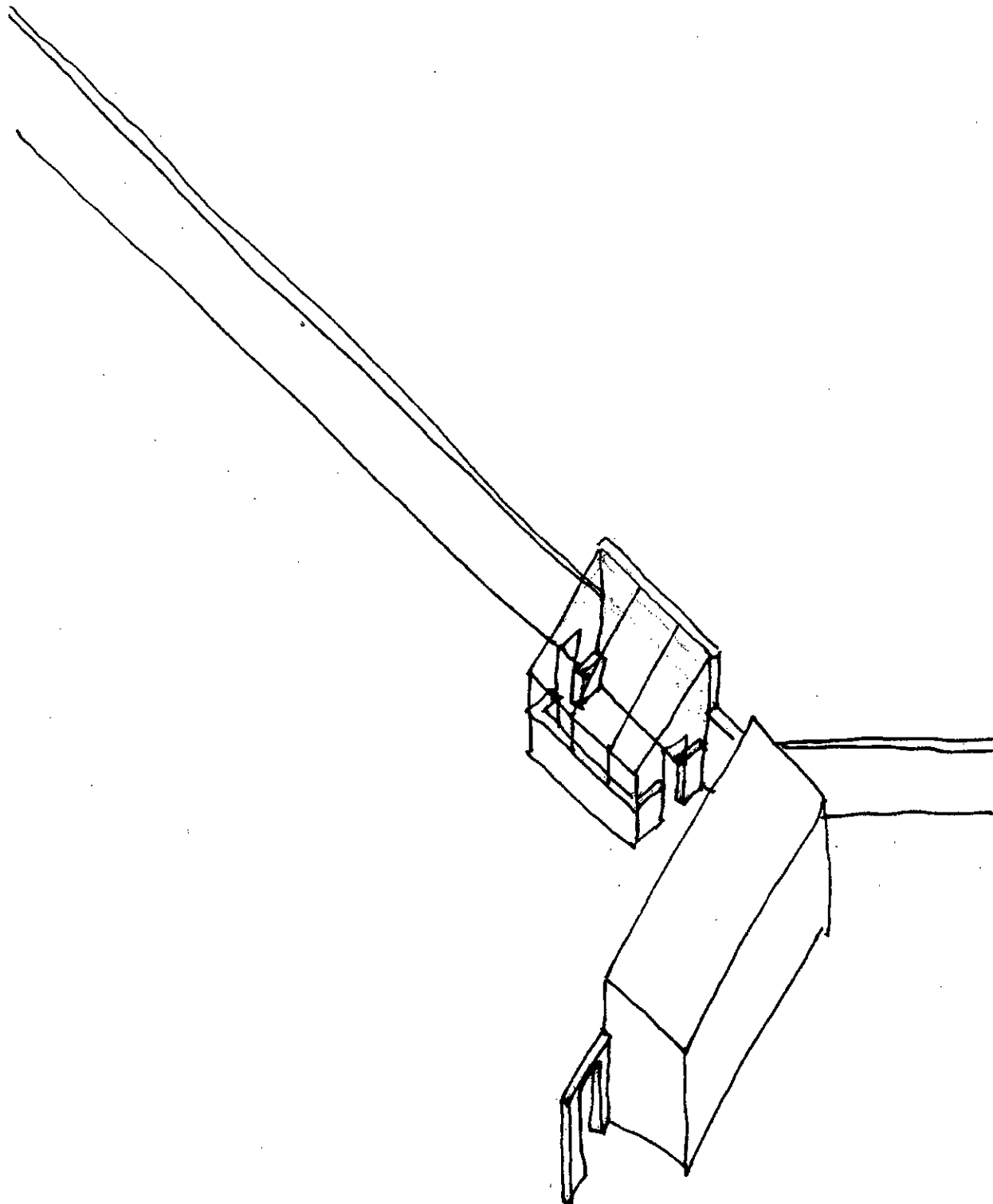


Figure 4 Plan of the 1863 hothouse addition to the greenhouse, with hot water jacket in the south wall and 4" pipes returning along the side of the raised bed

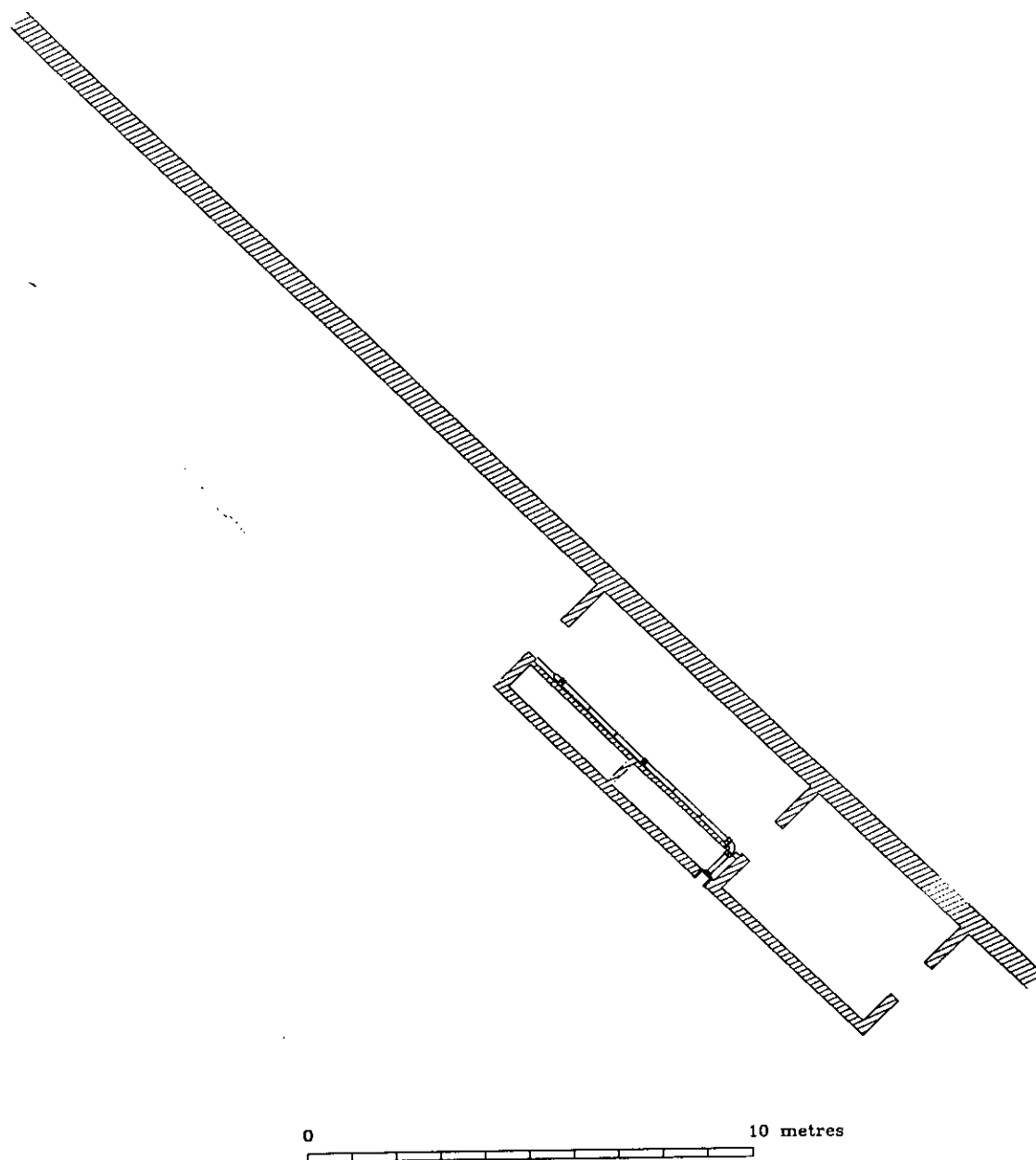


Figure 5 An axonometric sketch reconstruction of Phase 3, the hothouse, built early in 1863

