Statement of Andrew Fulton, 3 Feb 2012

Annexure 5

QUEENSLAND FLOODS COMMISSION OF INQUIRY

Request to Provide Further Written Information to Queensland Floods Commission of Inquiry

Andrew William FULTON, General Manager Infrastructure & Planning Services, Bundaberg Regional Council

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In accordance with *Section 5 of the Commissions of Inquiry Act 1950 (Qld)*, I, Andrew William FULTON, General Manager Infrastructure & Planning Services, Bundaberg Regional Council, provide the following statement of information.

1. **Levels Associated with Murdochs Road Drain**

   1.1 In relation to Mrs Borg's email regarding errors in levels of Murdochs Road drain, I have previously responded through a statutory declaration dated 30 January 2012. The levelling was checked by a registered engineering surveyor and levels were connected to *(permanent survey marker)* PSM54299 (Plan attached) with a published RL3.557 AHD.

2. **Issues Pertaining to Cleaning of the Drain**

   2.1 Council excavated and regraded the Murdoch Road drain in the parcel of land West of Palm View Drive (Lot 1 RP108605) and at the same time removed vegetation in Mr Robinson's property (Lot 6 SP212093), east of Palm View Drive, in October 2010. Photographic evidence of this work having occurred is shown in the two attached photos (P1010633.JPG, IMG_1781.JPG). Further cleaning works were indeed undertaken on Mr Robinsons property (Lot 6 SP212093) and Mr Newports's adjoining property (Lot 29 RP814879) on the 2 December 2010 with photographic

evidence of the work having occurred attached (IMG 1971.JPG, IMG 1972.JPG & IMG 1973.JPG).

2.2 In her email to the Commission Mrs Borg refutes that Council inspections occurred during October 2010. On Page 3900, Line 17-20 of the transcript Mr Ure highlights that the council did indeed enter Mr Robinsons property October 2010 and carried out inspections and cleaning works. This is further evidenced by photos taken during the inspection by council officer Mr Dwayne Honor on the 25 October 2010, as attached (P1010637.JPG, P1010639.JPG, P1010640.JPG, P1010641.JPG).

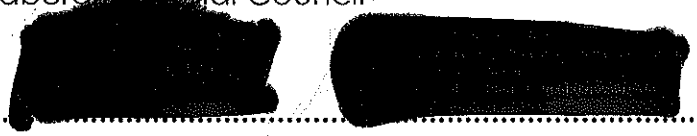
3. **Data Log of High Tide Issues**

3.1 Exhibit 768 provided to the Commission ("Gengers Road Tide Gates" graph) clearly shows that only the peak of the highest tides impact the downstream water surface level at the tide gates. The graph shows that it was not until a 2.98m high tide occurred on Saturday, 24 September 2011 that a difference in water level was recorded by the data logger on the downstream side of the gates.

3.2 Mr Borg stated on Page 3899, line 33-34 of the transcript that it was impossible for the tide to make it to the gates. This is clearly incorrect as shown by the graph. This can be further evidenced in subsequent hydraulic report commissioned by the Bundaberg Regional Council "Murdochs Road Drain – Preliminary Investigation of Drainage Outlets", Cardno, 2 December 2011 which states on Page 4"... *only the peaks of the largest high tides each month can penetrate up the Drain to the downstream side of the tidal bund.*".

Statement Prepared By:-

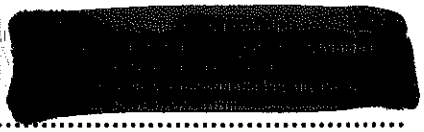
Mr Andrew William FULTON
General Manager Infrastructure & Planning Services
Bundaberg Regional Council



Signature

3 February 2012

Dated

Valerie Andrewartha 

Witness

Murdoch's Road Drain

Preliminary Investigation of Drainage Outlets

Project Number: 29370013

Prepared for Bundaberg Regional Council

2 December 2011

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1	11 November 2011	Michael Della	MD	Garry Lambourne	GL
2	2 December 2011	Michael Della	[redacted]	Garry Lambourne	[redacted]

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1 INTRODUCTION

Murdoch's Road Drain is located within the existing residential area of Moore Park Beach in Bundaberg. A plan showing the location and extent of the Drain is shown in Figure 1.

Bundaberg Regional Council has carried out periodic water level monitoring at a number of locations along the Drain since March 2010. The results of the monitoring show that:

- the water level along the Drain falls at a very slow rate, particularly for levels below approximately 1.3 mAHD; and
- the water surface level is almost uniform along the Drain between the western end of Woodlands Lane and the tidal bund located downstream of Moore Park Road.

This analysis was carried out to investigate options for improving the drainage along Murdoch's Road Drain, so that water levels would fall more quickly following periods of rainfall in the catchment.

2 EXISTING CONDITIONS

Murdoch's Road Drain runs through the middle of the residential area of the township of Moore Park. The drain runs generally parallel to, and on the north-eastern side of, Murdoch's Road and Malvern Drive (refer Figure 1).

The upstream end of the drain is situated near Sylvan Drive. It runs for a distance of approximately 7.5 kilometres in a south-easterly direction, before its confluence with Moore Creek. The Drain passes under a number of road crossings, including:

- Pandanus Street;
- Palm View Drive;
- Ohlaf Street; and
- Moore Park Road.

A number of private driveways also cross over the Drain, particularly in the reach between Palm View Drive and the western end of Woodlands Lane.

Approximately 750 metres downstream of Moore Park Road, a bund has been constructed across the creek to hinder the progress of tidal waters up the waterway. The bund includes three 375 mm diameter pipes, with tide flaps on the downstream face. Thus, the pipes are designed to let stormwater runoff from the upstream catchment to flow through the bund, but stop tidal waters from progressing upstream.

The downstream end of Murdoch's Road Drain is located at the confluence with Moore Creek, approximately 750 metres downstream of the tidal bund.

There is currently dense vegetation growing along the majority of the Murdoch's Road Drain.

3 TOPOGRAPHIC DATA

Airborne Laser Scanning (ALS) topographic data of the Moore Park Beach area was provided by Bundaberg Regional Council. The vertical accuracy of ALS data is defined as follows: 67% of the elevations are within 150 mm of the absolute ground accuracy over clear defined surfaces, while 90% are within 300 mm (ref. Fugro Spatial Solutions Pty Ltd).

Bundaberg Regional Council provided detailed ground survey along the Drain, from Palm View Drive to the western end of Woodlands Lane, a distance of approximately 900 metres (as shown in Appendix A). This survey included the details of all private driveway crossings over the Drain. A small lake weir is also contained in one of the properties. A summary of the surveyed data is shown in Table 1. All driveway crossings and the lake weir are contained within Council easements.

Table 1 Driveway Crossing Details

Driveway Crossing	Property Description	Crossing Details	Invert Level (mAHD)	Minimum Driveway Elevation (mAHD)
1	Lot 29 RP814879	1 / 675 mm	0.86	1.58
2	Lot 13 SP212156	1 / 675 mm	0.26	1.79
3	Lot 15 SP215844	1 / 675 mm	0.34	1.36
4	Lot 25 RP814879	2 / 600 mm	0.51	1.25
5	Lot 24 RP814879	1 / 450 mm Lake Weir	1.08 0.84	1.90 -
6	Lot 23 RP814879	1 / 525 mm	0.52	1.68
7	Lot 22 RP814879	1 / 900 mm	0.53	1.78
8	Lot 83 RP841664	1 / 900 mm	0.27	1.97
9	Woodlands Pathway	1 / 900 mm	0.21	1.34

The details of the culvert crossings at the public roads and the tidal bund were also provided by Bundaberg Regional Council. A summary of the culvert details is shown in Table 2.

Table 2 Road and Tidal Bund Culverts

Location	Pipe Details	Invert Level (mAHD)
Pandanus Street	4 / 900 mm	1.08
Palm View Drive	2 / 1050 mm	0.87
Ohlaf Street	2 / 1050 mm	0.72
Moore Park Road	4 / 900 mm	0.88
Tidal Bund	3 / 375 mm	0.78

The level along the top of the tidal bund varies from approximately 2.0 to 2.2 mAHD, based on Council survey data. In comparison, the tide levels at Burnett Heads and Bargara Beach are:

- Highest Astronomical Tide level = 1.98 mAHD; and
- Mean High Water Springs = 1.19 mAHD (*Queensland Tide Tables*, 2011).

Bundaberg Regional Council provided some surveyed spot levels along the invert of the existing Drain, in a couple of locations:

- downstream of the tidal bund; and
- between Ohlaf Street and Moore Park Road.

For the purposes of this study, it was assumed that these spot levels were indicative of the levels along the invert of the Drain, and that there were no intermediate high points between the surveyed levels.

Bundaberg Regional Council has carried out periodic water level monitoring along the Drain, between Palm View Road and the tidal bund, since March 2010. The surveyed water levels are shown in Appendix B.

Bundaberg Regional Council also recently installed a water level monitoring gauge at the tidal bund. This gauge records the water level just upstream and just downstream of the bund. The results recorded in September and October 2011 are shown in Appendix C. These results demonstrate that only the peaks of the largest high tides each month can penetrate up the Drain to the downstream side of the tidal bund. However, the flap-gated pipes prevent the tide from progressing to the upstream side of the bund.

4 EXISTING DRAINAGE

4.1 Driveway Crossings

The driveway crossing survey data shown in Table 1 indicates that the water level in the Drain upstream of Lot 24 RP814879 will not drain below approximately 1.08 mAHD, due to the level of the pipe crossing in that property.

In addition, the size of the pipe in this property (450 mm diameter) is the smallest of all of the driveway crossings. A 450 mm diameter pipe provides approximately 44% of the flow area compared to a 675 mm diameter pipe, and only 25% of the flow area compared to a 900 mm diameter pipe. In can therefore be seen that this pipe crossing provides a significant constriction to the flow in the Drain, due to both its elevation and relatively small diameter.

The level of the outlet of the lake weir within this property is 0.84 mAHD. Thus, the weir provides another constriction to the flow along the Drain.

The driveway crossing of the next property downstream (Lot 25 RP814879) has a slightly larger pipe, with a diameter of 525 mm. However all other pipes crossings provide much larger flow areas, with either two 600 mm pipes, a 675 mm pipe, or a 900 mm pipe.

Thus, the water levels upstream of Lot 24 RP814879, including the area around Palm View Drive, will only fall below a level of 1.08 mAHD due to the slow processes of evaporation and seepage to groundwater.

4.2 Major Culverts

The details of the major culverts at the public roads and tidal bund are shown in Table 2. This shows that the size of the flap-gated pipes at the tidal bund (3 / 375 mm) are significantly smaller than the other major culverts at the road crossings.

The flow area provided by the culverts at Palm View Drive and Ohlaf Street (by 2 / 1050 mm pipes) is approximately 1.7 m². The flow area provided by the culverts at Pandanus Street and Moore Park Road (by 4 / 900 mm pipes) is approximately 2.5 m². However, the flow area provided by the culverts at the tidal bund (by 3 / 375 mm pipes) is only approximately 0.3 m². This is equivalent to a single pipe with a diameter of approximately 650 mm.

Given that the tidal bund is at the downstream end of Murdoch's Road Drain, these small culverts have the potential to cause a significant constriction to the flow from the overall catchment.

4.3 Agricultural Drain

In addition to the Murdoch's Road Drain, a second drain, known as the Agricultural Drain, is located in the Moore Park Beach area. The Agricultural Drain runs generally parallel to, and on the south-western side of Murdoch's Road (refer Figure 1).

The Agricultural Drain operates in a significantly different manner to the Murdoch's Road Drain. As discussed in the preceding sections, there are a number of factors which prevent the free flow of water along Murdoch's Road Drain. In contrast, the main features of the Agricultural Drain are as follows.

- Hydraulic Roughness – Upstream of Moore Park Road, the Agricultural Drain is an earth channel with no vegetation. Thus, it provides a very smooth path for the conveyance of stormwater runoff. In contrast, Murdoch's Road Drain contains dense vegetation, and thus a high hydraulic roughness.

- Straight Channel – The Agricultural Drain is generally straight along its entire length, with only a few minor changes of direction. In contrast, Murdoch's Road Drain provides a tortuous path for the flow of stormwater.

- Channel Slope – Survey provided by Bundaberg Regional Council indicates that Agricultural Drain falls approximately 1.2 metres between Murdoch's Linking Road and Moore Park Road. In contrast, Murdoch's Road Drain actually has a slight uphill grade along a similar length (between Palm View Drive and Moore Park Road).

- Culvert Crossings and Weirs – There are no private driveway crossings or lake weirs along the Agricultural Drain. There are three small farm crossings over the Drain, but these crossings can be overtopped at a relatively low level and thus would not provide a significant restriction to the flow. The Drain crosses under only one public road at Moore Park Road, which comprises culverts consisting of 4/2150 x 1850 mm box culverts. These culverts provide a flow area of approximately 15.9 m². In contrast, Murdoch's Road Drain contains nine private driveways (some with pipes and driveways at a relatively high elevation), a lake weir, and four roadway crossings. The flow area of the culverts at Moore Park Road in Murdoch's Road Drain is approximately 2.5 m².

- Tidal Barrier – A tidal barrier is located near the downstream end of the Agricultural Drain. The barrier comprises three pairs of tide gates, with each pair of gates providing an open area through the tidal barrier of up to approximately 3.0 metres wide and 2.2 metres higher. Thus, the total flow area at the tidal barrier is 19.8 m². In contrast, the tidal barrier near the downstream end of Murdoch's Road Drain comprises 3/375 mm pipes, providing a flow area of only 0.3 m².

It can therefore be seen that the Agricultural Drain provides a significantly better flow path for the conveyance of stormwater runoff along its entire length, compared to the Murdoch's Road Drain.

Thus, only carrying out channel works on Murdoch's Road Drain downstream of the existing tidal barrier would not eliminate the long periods of ponded water occurring in other parts of the Drain further upstream.

5 OPTIONS FOR DRAINAGE IMPROVEMENTS

Bundaberg Regional Council initially suggested three options for improving the drainage of the Murdoch's Road Drain. These options are listed below.

Option A	Open channel or piped drainage system (or combination of both) between the area upstream of Moore Park Road and the ocean.
Option B	Open channel or piped drainage system (or combination of both) between the area upstream of the tidal bund and the ocean.
Option C	De-silting, vegetation removal and regrade of drain downstream of the tidal bund.

Plans showing the alignment of the proposed drainage system for Options A, B and C are shown in Appendix D.

Following discussions with Council, it was agreed that a piped drainage option would be preferable for Options A and B, rather than constructing areas of open channel.

In correspondence received by Council dated 28 February 2001, the Department of Environment and Resource Management (DERM) advised that:

- they have no record of approvals for the existing tidal bund and flap gate culverts; and
- if tide gates would be effective in assisting with drainage control, then relocation to Moore Park Road would be preferred to the current location due to the disturbance already created by the road.

Also, as discussed in Section 4, the existing drainage infrastructure along Murdoch's Road Drain provides some constrictions to the flow. In particular:

- some driveway crossing contain pipes significantly smaller than other driveways; and
- the pipes at the tidal bund are significantly smaller than the other major culverts under the public roads.

Consequently, the options investigated were revised as follows.

Option A1	As per Council's Option A, i.e. pipe drainage system between the area upstream of Moore Park Road and the ocean (a length of approximately 750 metres).
Option A2	Option A1 plus upgrade all driveway crossings to a suitable standard.
Option B1	As per Council's Option B, i.e. pipe drainage system between the area upstream of the tidal bund and the ocean (a length of approximately 450 metres).
Option B2	Option B1 plus upgrade all driveway crossings to a suitable standard.
Option C1	Upgrade the culverts at the tidal bund to 4 / 900 mm pipes.
Option C2	Option C1 plus Council's Option C, i.e. de-silting, vegetation removal and regrade of drain downstream of the tidal bund.
Option C3	Option C2 plus excavate a rectangular cross section six metres wide along the drain downstream of the tidal bund to a uniform level of -1.0 mAHD.
Option C4	Option C3 plus upgrade all driveway crossings to a suitable standard.

Option C5	Remove the tidal bund altogether, and install flap-gates on the downstream side of the existing 4 / 900 mm pipes at Moore Park Road (in accordance with DERM's preference).
Option C6	Option C5 plus upgrade all driveway crossings to a suitable standard.

The standard adopted for the driveway crossings comprised:

- maintain the existing crossings with a 900 mm pipe;
- upgrade the other crossings to 2 / 600 mm pipes, with an invert elevation of 0.8 mAHD; and
- the elevation of all driveways was raised or lowered to 1.7 mAHD.

For the purposes of the modelling, it was assumed that the details of the pipe lines for Options A1, A2, B1 and B2 were as follows:

- Diameter = 900 mm;
- Upstream Invert Level = 0.9 mAHD (similar to the invert levels of the culverts at Palm View Drive, Ohlaf Street, Moore Park Road, and the tide gates);
- Downstream Invert Level = 0.0 mAHD; and
- Flap gate located at downstream end to prevent backflow up the pipe.

6 HYDRAULIC MODEL

6.1 Model Setup

A hydraulic model of the Moore Park Beach area was set up using the combined 1-dimensional/2-dimensional unsteady flow software TUFLOW (Build 2010-10-AC-iSP-w64). TUFLOW models free-surface flows in one-dimensional links (such as open channels, pipes and culverts, bridges, etc) and two-dimensional domains.

The model used the topographic data provided by Council, as discussed in Section 3. Based on this data, the model was set up using a 5.0 metre grid in the 2-dimensional domain. 1-dimensional links were used to model the culverts at the road crossings, tidal bund, and private driveways.

A timestep of 2.5 seconds was used in the model.

The Manning's n roughness values used in the model are shown in Table 3.

Table 3 Manning's n Values

Land Use	Manning's n Value
Road Reserves	0.025
Grassed Areas	0.05
Existing Murdoch's Road Drain	0.15
Cleared Drain	0.025

A tidal boundary condition was used at the downstream end of the model, based on predicted tides at the Bundaberg Port.

The model assumed an initial water level of 1.65 mAHD in all areas upstream of the tidal bund. This level is similar to the top of bank level along the Drain where the private driveway crossings are located (i.e. between Palm View Drive and Woodlands Lane). It is also similar to the water levels recorded along the Drain in December 2010 (which varied from 1.64 mAHD at Palm View Drive to 1.41 mAHD at the tidal bund).

Following periods of rainfall in the catchment, the groundwater level in the Moore Park Beach area rises. Some of this groundwater seeps into the Murdoch's Road Drain. Thus, a constant groundwater inflow into the Drain was applied in the model. Based on groundwater modelling of the Moore Park Beach area carried out by Cardno, a constant inflow of 100 L/s was adopted.

6.2 Drainage Scenarios

The TUFLOW model was used to evaluate the performance of nine drainage scenarios: existing conditions; and the eight improvement options listed in Section 5.

For each scenario, the model was run for a simulation time of 30 days.

The results are discussed in the following sections.

6.3 Existing Conditions

The calculated water levels at a number of locations along the Drain under existing conditions are shown in Figure E1 (in Appendix E). The results show that the water levels slowly decrease over the simulation period of 30 days. The rate at which the water level drops becomes slower as the simulation progresses. Towards the end of the simulation, the water level along the Drain is dropping at a rate of only a few millimetres per day.

Figure E1 indicates the tidal influence downstream of the tidal bund. The results show that only the peaks of the largest high tides each month can penetrate up the Drain to the location of the tidal bund. This is consistent with the monitoring carried out at the tidal bund (as discussed in Section 3).

The calculated levels at Palm View Drive are approximately 100-200 mm higher than those at Ohlaf Street and Moore Park Road. This is consistent with the water level monitoring results collected by Council (as shown in Appendix B), when the water levels at Palm View Drive are above about 1.35 mAHD.

The water level monitoring results in Appendix B also show that Council carried out water level monitoring along the Drain in January 2011. The results are summarised in Table 4

Table 4 Measured Water Levels – January 2011

Data	Location	Average Water Level (mAHD)
20 January 2011	Palm View Drive	1.65
	Woodlands La – Moore Park Rd	1.41
31 January 2011	Palm View Drive	1.49
	Woodlands La – Moore Park Rd	1.29

These monitoring results show that it took approximately 11 days for the water level at:

- Palm View Drive to drop from 1.65 mAHD to 1.49 mAHD; and
- Woodlands Lane to Moore Park Road to drop from 1.41 mAHD to 1.29 mAHD.

In comparison, the model results shown in Figure E1 (in Appendix E) indicate that it took:

- approximately 10.5 days for the water level at Palm View Drive to drop from 1.65 mAHD to 1.49 mAHD; and
- approximately 8 days for the water level from Woodlands Lane to Moore Park Road to drop from 1.41 mAHD to 1.29 mAHD.

Thus, the model results are generally consistent with Council's water level monitoring. The reason for the differences is due to the fact that rainfall (more than 60 mm) occurred in Bundaberg during this 11 day period in January 2011. This rainfall would prolong the period of elevated water levels along the Drain. This impact was not included in the modelling.

At the start of the simulation, there is a large difference between the water levels upstream and downstream of the tidal bund. This is due to the assumed starting water levels. However, as the simulation progresses, the difference in water level diminishes to approximately 40 mm.

The calculated water levels on the upstream side of the nine driveway crossings between Palm View Drive and Woodlands Lane are shown in Figure E2 (in Appendix E). These results show that there is a large afflux due to Driveway5, i.e. Lot 24 RP814879. As discussed in Section 4.1, this driveway crossing presents a significant constriction to the flow in the Drain, due to both its higher elevation (1.08 mAHD) and relatively small diameter (450 mm) compared to the other driveways. The weir in the lake within this property also causes a restriction to the flow.

6.4 Model Results

The calculated flood levels at the road crossings for Drainage Options A1, A2, B1, B2, C1, C2, C3, C4, C5 and C6 are shown in Figures E3, E4, E5, E6, E7, E8, E9, E10, E11 and E12 (in Appendix E) respectively.

In addition, a comparison of the water levels from each Drainage Option at Palm View Drive and at Moore Park Road are shown in Figures E13 and E14 (in Appendix E) respectively.

The calculated water levels on the upstream side of the nine driveway crossings between Palm View Drive and Woodlands Lane, with Drainage Options A2, B2 and C6 in place, are shown in Figures E15, E16 and E17 (in Appendix E) respectively.

The results of the analyses are summarised below.

Palm View Drive to Lot 24 RP814879

A significant improvement in the faster reduction of water levels around Palm View Drive (including the first five driveway crossings) can only be achieved by upgrading the private driveway crossings (as shown by the results for Options A2, B2, C4 and C6, in Figures E4, E6, E10 and E17 respectively). A comparison of the results at Palm View Drive is shown in Figure E13 (in Appendix E).

In particular, the existing crossing at Driveway5 (in Lot 24 RP814879) and the existing lake weir in this property present a significant constriction to the flow along this reach of Murdoch's Road Drain.

Lot 24 RP814879 to Moore Park Road

All Drainage Options provide a significant improvement in the faster reduction of water levels at Moore Park Road, as shown in Figure E14 (in Appendix E). (Note that the levels shown at Moore Park Road are indicative of the water levels between Driveway6 and Moore Park Road.) However, this faster reduction is only significant when the water level in the Drain is in excess of approximately 1.25 to 1.3 mAHD. As the water level in the Drain falls below this level, there is no significant improvement in the speed of the reduction of water levels, due to the very shallow depth of flow in the Drain and through the culverts. That is, when the water level drops below approximately 1.3 mAHD, the flow in the Drain is controlled by the low hydraulic conveyance of the channel (i.e. shallow flow depth through dense vegetation in the bottom of the channel).

Tidal Bund

As per the previous point, Option C1 (i.e. upgrading the culverts at the tidal bund to 4 / 900 mm pipes) provides an improvement in the faster reduction of water levels in the Drain. However, Options C2 (i.e. de-silting, vegetation removal and regrade of drain downstream of the tidal bund) and C3 (i.e. excavate the drain downstream of the tidal bund to a uniform level of -1.0 mAHD) do not provide any significant additional benefit (refer Figure E14 in Appendix E).

It can therefore be concluded that the existing 3 / 375 mm pipes through the tidal bund present a significant restriction to the flow in the downstream reach of the Drain, when the water level in the Drain is higher than approximately 1.3 mAHD.

Similarly, doing works in the Drain downstream of the tidal bund would have no significant benefit on its own, i.e. without upgrading the existing pipes at the tidal bund.

As discussed in Section 4.3, carrying out works in the channel downstream of the tidal bund would not make Murdoch's Road Drain operate in a manner similar to the Agricultural Drain.

Options C5 and C6 (i.e. remove the existing tidal bund, and install flap-gates on the downstream side of the existing 4 / 900 mm pipes at Moore Park Road) provides a similar benefit to Option C1 (refer Figure E14 in Appendix E). Thus, rather than constructing new pipes in the tidal bund, a similar drainage benefit would be obtained more simply by adding flap gates to the existing pipes at Moore Park Road.

It would not be necessary to remove all of the existing tidal bund for Option C5. Only approximately 5 to 10 metres of the bund would need to be removed, as this would provide a flow area greater than that which would be available through the culverts at Moore Park Road.

6.5 Summary of Results

There are two areas which present a significant restriction to the flow in Murdoch's Road Drain:

- the existing driveway crossing and lake weir in Lot 24 RP814879; and
- the small pipes through the tidal bund.

The drainage analysis has shown that significant improvements in the faster reduction of water levels along the Drain can be achieved. However, this faster reduction is only significant when the water level in the Drain is in excess of approximately 1.25 to 1.3 mAHD. As the water level in the Drain falls below this level, there is no significant improvement in the speed of the reduction of water levels, due to the very shallow depth of flow in the Drain and through the culverts.

The options available for improving the flow in the Drain include:

- Option A1/A2 – constructing a pipe from the area upstream of Moore Park Road to the ocean;
- Option B1/B2 – constructing a pipe from the area upstream of the existing tidal bund to the ocean;
- Option C1/C2/C3/C4 – upgrade the culverts at the tidal bund to 4 / 900 mm pipes; and

- Option C5/C6 – remove at least 5 to 10 metres of the tidal bund, and install flap gates on the downstream side of the existing 4 / 900 mm pipes at Moore Park Road.

All of the options provide a similar benefit in terms of reduction of water levels along the Drain. However, Options C5 and C6 provide the following advantages:

- they are the lowest cost options;
- the works could be completed within a short time frame; and
- the new flap gates at Moore Park Road would be located in an area under the control of Bundaberg Regional Council.

Moore Park Road is located approximately 750 metres upstream of the existing tidal bund. Thus, the environmental impacts of relocating the tide gates to Moore Park Road would need to be examined.

Option C6 provides the additional benefit compared to Option C5 of a significant improvement in the faster reduction of water levels between Palm View Drive and Woodlands Lane, where the nine existing driveway crossings are located.

7 CONCLUSIONS

Murdoch's Road Drain is located within the existing residential area of Moore Park Beach in Bundaberg. A stormwater drainage investigation was carried out to investigate options for improving the drainage along Murdoch's Road Drain, so that water levels would fall more quickly following periods of rainfall in the catchment.

A TUFLOW model of the study area was setup to evaluate:

- existing conditions along the Drain; and
- a range of drainage improvement options.

The results of the TUFLOW model for existing conditions were consistent with the findings of Council's water level monitoring along the Drain.

The analysis of the drainage improvement options showed that significant improvements in the faster reduction of water levels along the Drain can be achieved with all options. However, this faster reduction is only significant when the water level in the Drain is in excess of approximately 1.25 to 1.3 mAHD. As the water level in the Drain falls below this level, there is no significant improvement in the speed of the reduction of water levels, due to the very shallow depth of flow in the Drain and through the culverts.

A driveway crossing and lake weir in Lot 24 RP814879 presents a significant restriction to the flow in Murdoch's Road Drain, in the area around Palm View Drive. Thus, upgrading these structures would improve the drainage in this area.