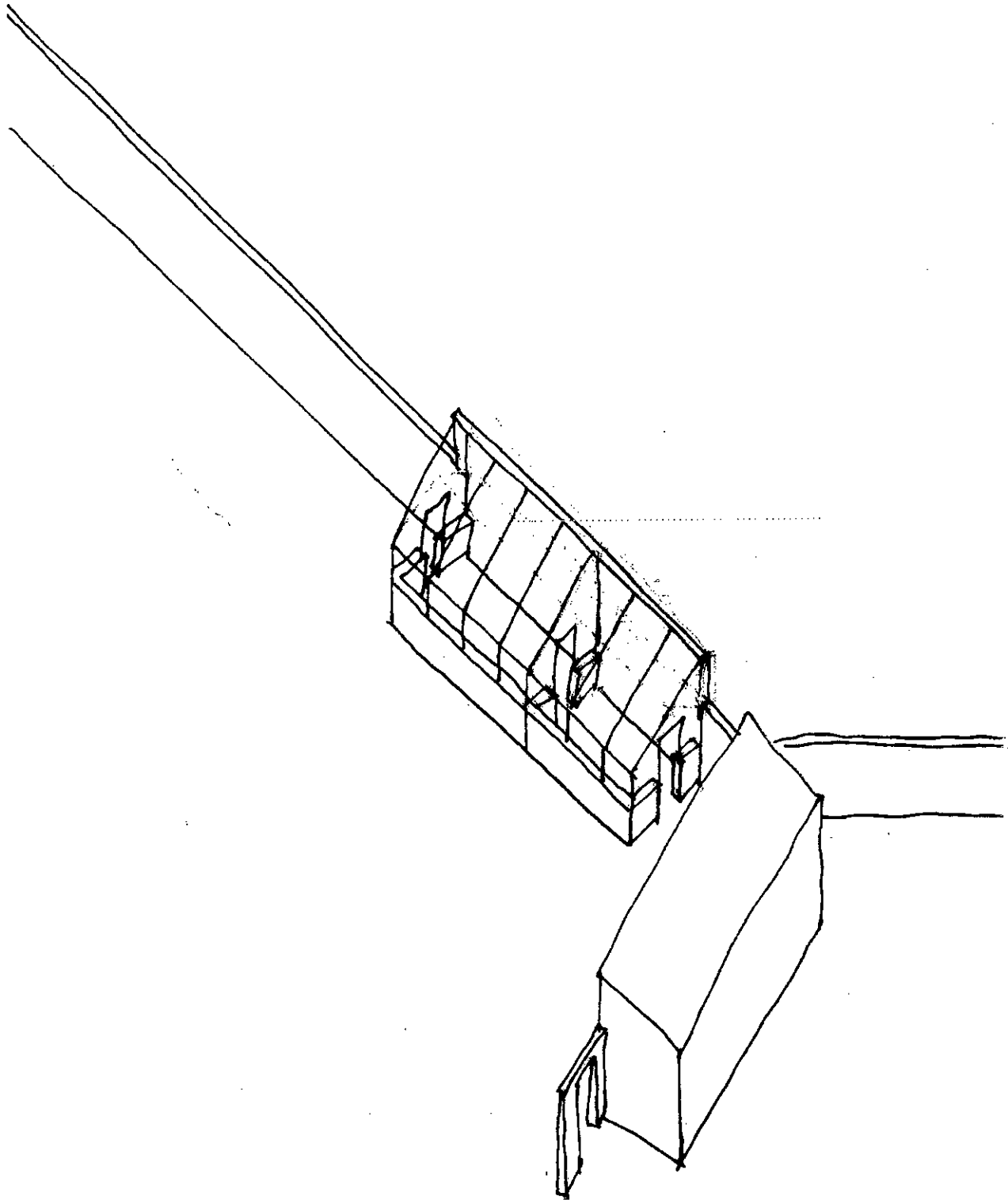


Figure 6 Front of the water jacket set in the south wall of the hothouse of 1863

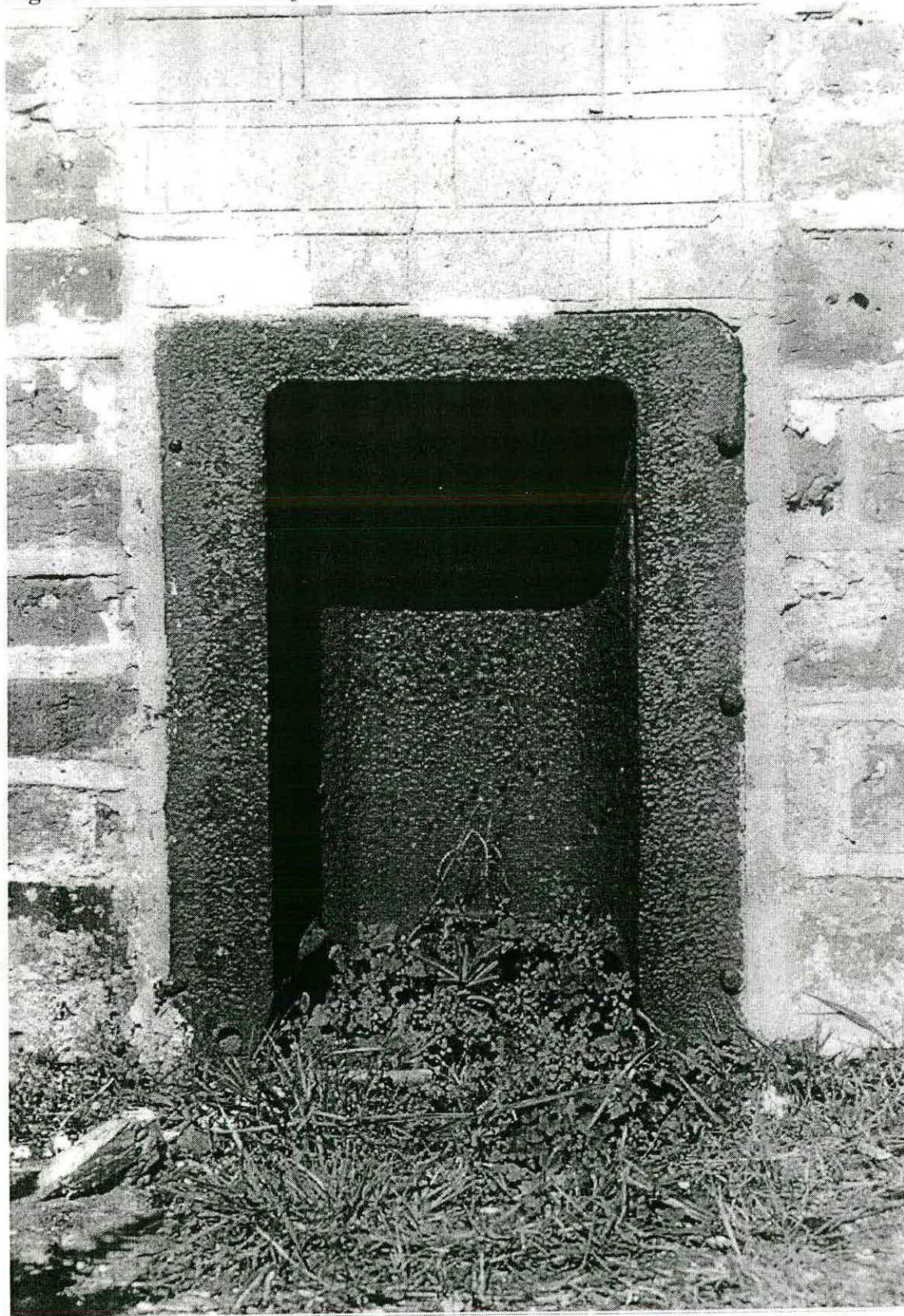


Figure 7 Back of the water jacket set in the south wall of the hothouse of 1863, with the original 4" pipes. The curved pipe belongs to the 1864 extension.