All of the drainage options provide a similar benefit in terms of reduction of water levels downstream of Lot 24 RP814879. However, Options C5 and C6 provide the following advantages:

- they are the lowest cost options;
- the works could be completed within a short time frame; and
- the new flap gates at Moore Park Road would be located in an area under the control of Bundaberg Regional Council.

Moore Park Road is located approximately 750 metres upstream of the existing tidal bund. Thus, the environmental impacts of relocating the tide gates to Moore Park Road would need to be examined.

Option C6 provides the additional benefit compared to Option C5 of a significant improvement in the faster reduction of water levels between Palm View Drive and Woodlands Lane, where the nine existing driveway crossings are located.

Figures

Figure 1

Murdoch's Road Drain

Locality Plan

LEGEND

N
W E
S

Murdoch's Road Drain

Agricultural Drain

200 0 200 400 600

Metres

Scale: 1:20,000

Cardno
Shaping the Future

Cardno (QLD) Pty Ltd | ABN 57 051 074 992
Level 11, North Tower, 515 St Pauls Terrace
Locked Bag 4006, Fortitude Valley QLD 4006
Tel: 07 3369 9822 Fax: 07 3369 9722

SHEET	A3
Project No:	29370013
Date:	1 November 2011
Revision Number:	0
Designed by:	MD
Client Name:	Bundaberg Regional Council

File Path: M:\XXXXXX\MapInfo\Figures

Appendix A

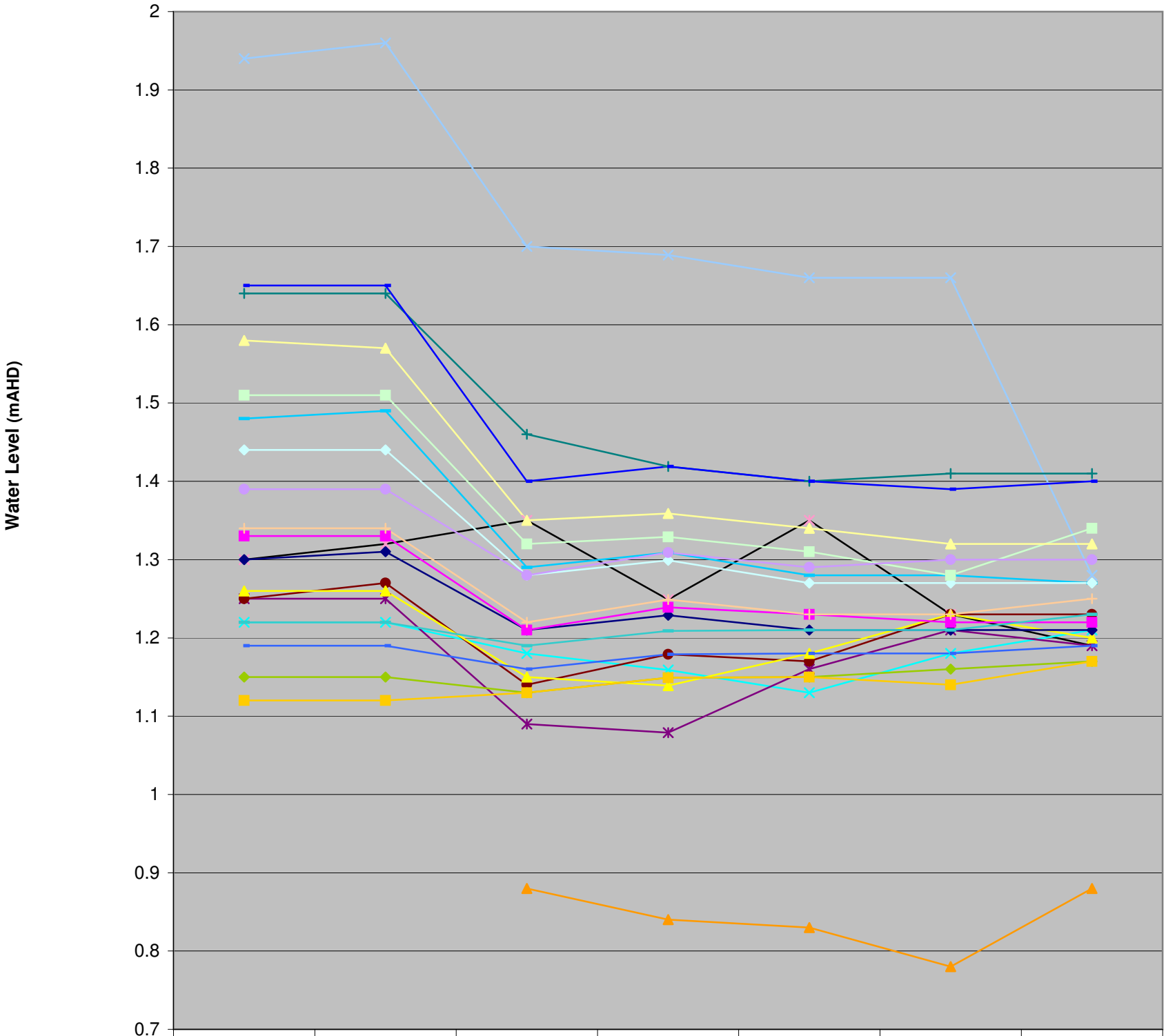
Bundaberg Regional Council Survey


PALM VIEW DRIVE
LOT 5 SP212093
LOT 6 SP212093
LOT 29 RP814879
LOT 13 SP212156
LOT 27 RP814879
LOT 15 SP215844
LOT 25 RP814879
LOT 24 RP814879
LOT 23 RP814879
LOT 22 RP814879
LOT 83 RP841664
LOT 82 RP841664
LOT 84 SP143283
LOT 4 RP841663
Driveway 1
Driveway 2
Driveway 3
Driveway 4
Driveway 5
Lake Weir
Driveway 6
Driveway 7
Driveway 8
Driveway 9

Appendix B

Murdoch's Road Drain Water Level Profiles

Moore Park Water Levels - Murdochs Road Drain



	A	B	D	E	F	G	H
10/03/2010	1.94	1.96	1.7	1.69	1.66	1.66	1.28
14/05/2010	1.3	1.32	1.35	1.25	1.35	1.23	1.19
17/08/2010	1.22	1.22	1.18	1.16	1.13	1.18	1.21
15/09/2010	1.25	1.25	1.09	1.08	1.16	1.21	1.19
8/10/2010	1.25	1.27	1.14	1.18	1.17	1.23	1.23
22/11/2010	1.26	1.26	1.15	1.14	1.18	1.23	1.2
23/12/2010	1.64	1.64	1.46	1.42	1.4	1.41	1.41
20/01/2011	1.65	1.65	1.4	1.42	1.4	1.39	1.4
31/01/2011	1.48	1.49	1.29	1.31	1.28	1.28	1.27
23/02/2011	1.44	1.44	1.28	1.30	1.27	1.27	1.27
28/02/2011	1.3	1.31	1.21	1.23	1.21	1.21	1.21
9/03/2011	1.33	1.33	1.21	1.24	1.23	1.22	1.22
14/03/2011	1.51	1.51	1.32	1.33	1.31	1.28	1.34
16/03/2011	1.58	1.57	1.35	1.36	1.34	1.32	1.32
6/04/2011	1.39	1.39	1.28	1.31	1.29	1.3	1.3
10/05/2011	1.34	1.34	1.22	1.25	1.23	1.23	1.25
10/06/2011	1.19	1.19	1.16	1.18	1.18	1.18	1.19
15/06/2011	1.22	1.22	1.19	1.21	1.21	1.21	1.23
15/07/2011	1.15	1.15	1.13	1.15	1.15	1.16	1.17
7/09/2011	1.12	1.12	1.13	1.15	1.15	1.14	1.17
15/11/2011			0.88	0.84	0.83	0.78	0.88

Reference Point

S:\Support Services\Design\Users\Tifa S\MISC\2011-2012\MOORE PARK BEACH WATER LEVEL MONITORING POINTS\MOORE PARK BEACH WATER LEVEL MONITORING POINTS | 22/11/2011 11:11:26 AM

Survey Data	
Survey No.:	BRC174
Height Datum:	AHD
Horiz. Datum:	"MGA 94, ZONE 56"
Scale Factor:	MGA GROUND (See Survey Notes)
Level Books:	Surveyor:

Scales

1:10000 0 100 200 300m

	Revisions	Verified	Date
A	ORIGINAL ISSUE		

Quality Certification

Design: Verified:

Drawn: Tifa Checked:

Approved By Engineer: Date:

RPEQ:

BUNDABERG REGIONAL COUNCIL

Locality: MOORE PARK BEACH

Facility Name:

Asset Name:

Details:

MOORE PARK BEACH
WATER LEVEL MONITORING POINTS
DETAIL PLAN FOR POINTS A, B, D, E, F, G, AND H

Associated Drawing No.: 40053 & 40054

2 of 2

Sheet Size: A3

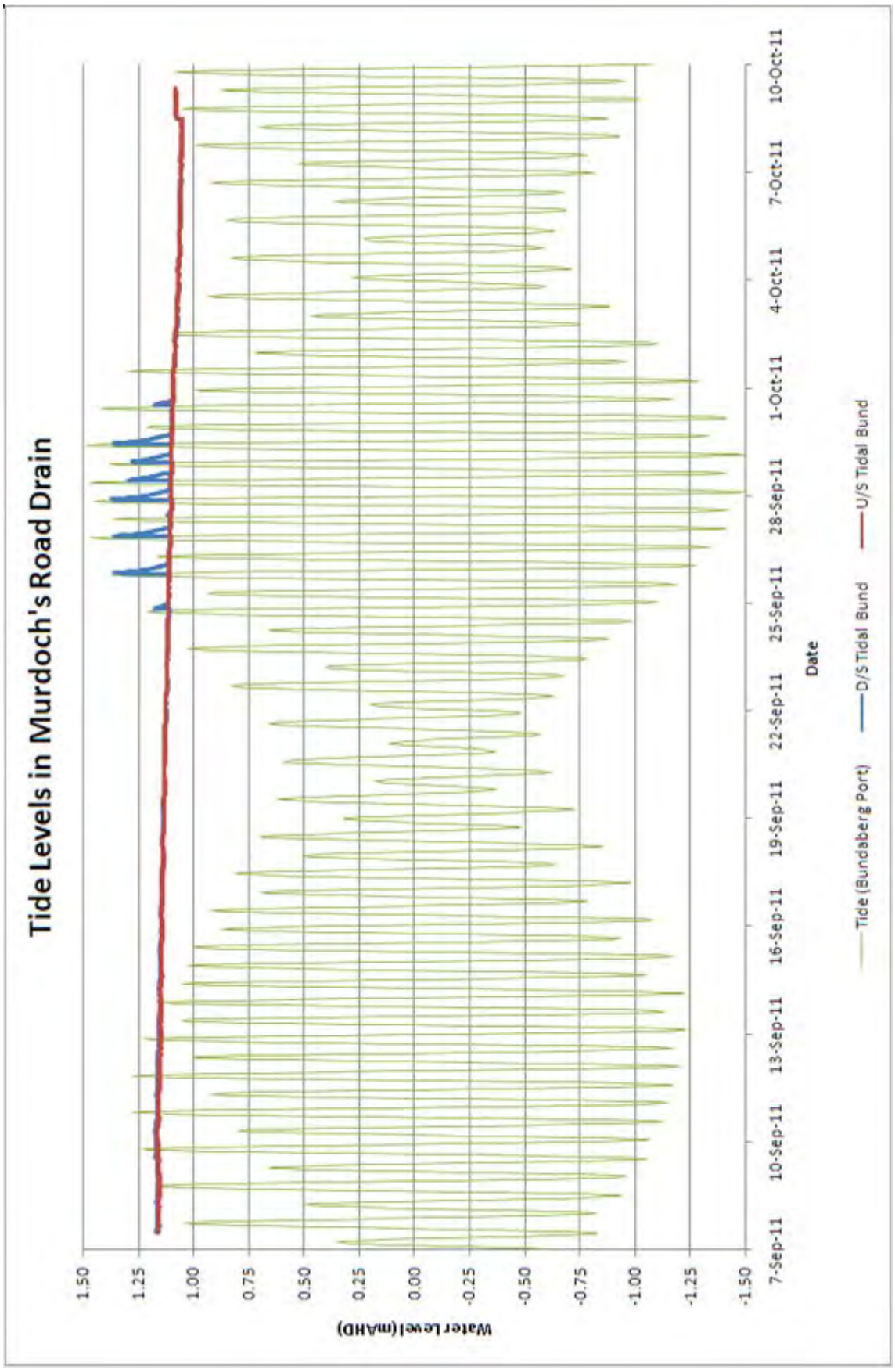
Project No.:

Drawing No.: 40054

Rev.: A

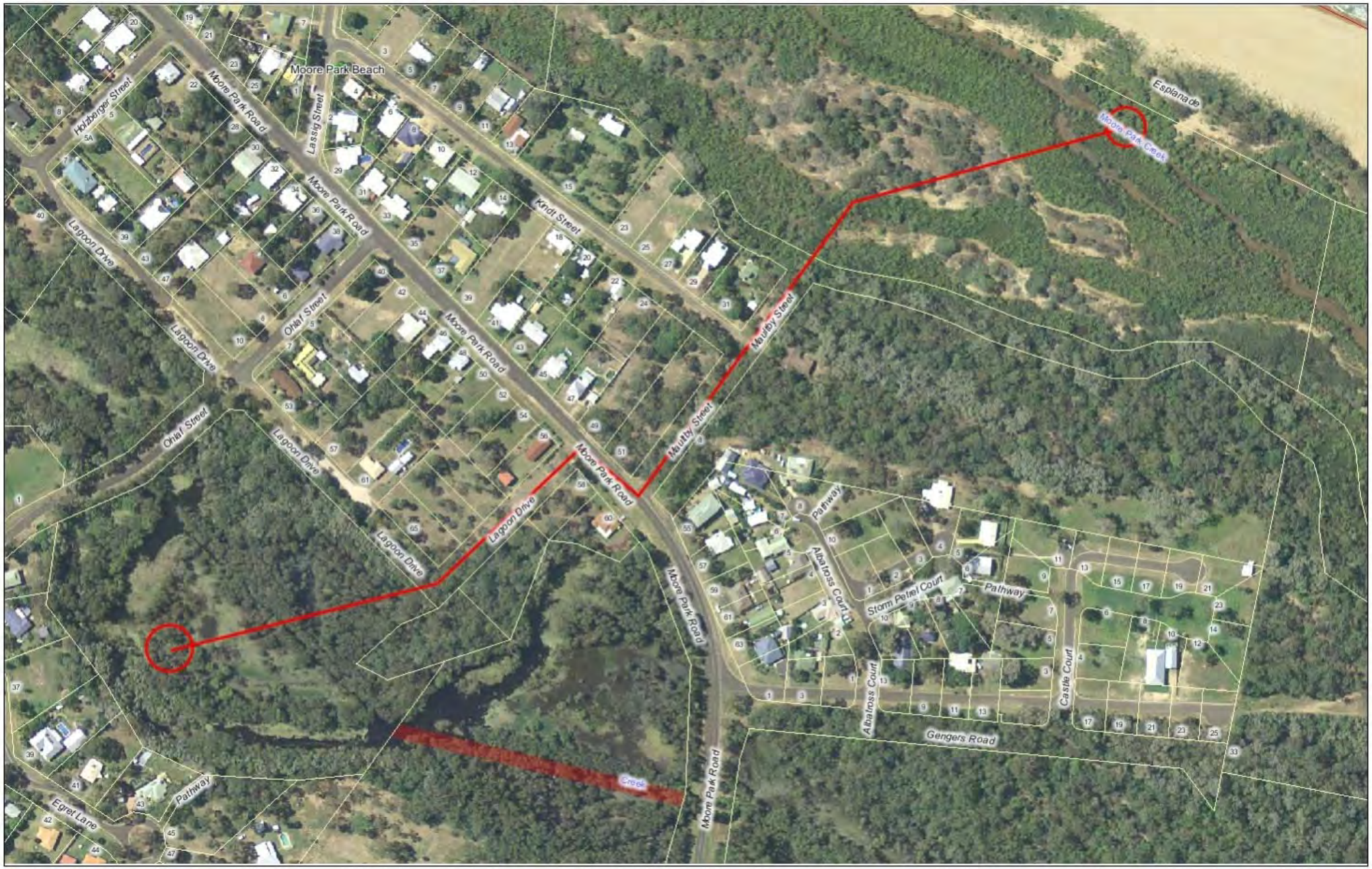
Appendix C

Tidal Conditions


Tide Levels in Murdoch's Road Drain
Water Level (mAHD)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
7-Sep-11
10-Sep-11
13-Sep-11
16-Sep-11
19-Sep-11
22-Sep-11
25-Sep-11
28-Sep-11
1-Oct-11
4-Oct-11
7-Oct-11
10-Oct-11
Date
Tide (Bundaberg Port)
D/S Tidal Bund
U/S Tidal Bund