Figure 8 "L" bends in the 4" pipe along the side of the raised bed, installed in the hothouse in 1863

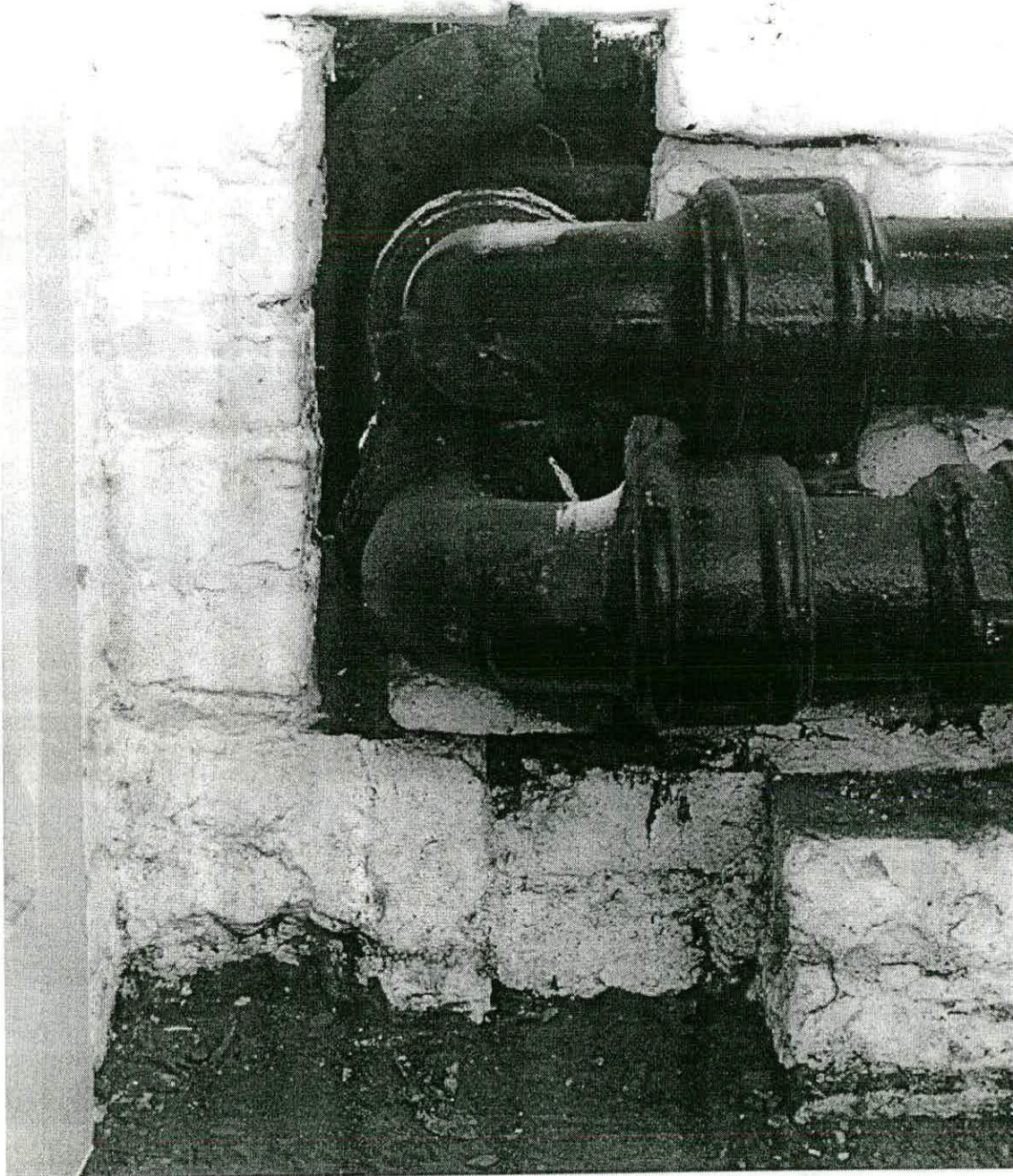


Figure 9 Annular rings cast in the 4" pipes installed along the side of the raised bed in the hothouse of 1863

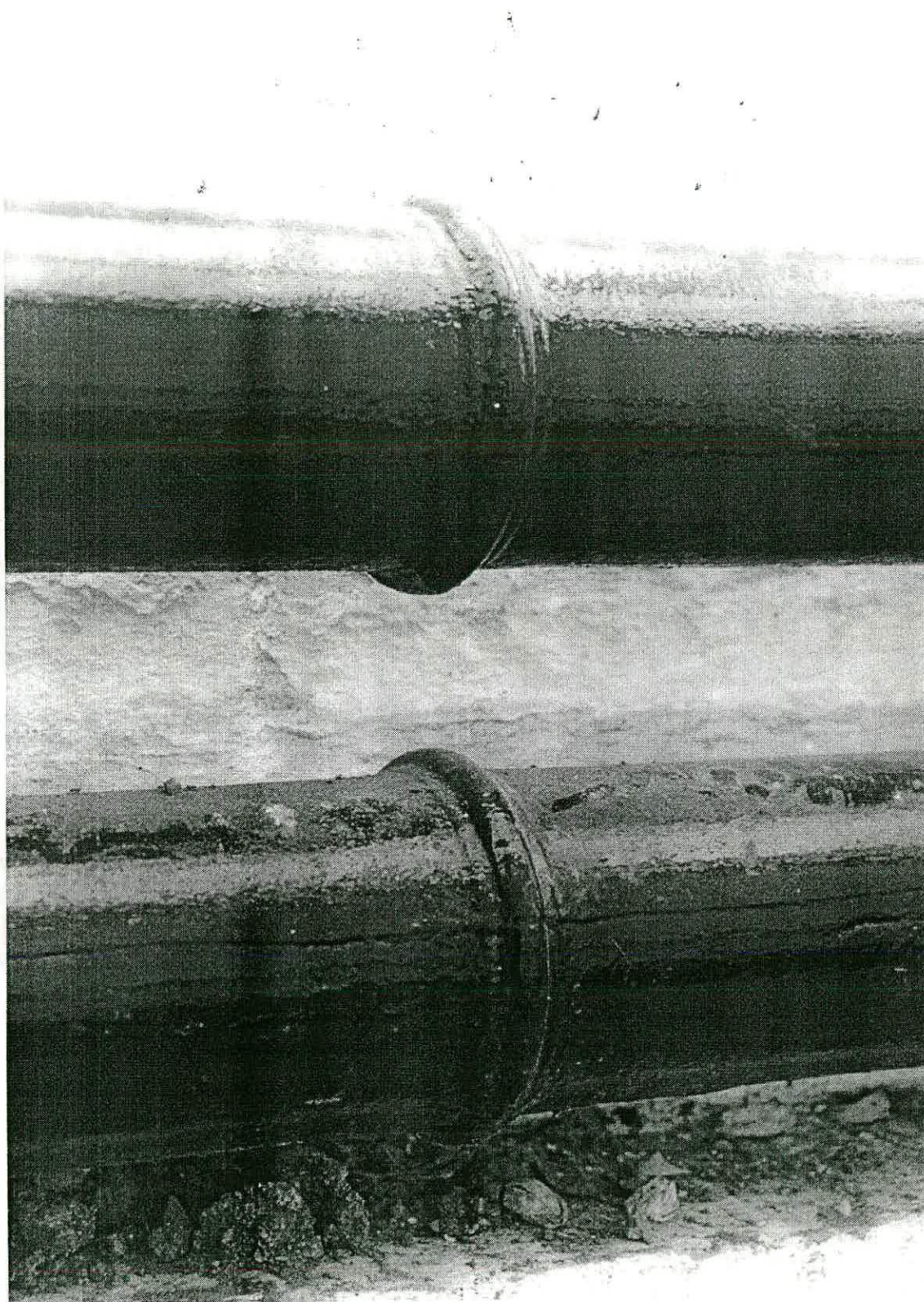


Figure 10 Joints in the 4" cast iron pipes on the side of the raised bed original to the hothouse of 1863

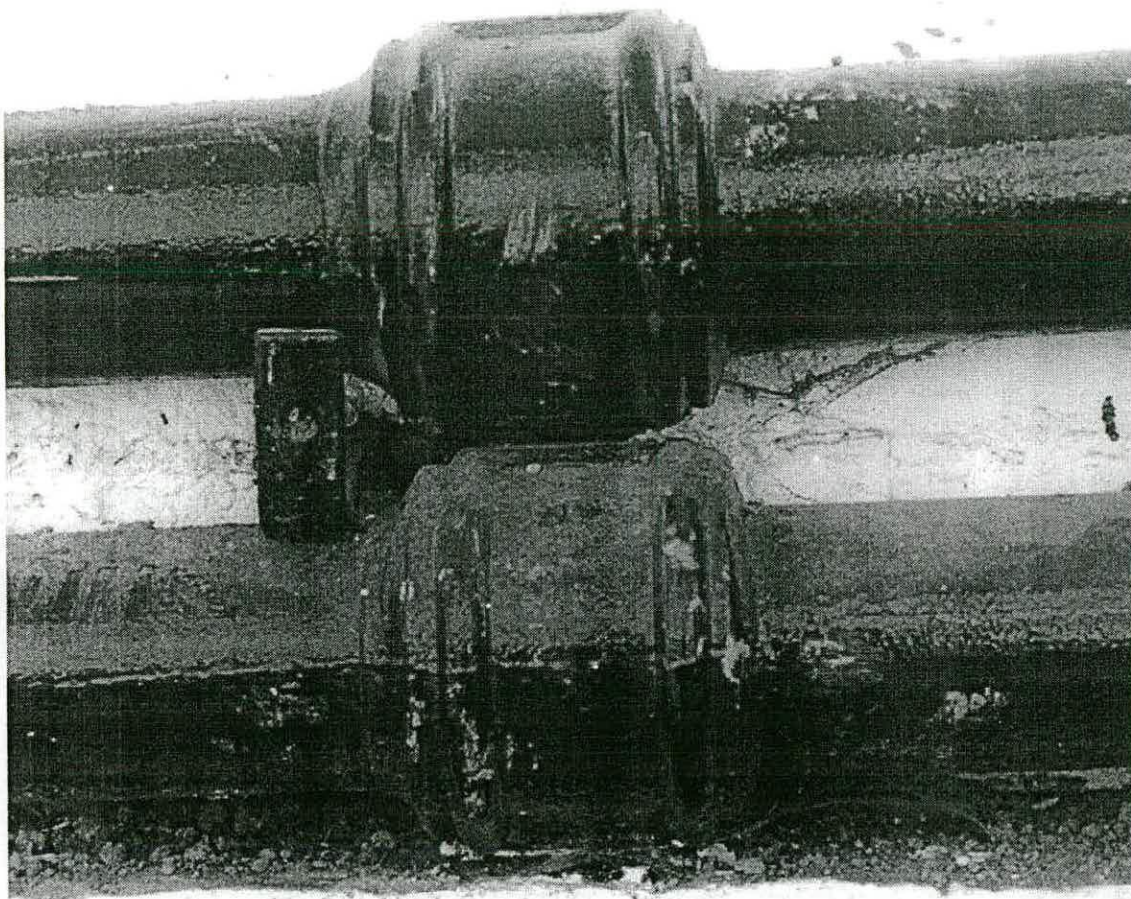


Figure 11 The “U” bend in the cast iron pipes along the side of the raised bed in the hothouse of 1863