Appendix D

Council Drainage Options



Printed By: dwaymay, May 11, 2011 12:34:29 PM

OPTION A

Scale = 1:2,432
on A3 Sheet

BUNDABERG REGIONAL COUNCIL

Printed By: dwaymay, May 11, 2011 12:40:43 PM

N W E S

OPTION B

Scale = 1:3,161
on A3 Sheet

BUNDABERG
REGIONAL COUNCIL

Printed By: dwaymay 11, 2011 12:44:03 PM

N
W E
S

OPTION C

Downstream of exist tide gates

Scale = 1:3,161
on A3 Sheet

Appendix E

TUFLOW Model Results

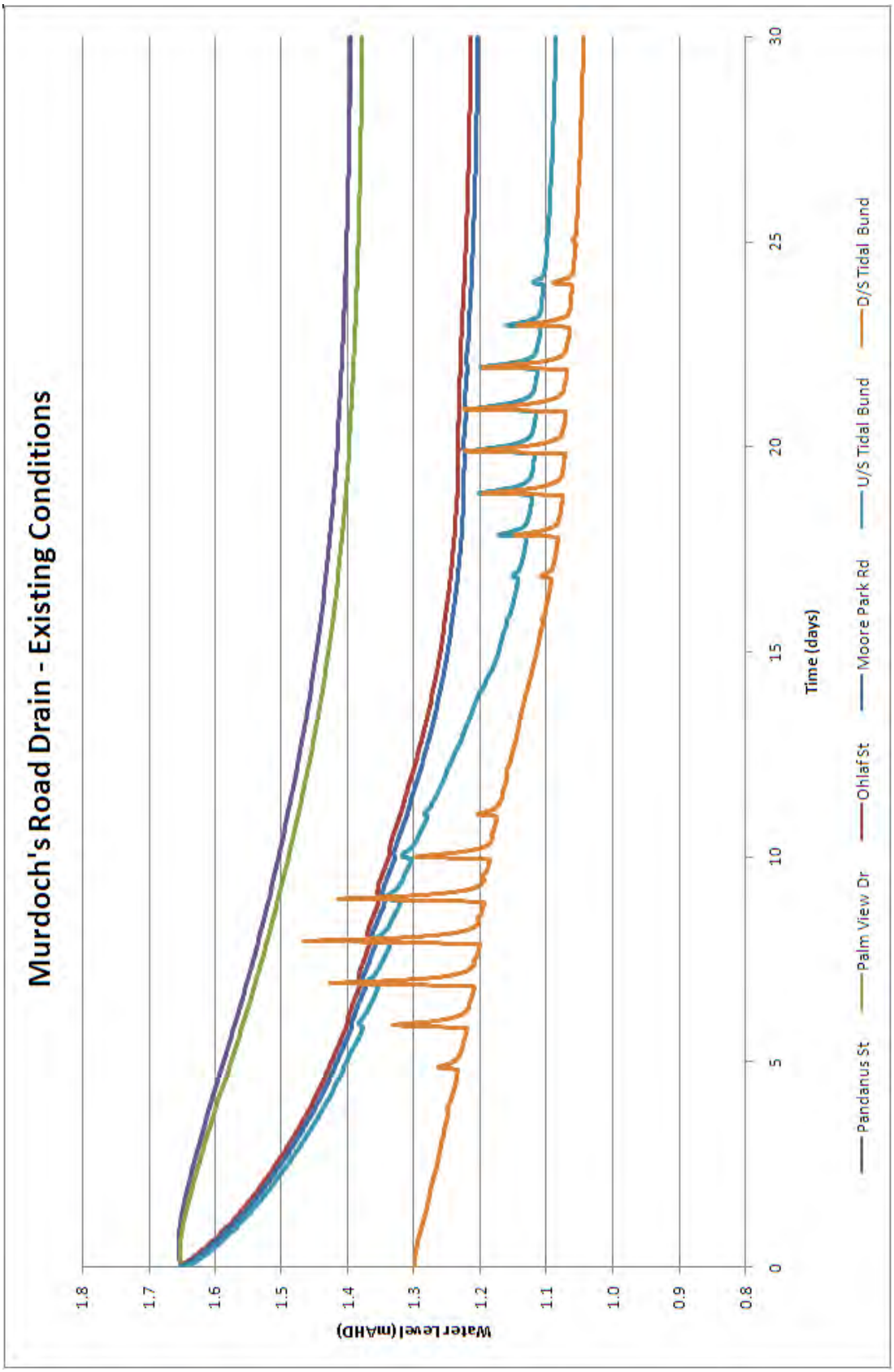


Figure E1. Water Levels at Roads & Tidal Bund – Existing Conditions