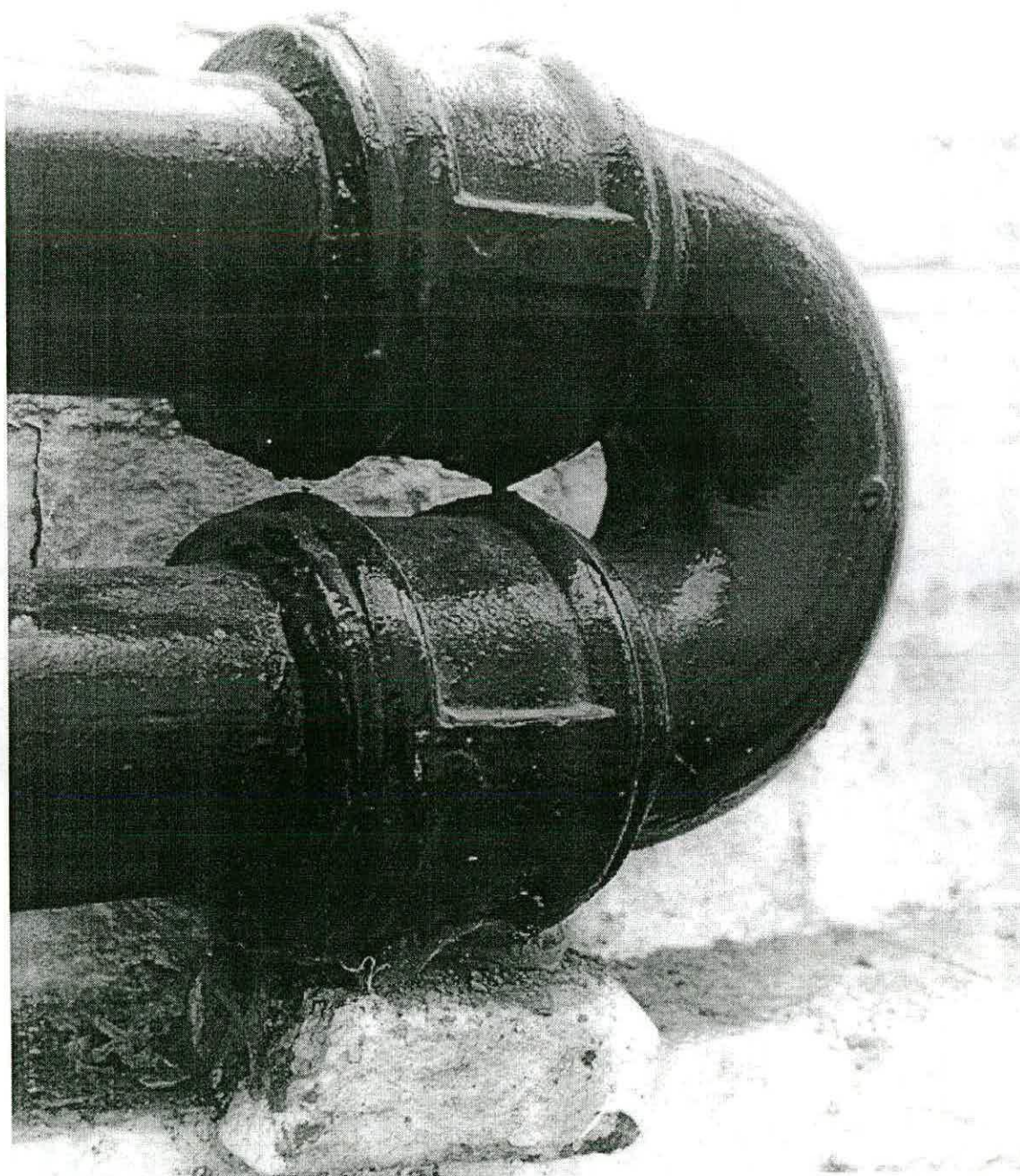


Figure 12 Simplified plan of the extension to the hothouse, added in 1864

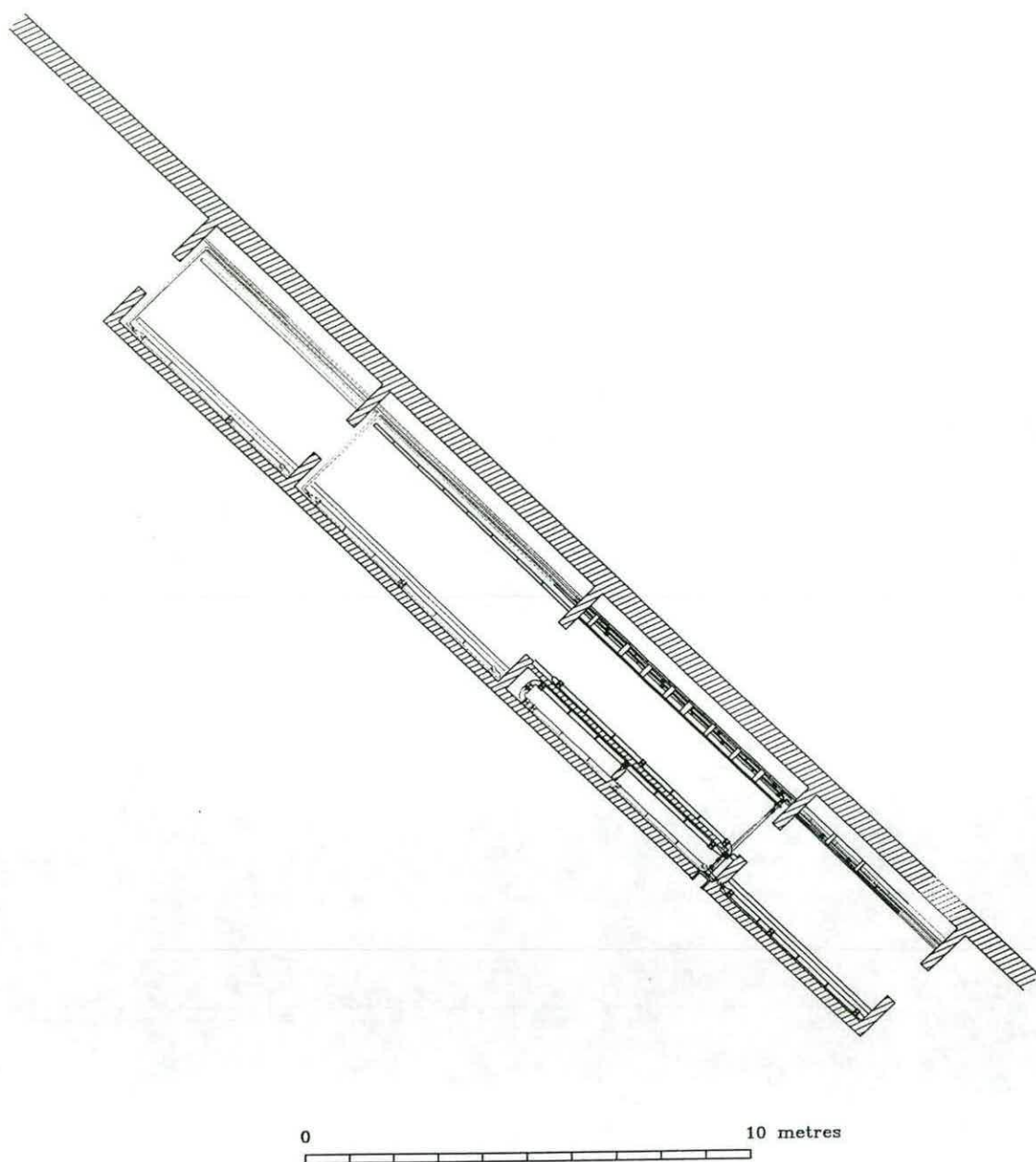


Figure 13 An axonometric sketch reconstruction of Phase 4, the extension of the hothouse/greenhouse in the spring of 1864

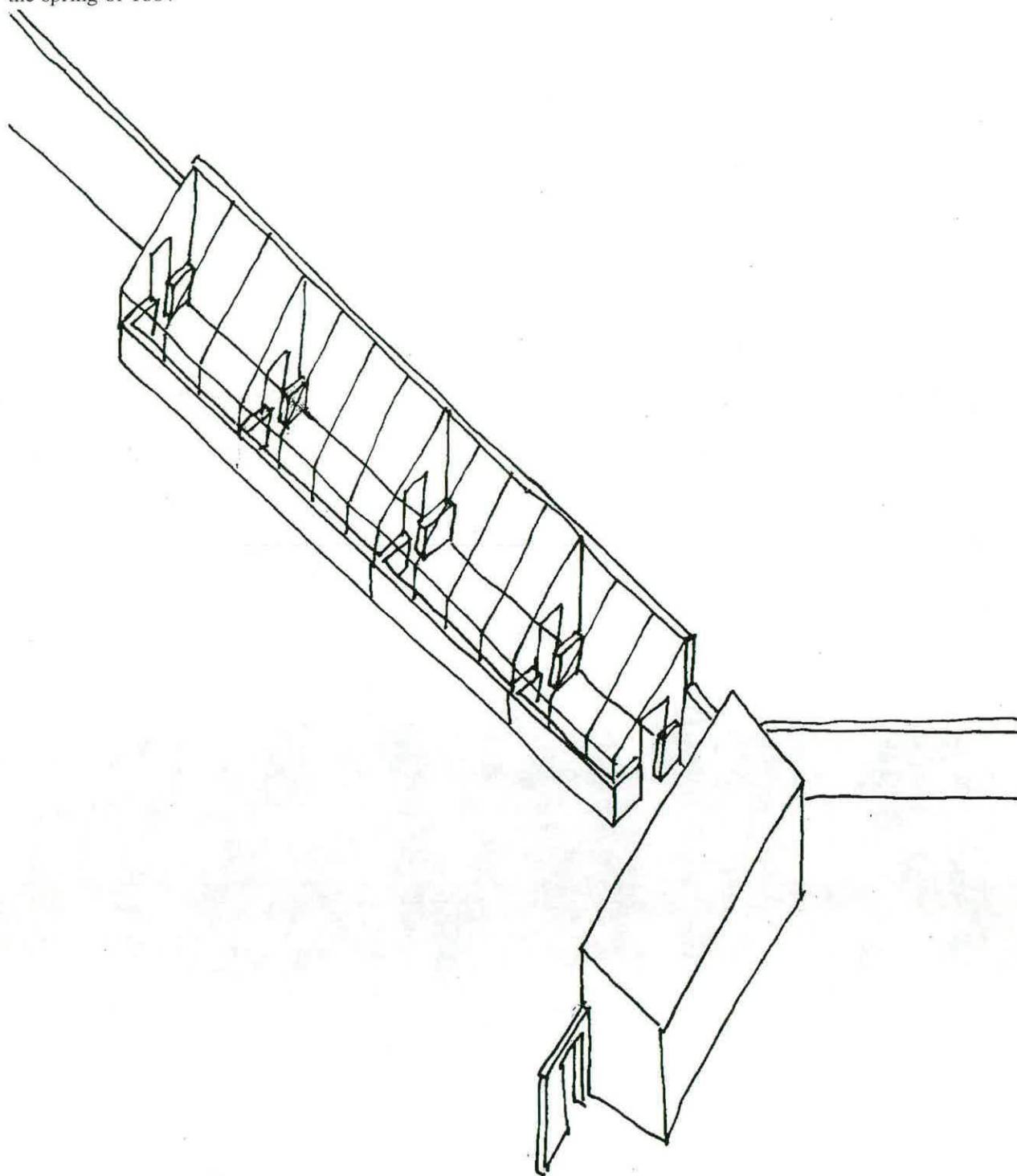


Figure 14 The channel on the north side of the hothouse for the 2" pipes, part of the heating system for the extended hothouse, dating from 1864



Figure 15 A stop valve in a 2" pipe dating from the extension to the hothouse in 1864