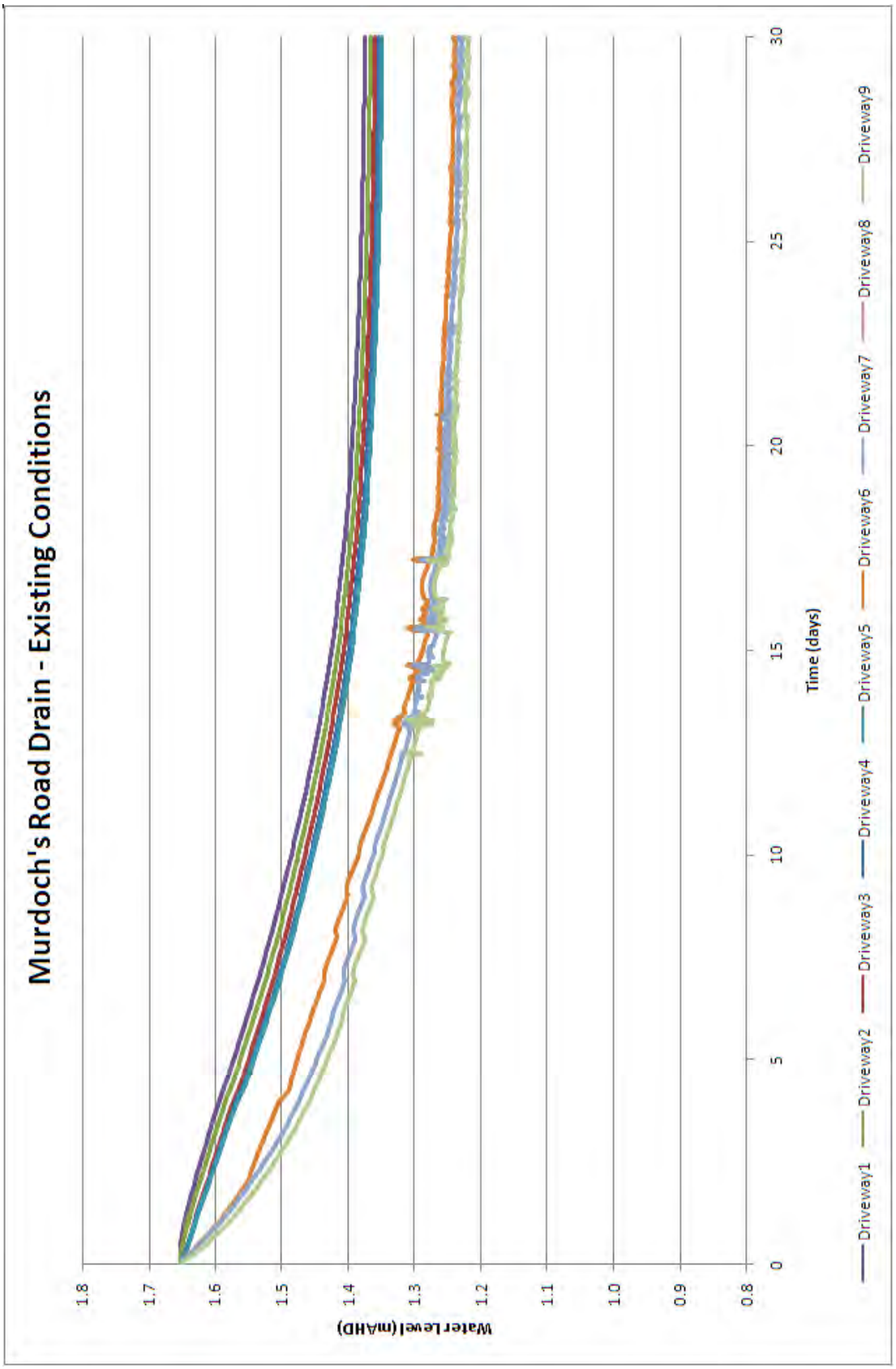


Figure E2. Water Levels at Driveway Crossings – Existing Conditions

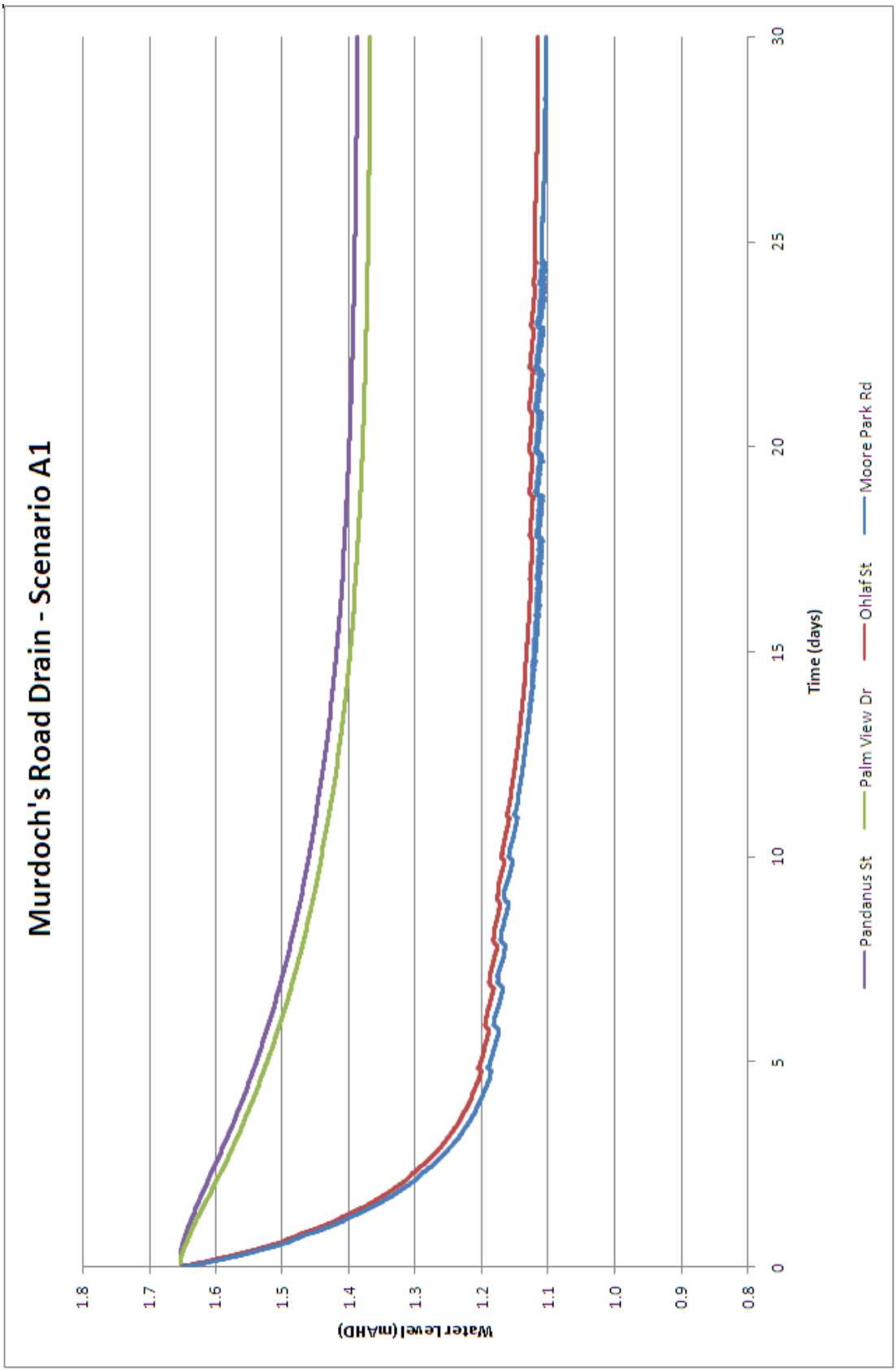


Figure E3. Water Levels at Roads – Option A1

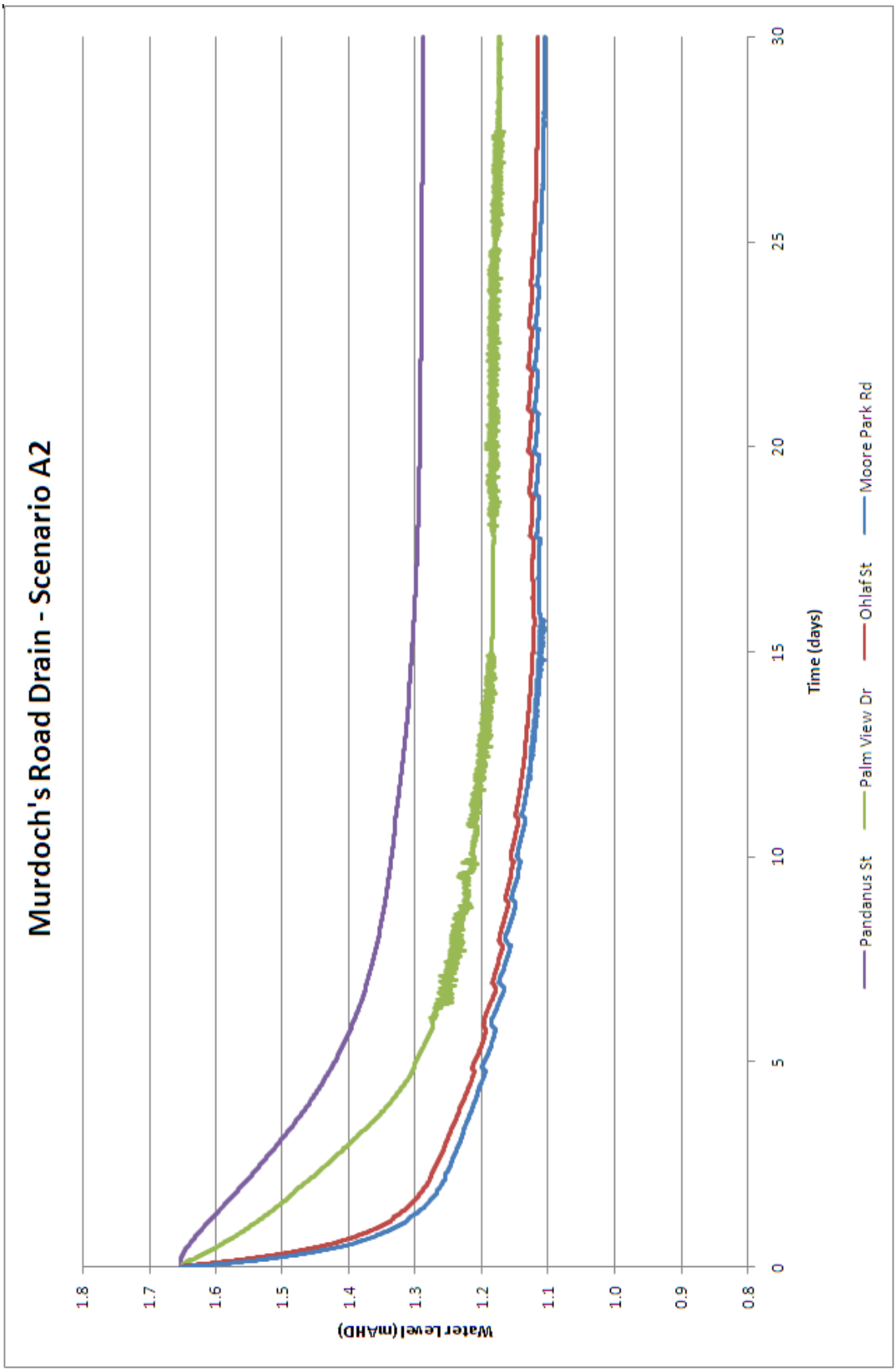


Figure E4. Water Levels at Roads – Option A2

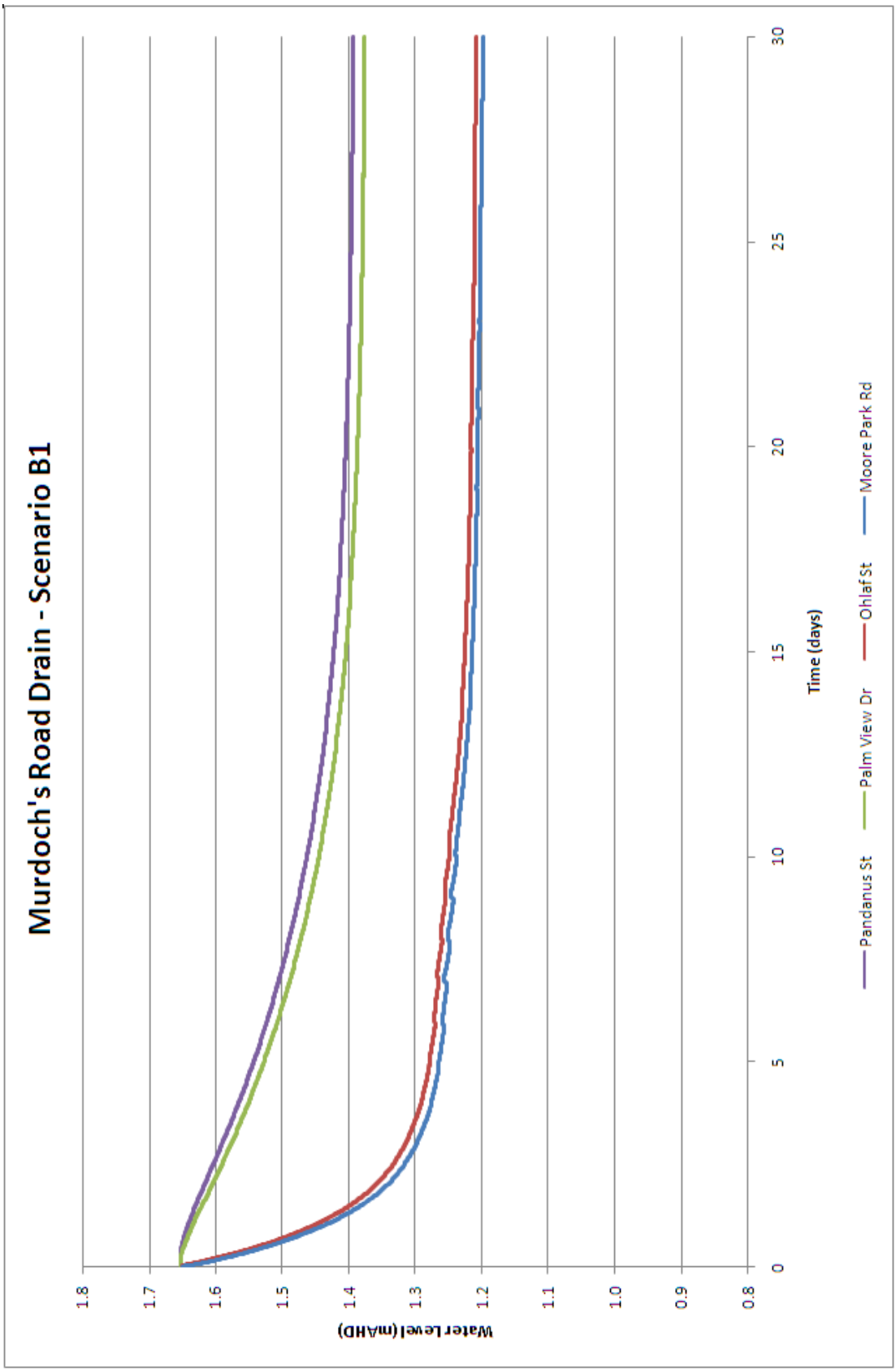


Figure E5. Water Levels at Roads – Option B1

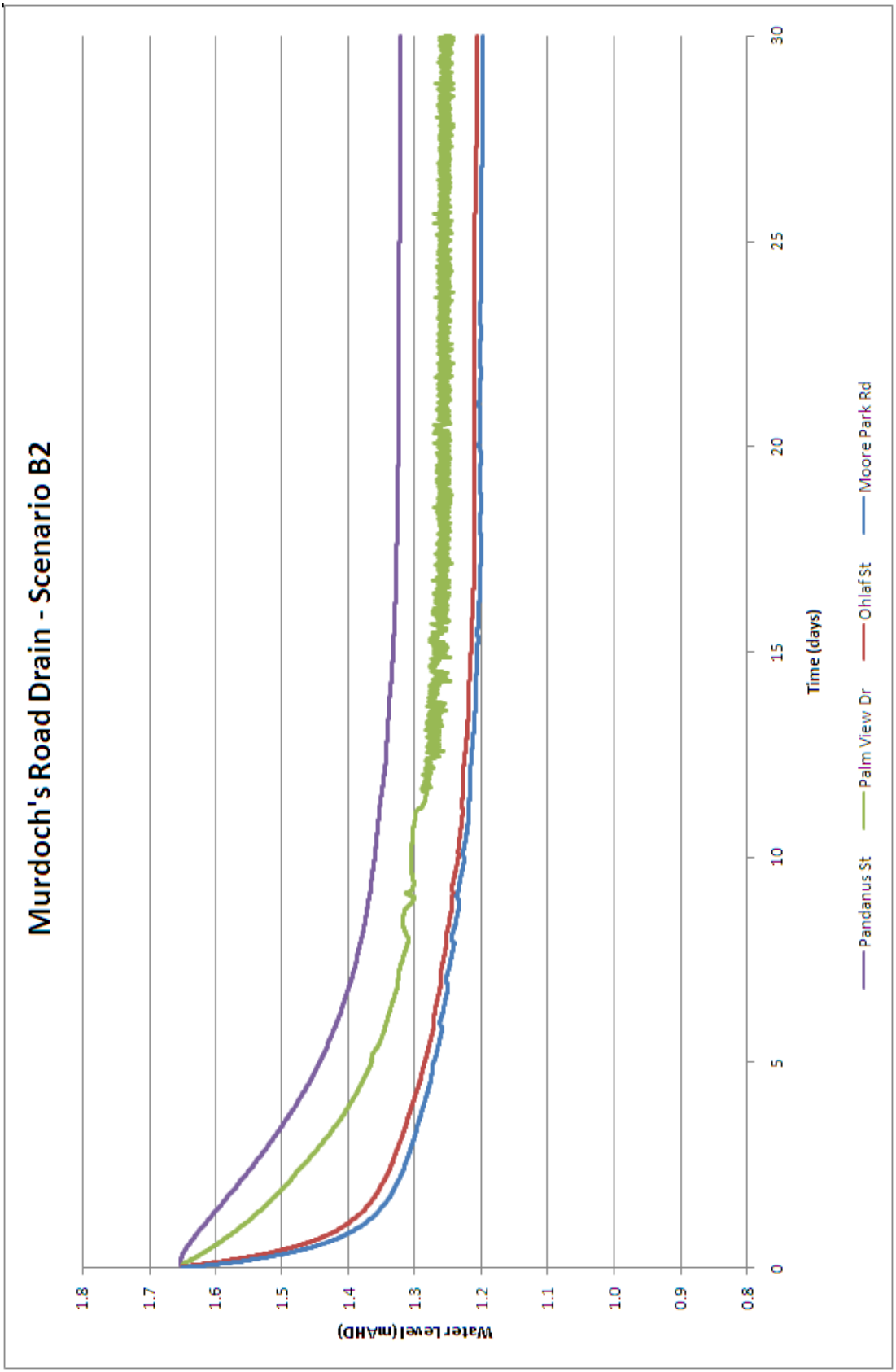


Figure E6. Water Levels at Roads – Option B2