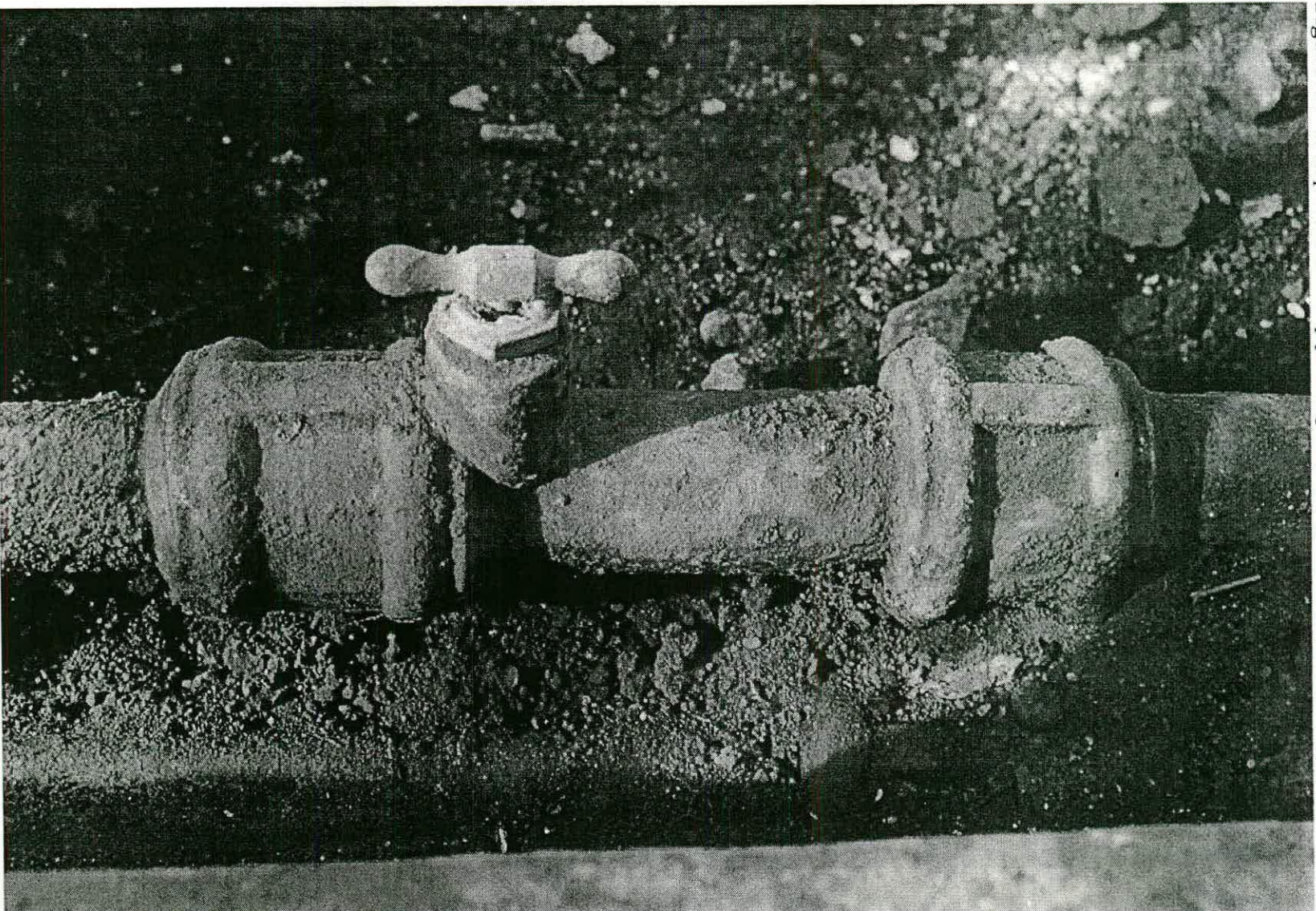


Figure 16 Stop valve and converter from 4" to 2" pipe in the southwest corner of the first greenhouse of 1856, part of the system installed in 1864



Figure 17 Simplified plan of the heating system in the greenhouse and laboratory complex, of 1881

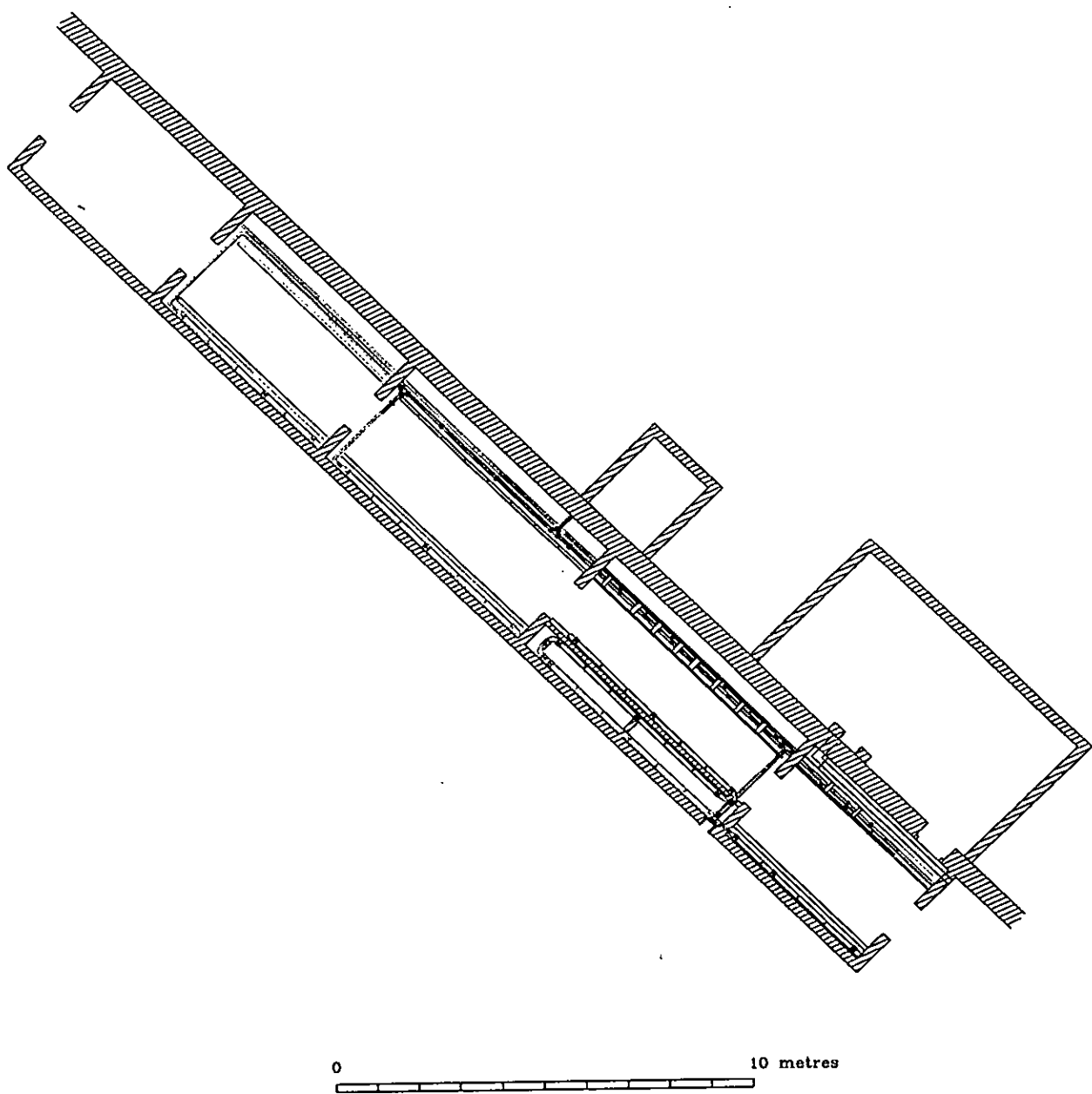


Figure 18 An axonometric sketch reconstruction of Phase 5, the final addition at the west end and construction of laboratory some time after 1868-9, probably 1881