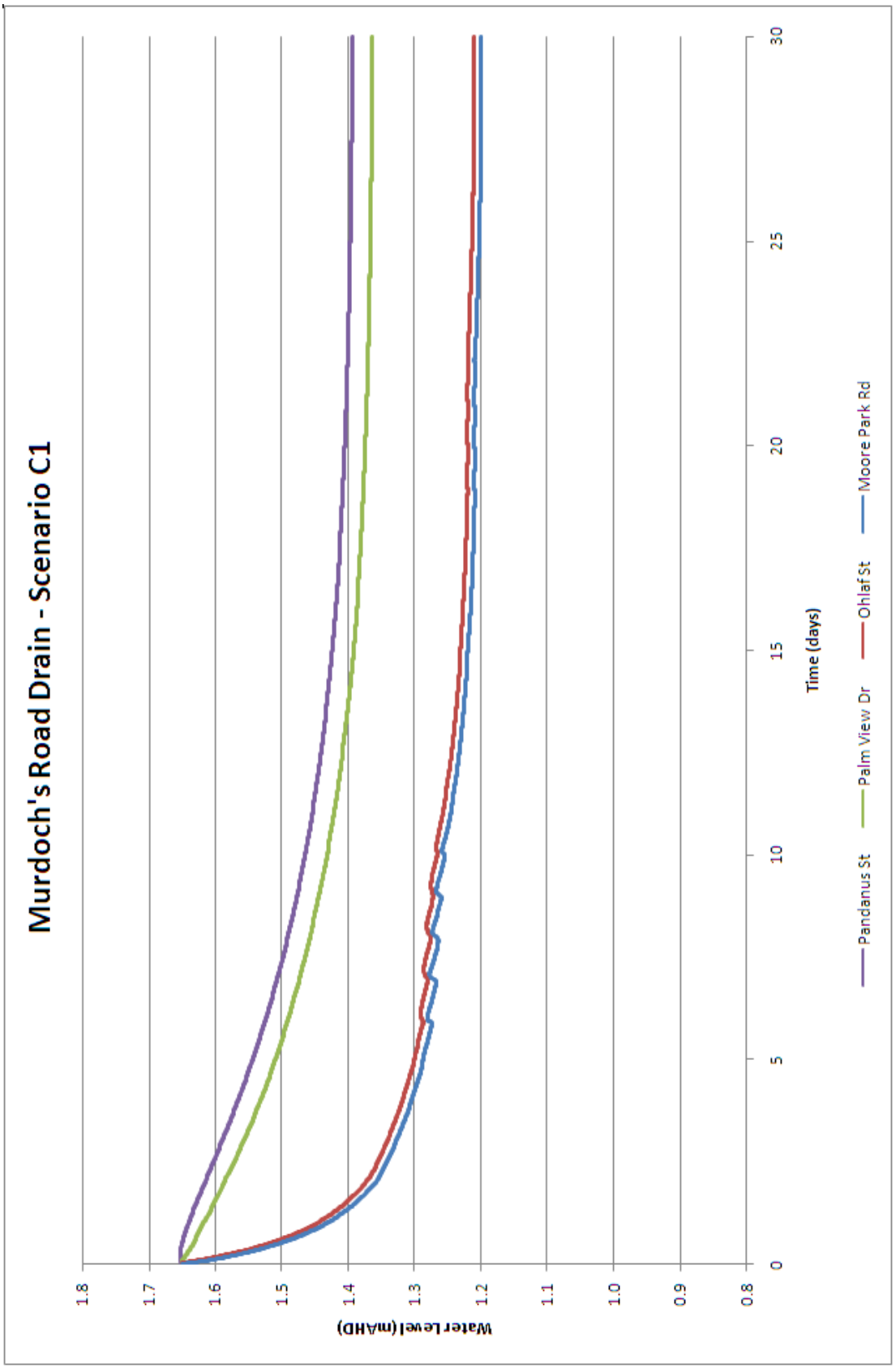


Figure E7. Water Levels at Roads – Option C1

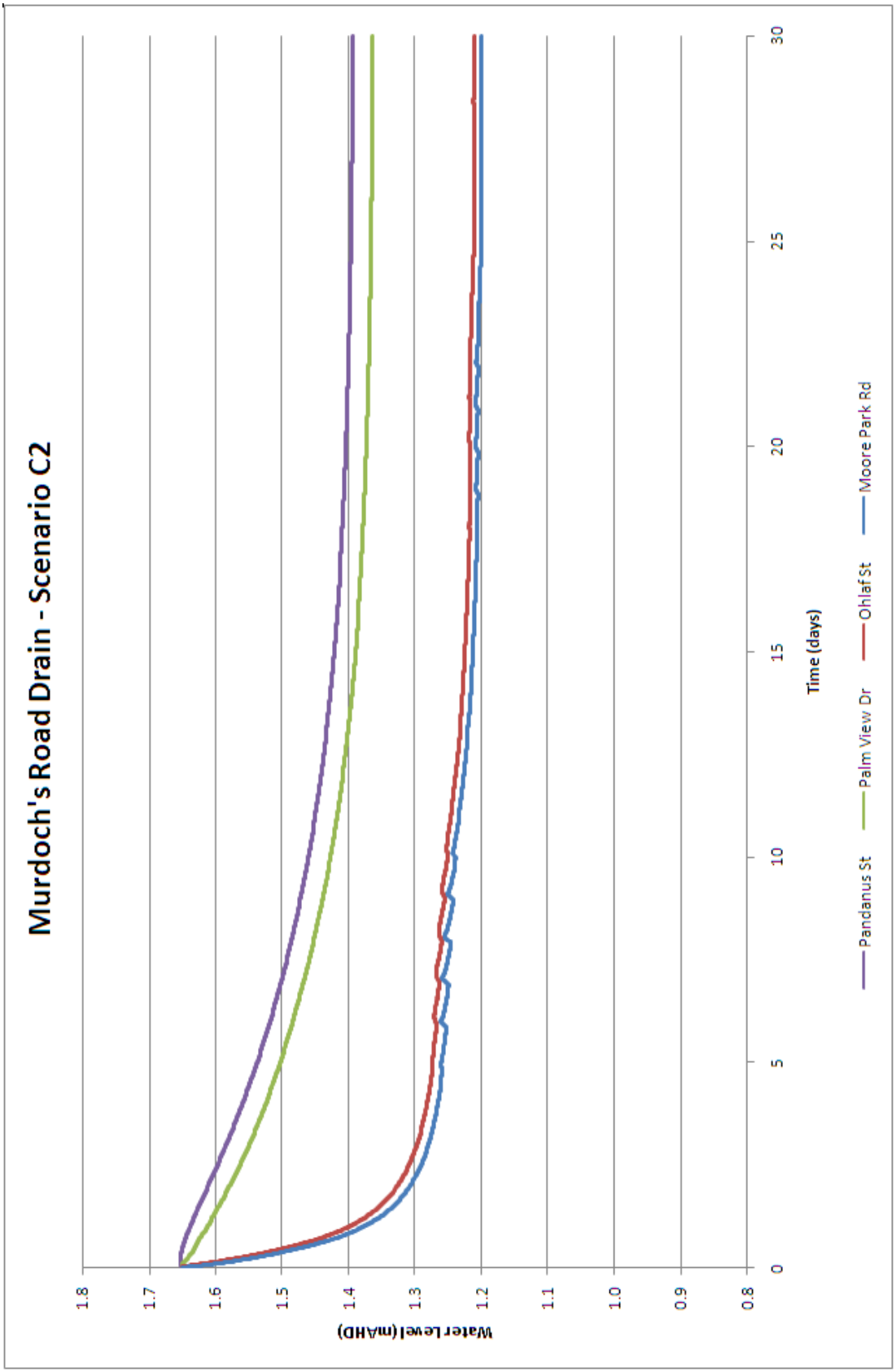


Figure E8. Water Levels at Roads – Option C2

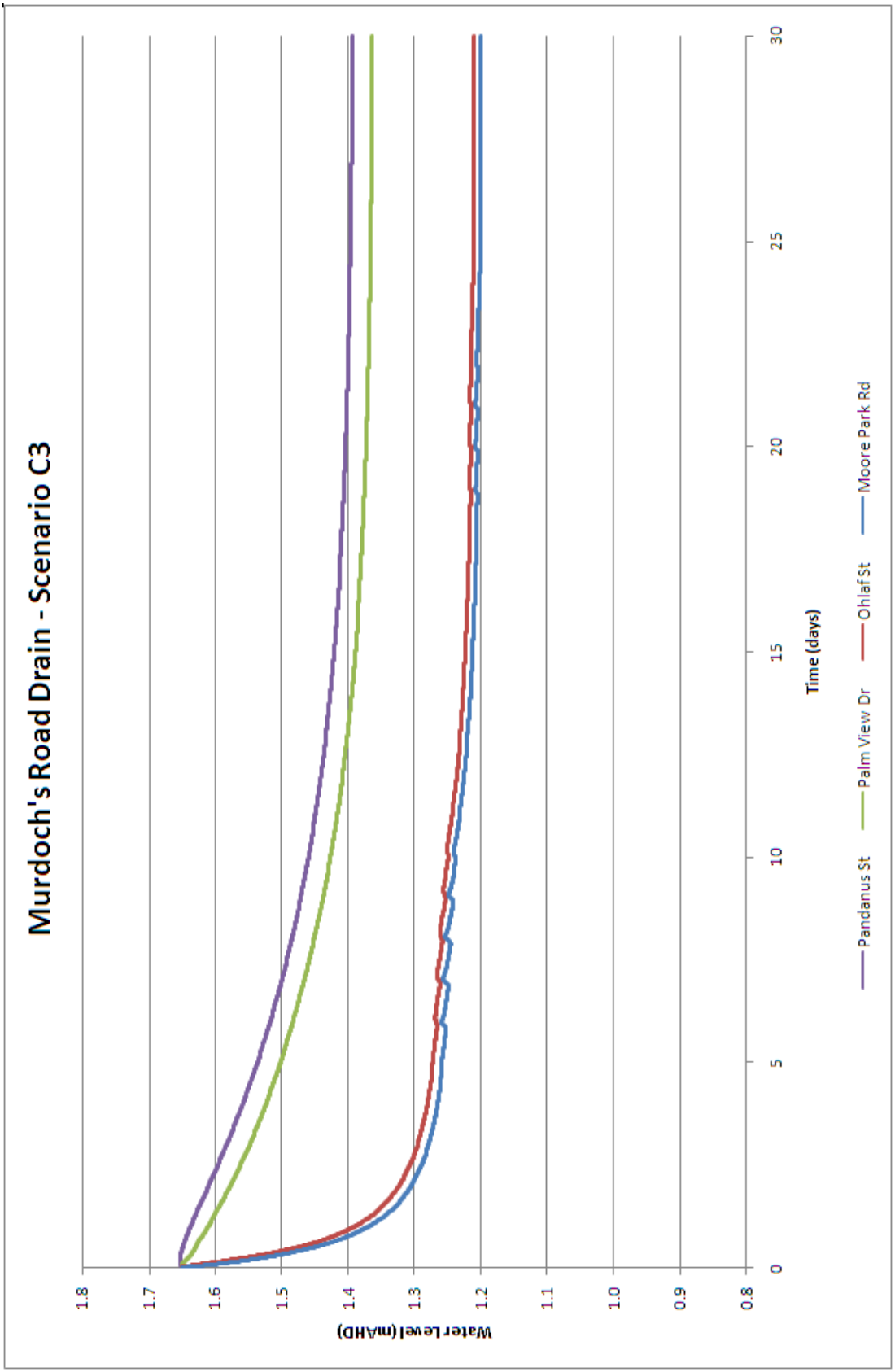


Figure E9. Water Levels at Roads – Option C3

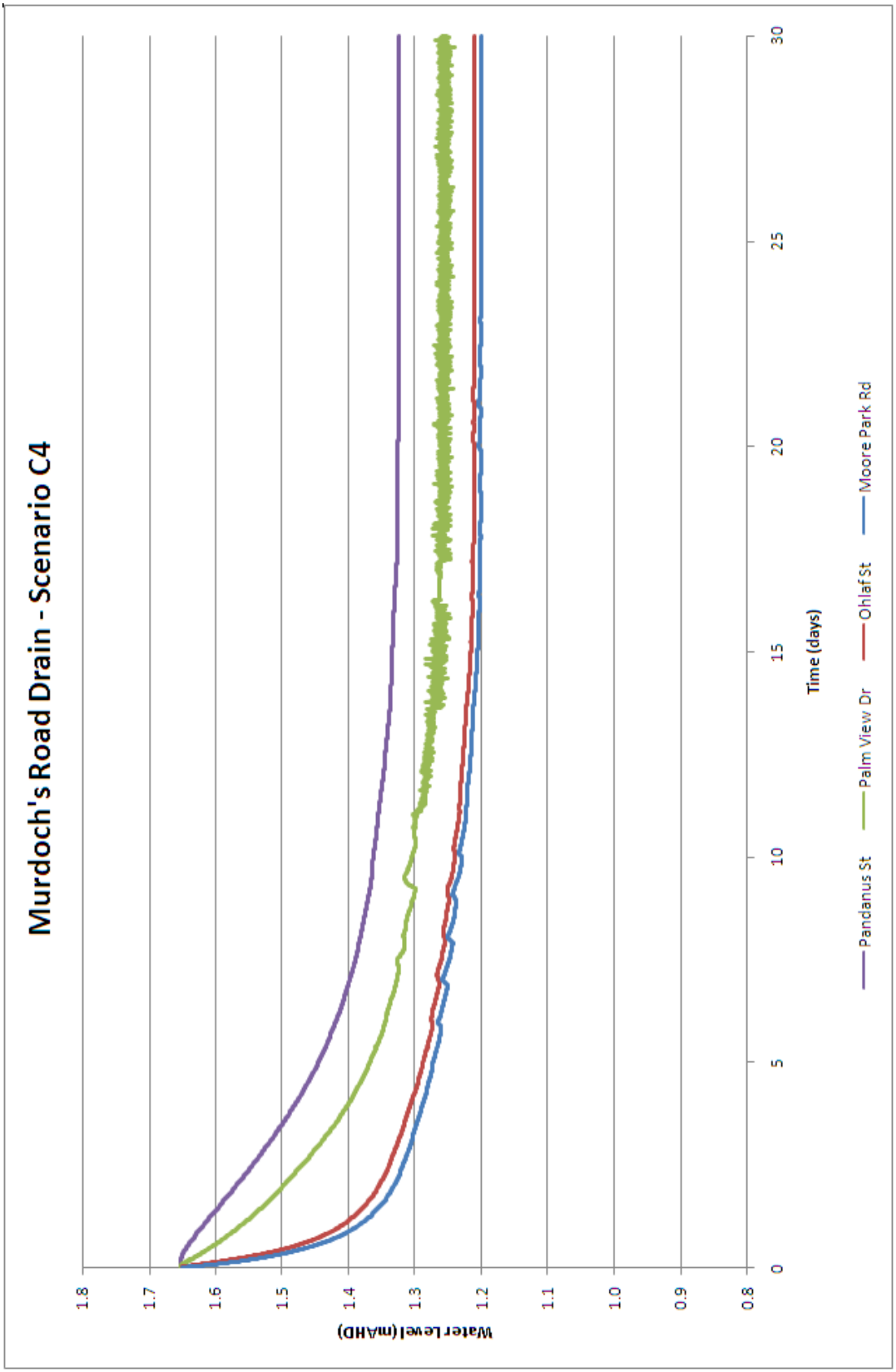


Figure E10. Water Levels at Roads – Option C4

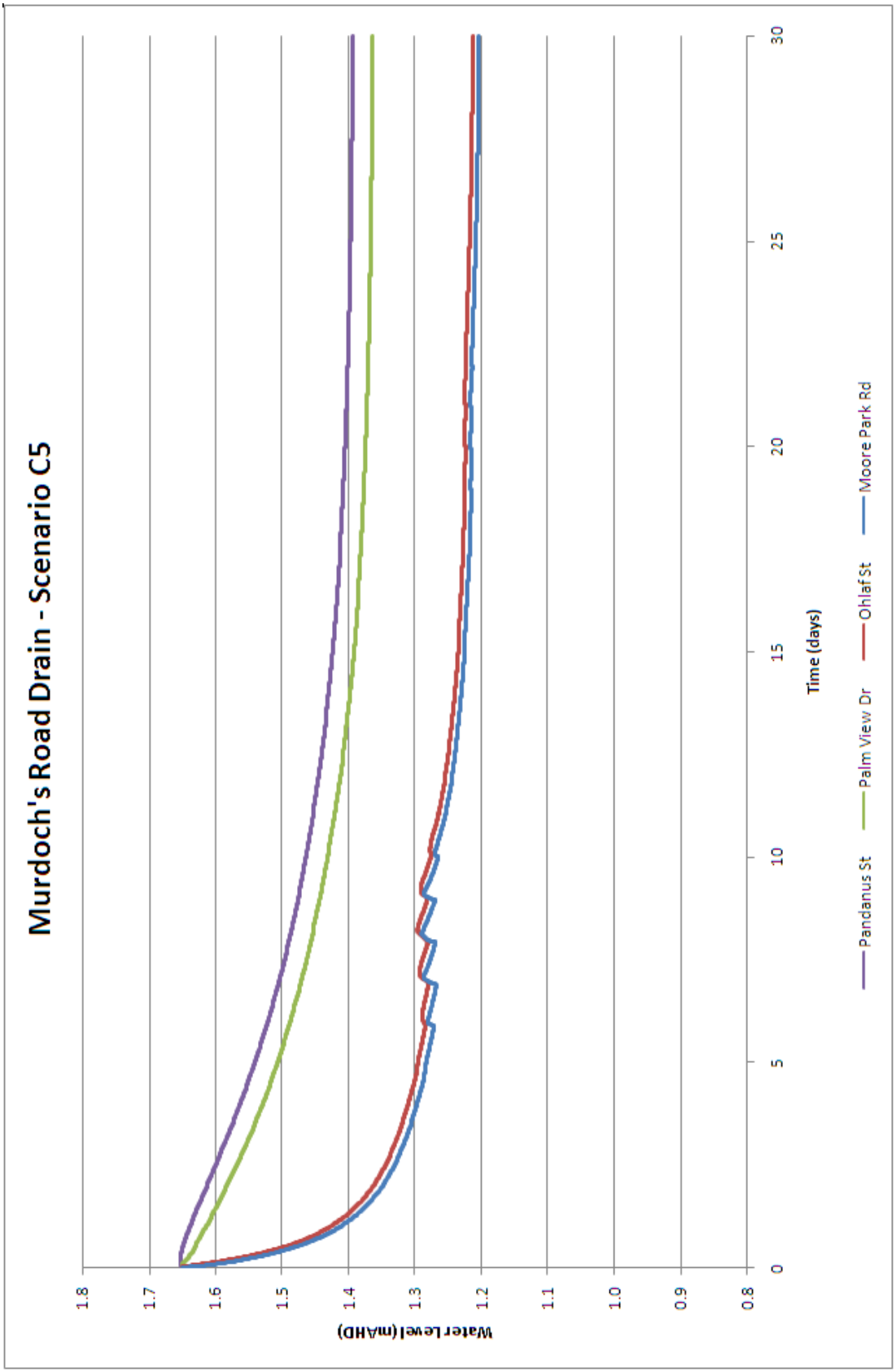


Figure E11. Water Levels at Roads – Option C5

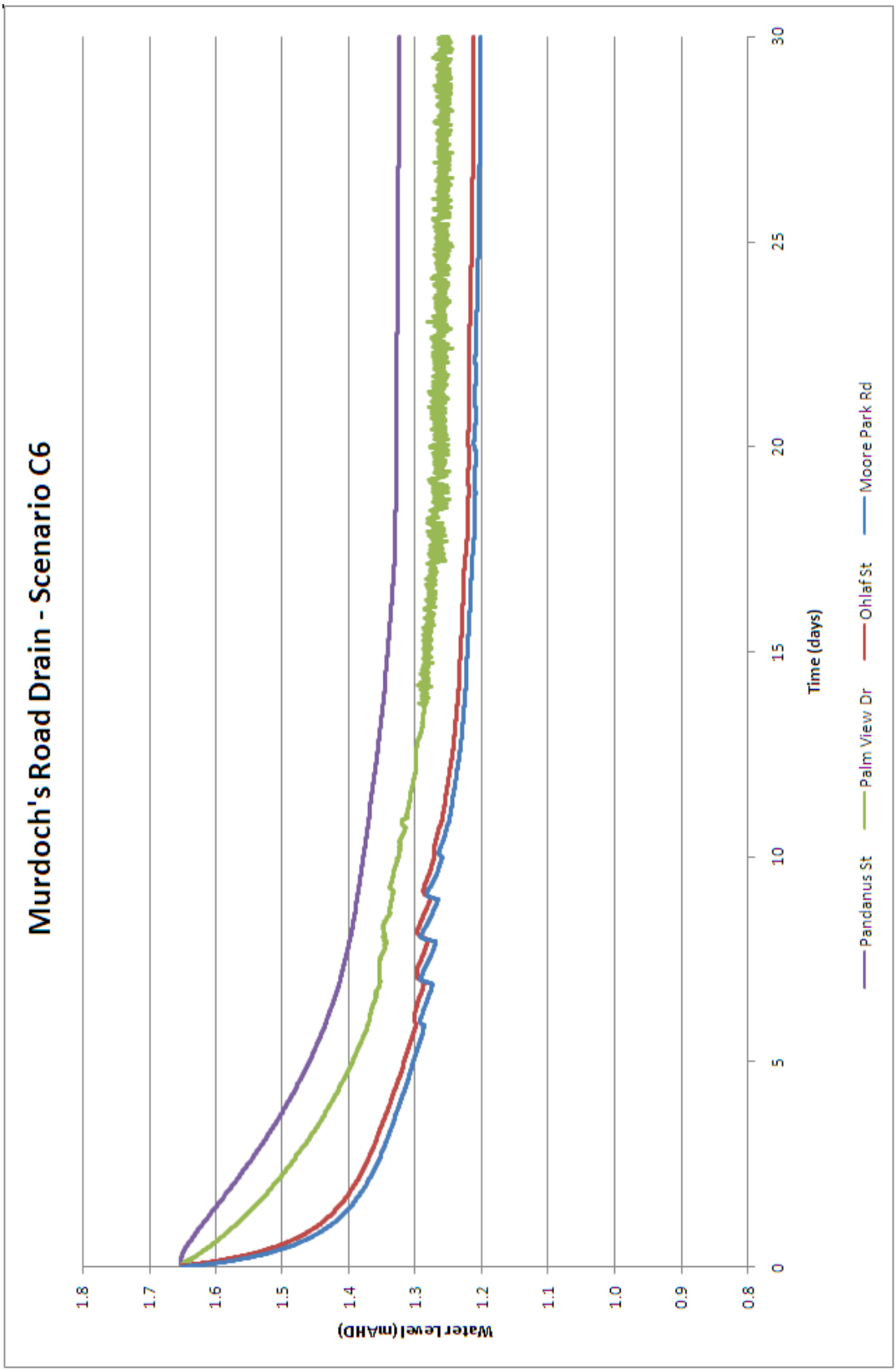


Figure E12. Water Levels at Roads – Option C6