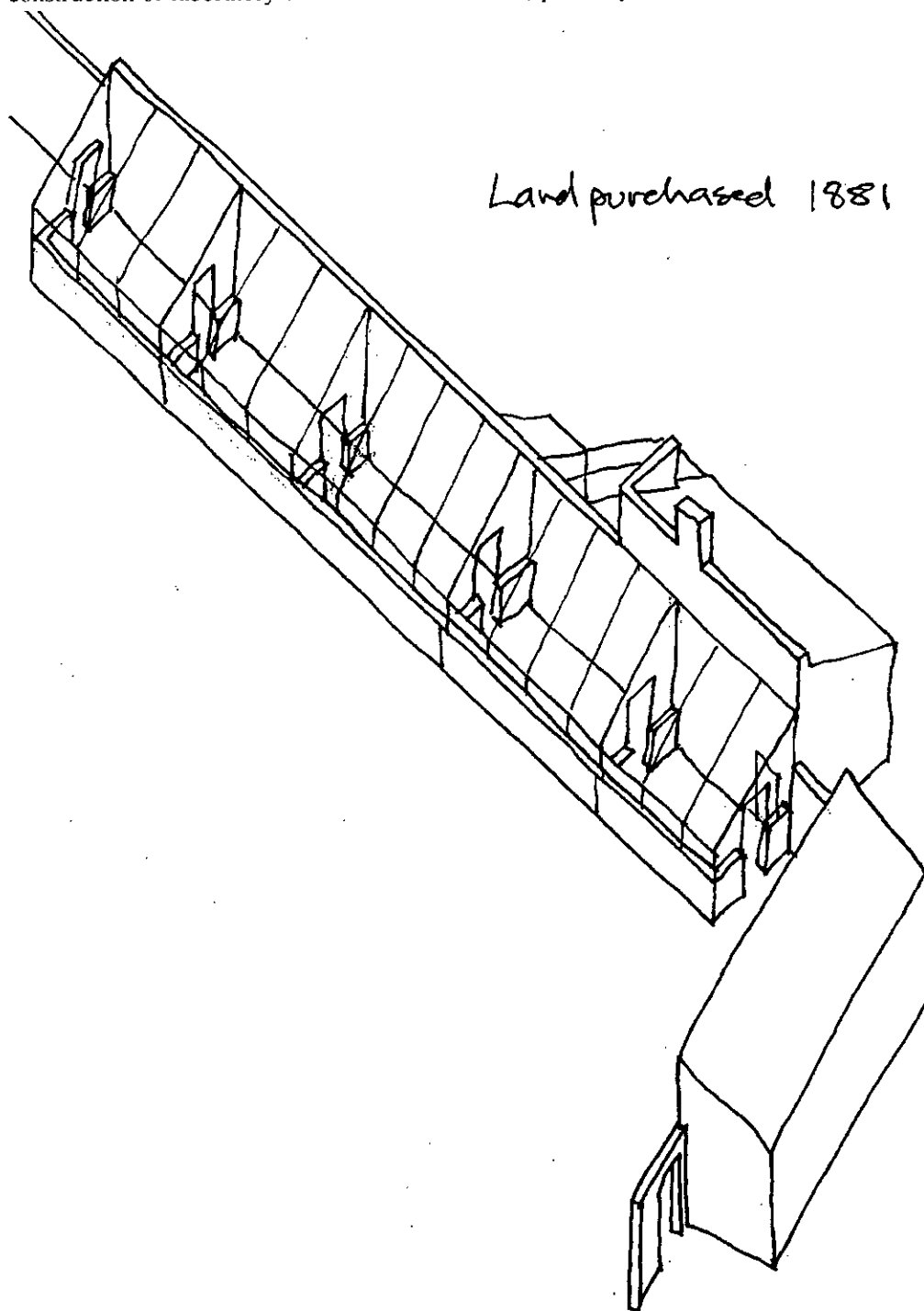


Figure 19 "T" joint in the 2" pipes in the west section of the present greenhouse, at the branch forming a loop to heat the small lean-to on the north side of the garden wall, part of the heating system installed probably in 1881