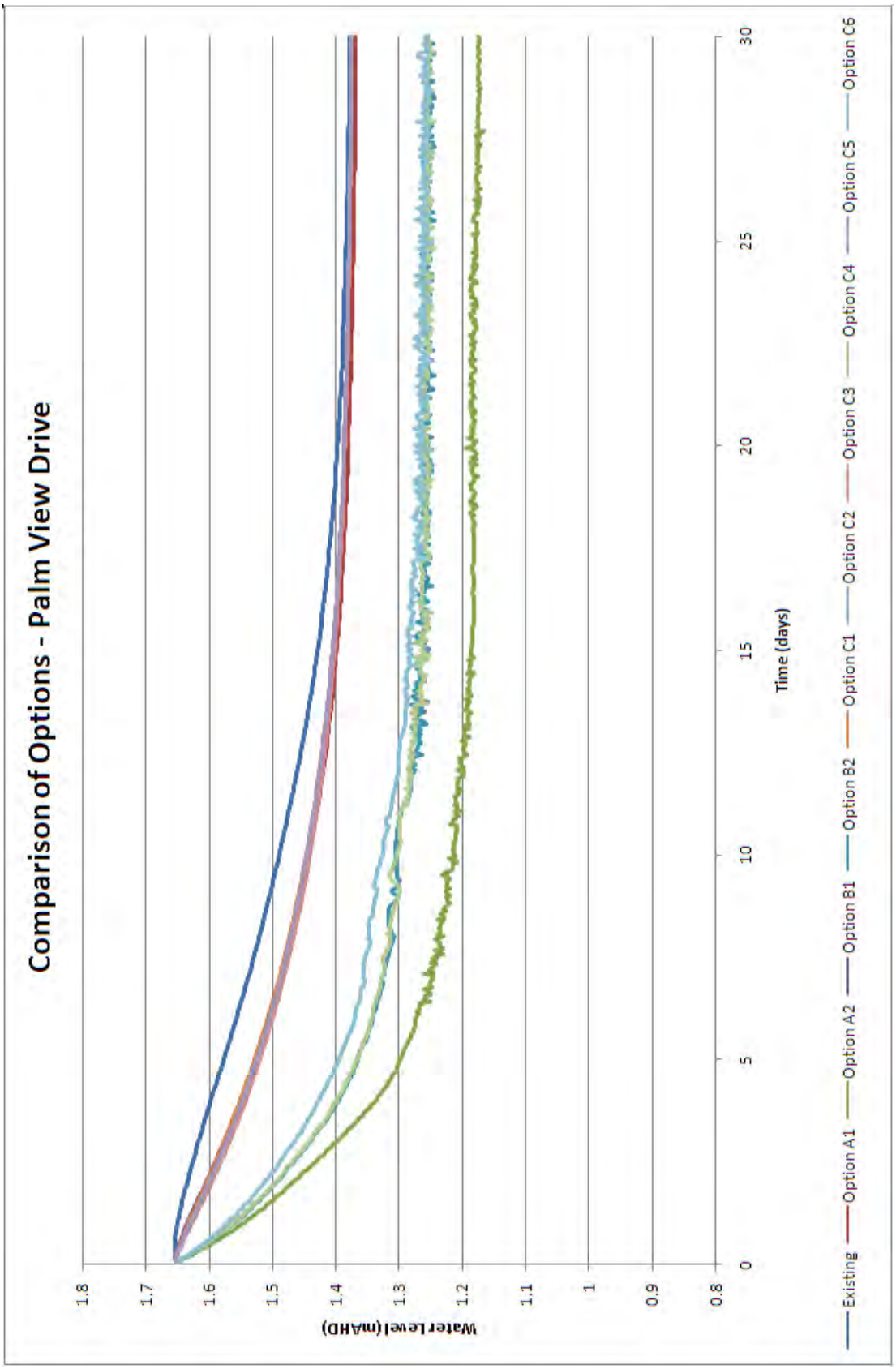


Figure E13. Comparison of Water Levels at Palm View Drive

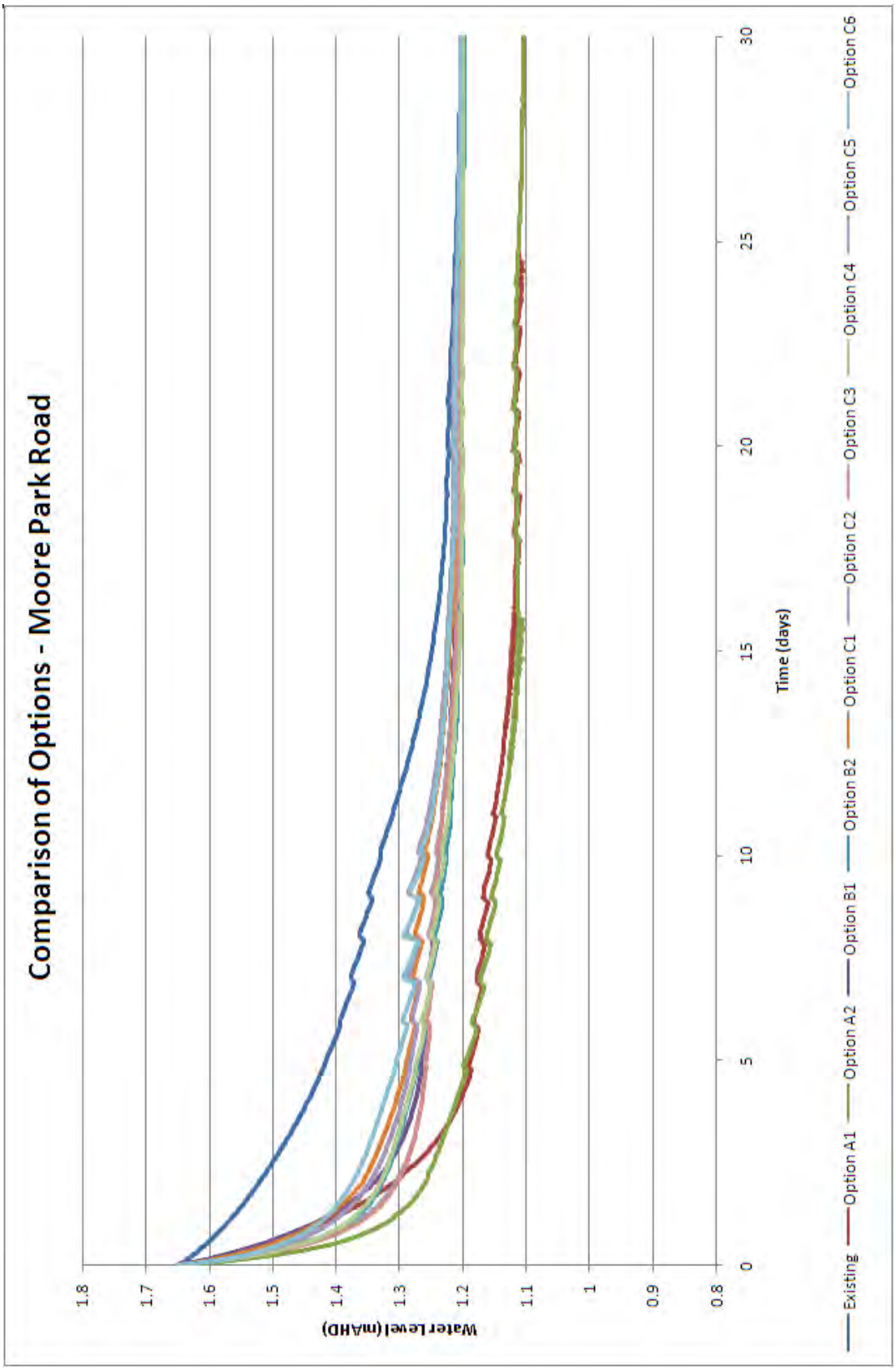


Figure E14. Comparison of Water Levels at Moore Park Road

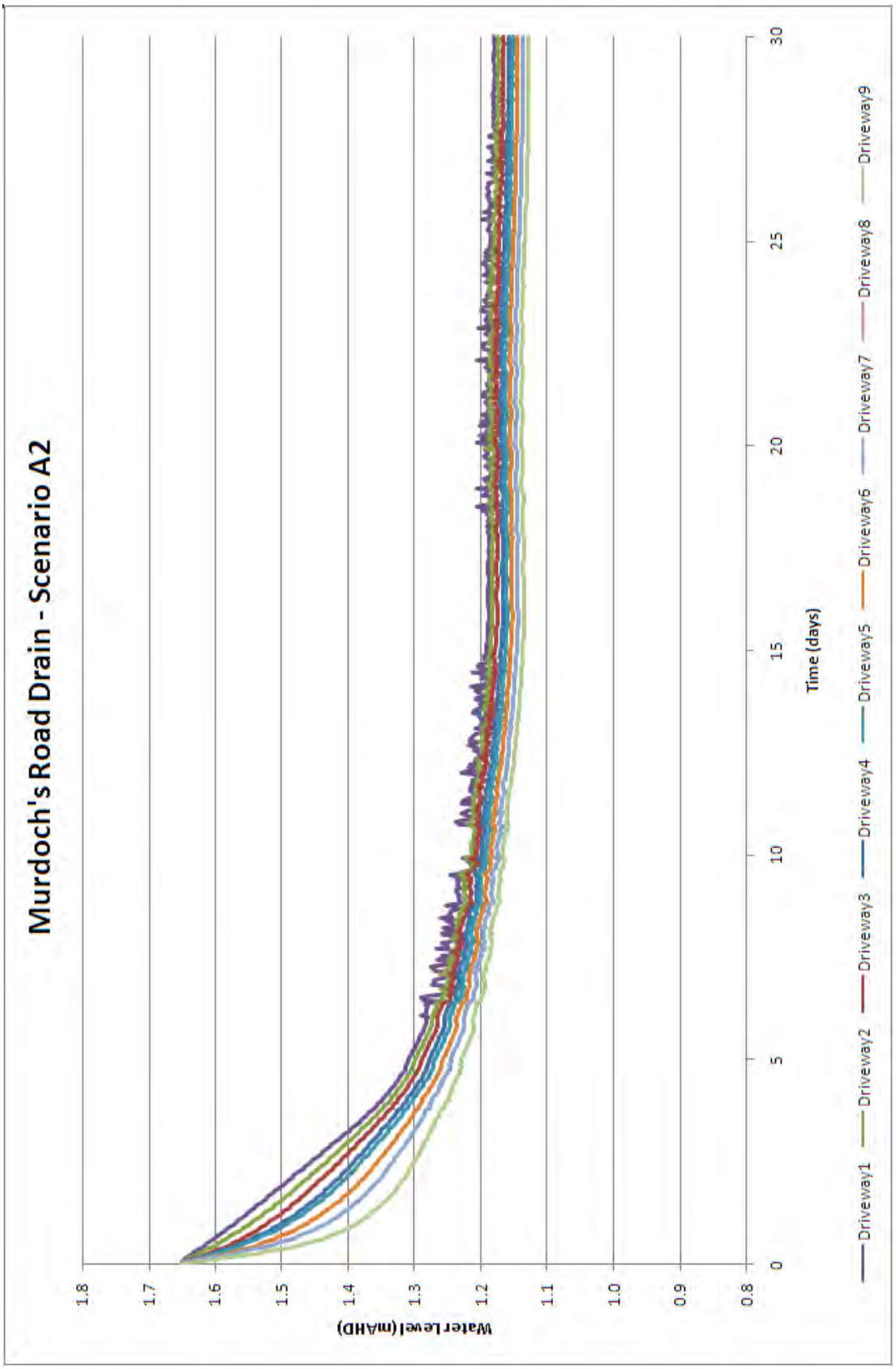


Figure E15. Water Levels at Driveway Crossings – Option A2

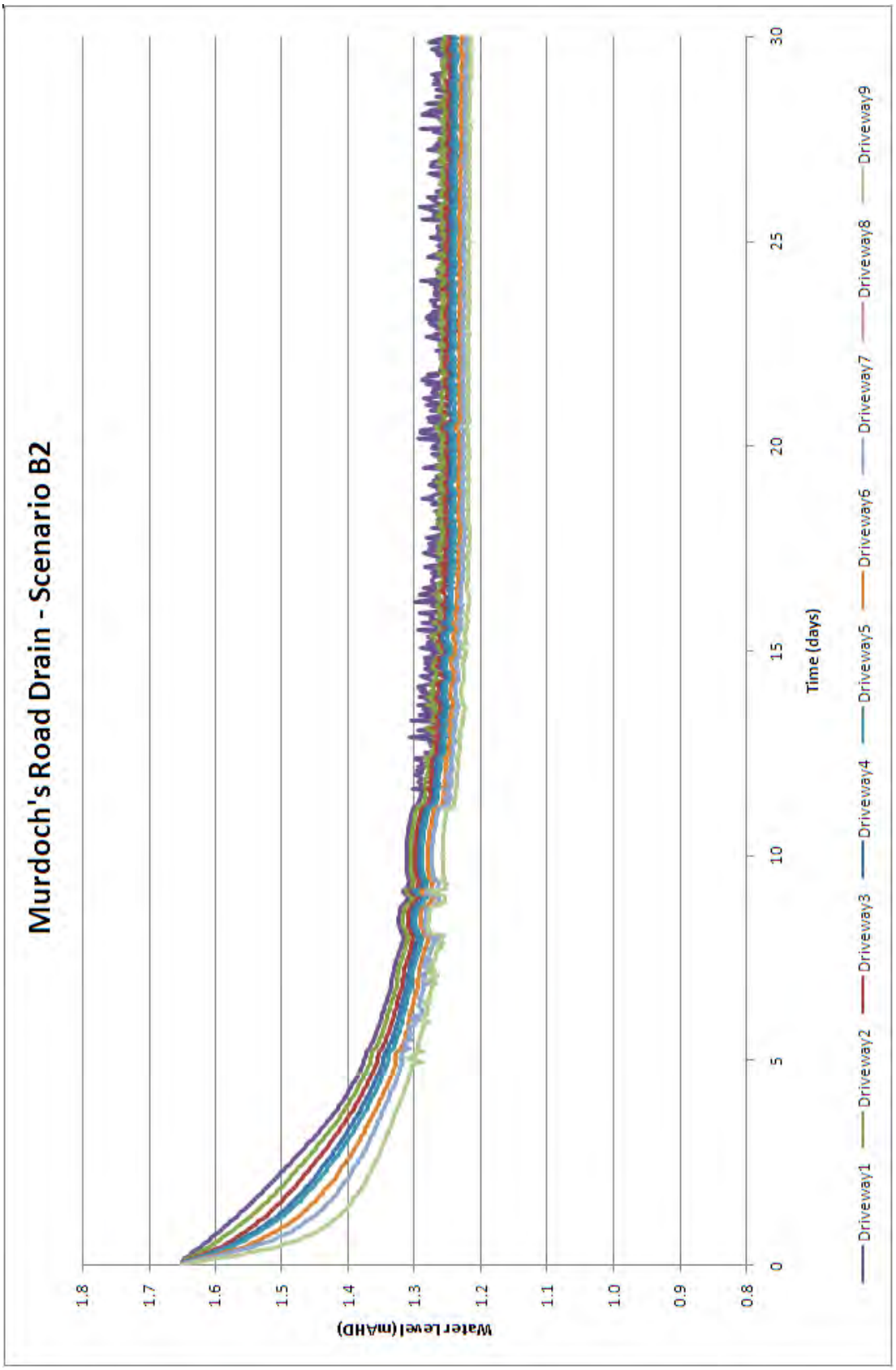


Figure E16. Water Levels at Driveway Crossings – Option B2

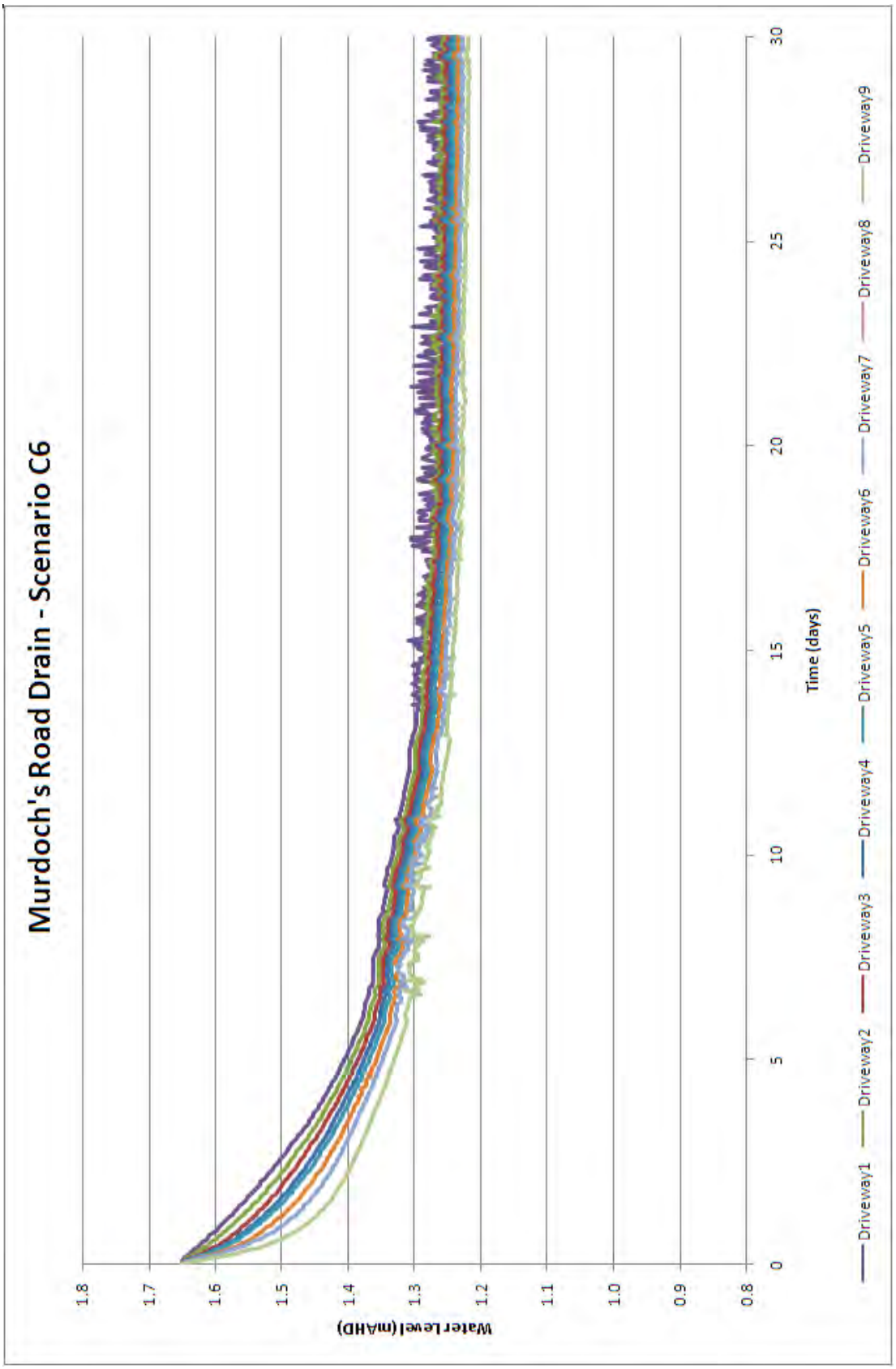


Figure E17. Water Levels at Driveway Crossings – Option C6