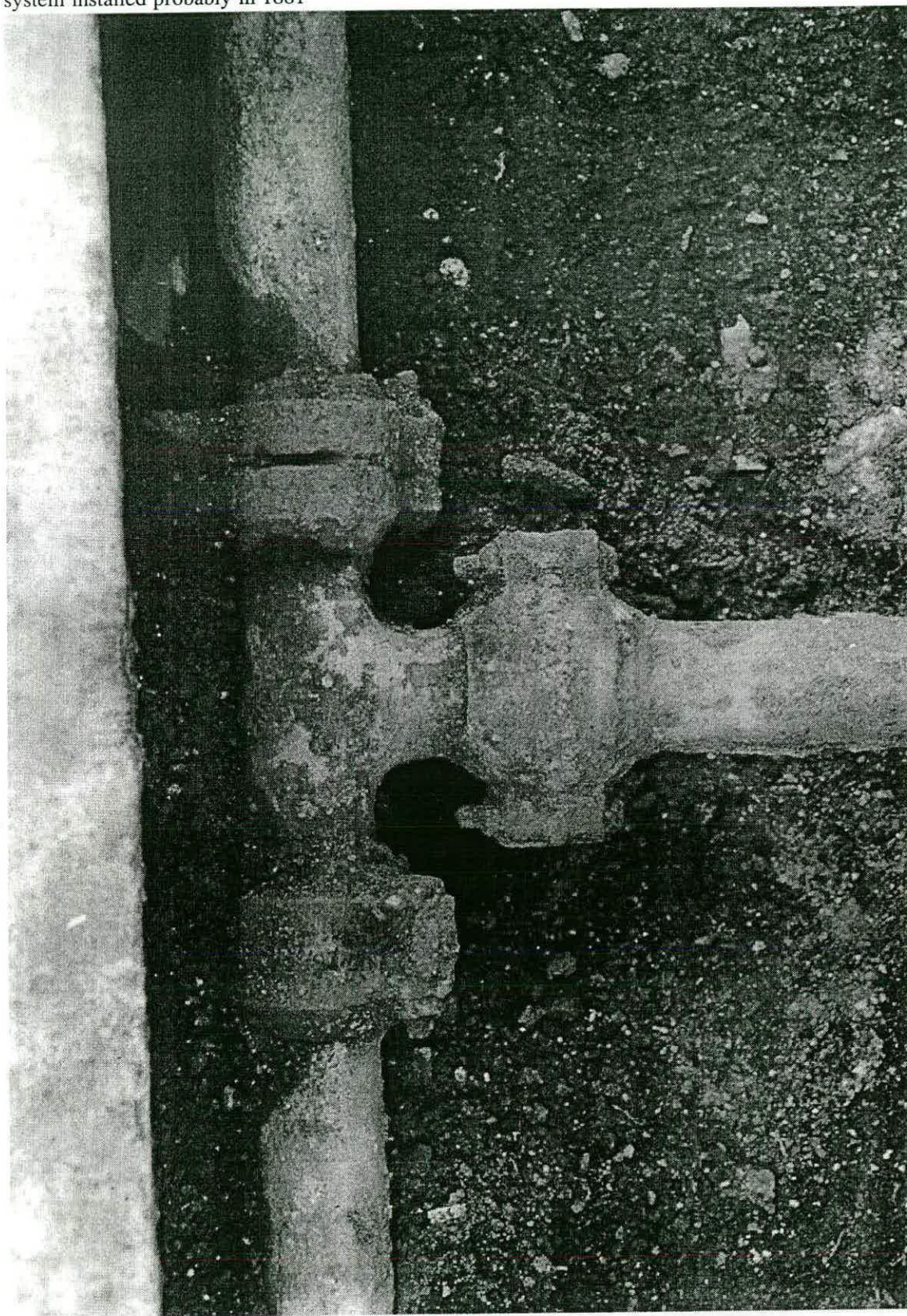
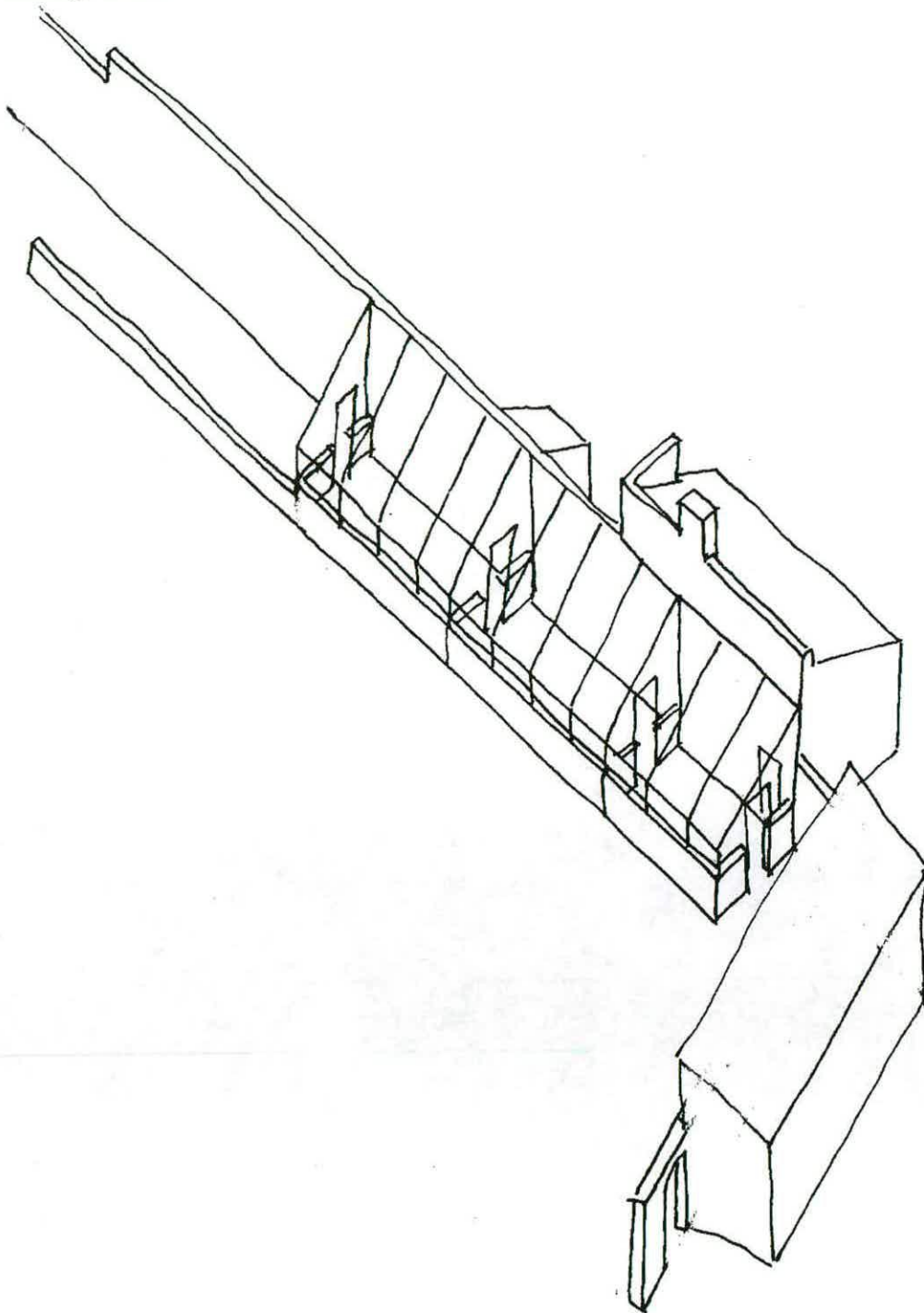


Figure 20 A bolted joint in the 2" pipes in the channel on the north side of the first greenhouse of 1856, probably a repair contemporary with the construction of the laboratory in 1881



Figure 21 An axonometric sketch reconstruction of Phase 8, the reduction in length of greenhouse and re-roofing, 1898-9



Appendix: Hothouses at Down House: some history by Dr JR Topham, Darwin Letters Project

First, some terminology. According to John Claudius Loudon's *Encyclopedia of gardening* (1834), a book which Darwin obtained in 1841, the word "hothouse" has two meanings. It is applied, firstly, to all forms of protected plant accommodation, including cold frames, glass cases, greenhouses, orangeries, conservatories, dry-stoves, and moist-stoves (p. 1012). In addition, however, it has a more particular meaning as a synonym of a moist-stove (p.1100), and it is apparently in this sense that Darwin used it.

Darwin's first construction in the Down House garden was a greenhouse (possibly heated), built in the winter of 1855-56. In a letter to Joseph Dalton Hooker of 19 April [1855] (*Correspondence* vol. 5), Darwin stated that he did not have a greenhouse. An entry in his Classed account book (Down House MS) for 1 February 1856 indicates that he paid £67 to John Strudwick, a builder from Westerham, to build a greenhouse. Thereafter, there are frequent references in the correspondence to Darwin's using this new construction.

Darwin's second construction was a small hothouse, built in the winter of 1863-64. This new building was explicitly designed for "experimental purposes" (see *Correspondence* vol. 11, letter to Thomas Rivers, 15 January [1863]). It was built at the suggestion, and under the superintendence, of John Horwood, gardener to Darwin's neighbour, George Henry Turnbull. Horwood had charge of the hothouses at his master's house, of which Darwin had had "free use" while preparing his book on orchids in 1861 and 1862. The hothouse was built in January and February 1863, and cost a total of £75 15s. 3d.

Following his success with this first hothouse, Darwin decided in the spring of 1864 that he would expand his range of glasshouses further. In a letter of 26[--7] March 1864 (*Correspondence* vol. 12), he told Hooker: "I am so magnificent that I am thinking of building a large greenhouse & turning the present green house into a cool Stove." His Classed account books (Down House MS) record that on 14 April 1864 he paid Horwood £14 for "Iron Pipes for Hothouse". On 30 June and 9 July he paid out a total of £112 10s. for a new greenhouse, mostly to William Ledger, a builder of Hayes, Bromley, but also a small sum to Horwood, apparently again for "Iron Pipes". The suggestion of pipes clearly implies that the new greenhouse was heated, at least in part.

There are several references to the various glasshouses at Down House in subsequent correspondence, but the most illuminating is Darwin's statement in a letter to W. C. Tait, 6 March [1869], that he had "4 [glass]houses of different temperatures." Taken together with this, Hooker's later reference to Darwin's "warmer greenhouse" implies that the new, large greenhouse built in 1864, actually comprised two separate sections, kept at different temperatures.

I would speculate that the large greenhouse built in 1864 is the one that remains at Down House today. In *Life and letters*, Francis Darwin stated that his father's daily visits to the greenhouse, "where he looked at any germinating seeds or experimental plants which required a casual examination" preceded his constitutional round the Sandwalk--a piece of geographical information which certainly supports this supposition. Moreover, an engraving at the New York Botanical Garden, labelled "the greenhouse in which Mr. Darwin's experiments and observations were made", shows an internal view apparently of the existing greenhouse, with several subdivisions (though only one internal door is visible), and iron pipes in at least one section. This all seems consistent with the idea that the greenhouse had two sections kept at different temperatures.

The two hothouses must, I would suggest, have been demolished at some later period. The hothouse built in 1863 was apparently "more than 100 yards" from the house (see letter to J. D. Hooker, [25 January 1864]), but nothing else is known of its location.