



**Water Authority  
of Western Australia**

# **Victoria Bickley Redevelopment**

1200 Dia Gravity Outlet Main

Stage 1

Environmental Management Plan

Report No. WP 151  
January 1992



**Water Authority**  
of Western Australia

**WATER RESOURCES DIRECTORATE**  
Water Resources Planning Branch  
Dams Section

# **Bickley Victoria Redevelopment**

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## *ERRATA*

BICKLEY VICTORIA REDEVELOPMENT  
1200 DIA GRAVITY OUTLET MAIN - STAGE 1

### ENVIRONMENTAL MANAGEMENT PLAN

The first paragraph of section 4.2 is modified by adding at the end the following new sentence; "Where blasting is used the public will be notified under the normal procedures established during the construction of the New Victoria Dam."

The second paragraph of section 4.2 is modified by altering the last sentence to read "Topsoil will then be respread, the area will be sown with native seed mix (see section 6), and the route will be left in a clean and tidy condition after construction."

The third paragraph of section 4.2 is modified by adding at the end the following new sentence; "This will bve done so as to not affect the flow of water in the water courses."

Section 4.3 is modified by adding "(see section 6)" to the last sentence.

BICKLEY VICTORIA REDEVELOPMENT  
1200 DIA GRAVITY OUTLET MAIN

CONSTRUCTION FROM VICTORIA PUMP STATION TO BICKLEY DAM  
ENVIRONMENTAL MANAGEMENT PLAN

1. INTRODUCTION

The Bickley Victoria Redevelopment Scheme was formally approved by the Minister for Environment on July 24 1990. Work on the project is well advanced with the first stage, the construction of the New Victoria Dam largely completed last year. The next stage of the project involves the first stage of the upgrading of the gravity outlet main from the New Victoria Dam to the Canning Trunk Main (see figure 1). The upgrading is required to improve the flows into the trunk main in order that supply pressures can be maintained as the demand for water expands in the northern suburbs.

The conditions of approval for the project require the Water Authority to, among other matters;

- the Water Authority will develop environmental management guidelines for the various parts of the works and incorporate these in the various contracts and construction specifications
- prepare clearing and rehabilitation prescriptions for the various items of the work
- ensure that cultural heritage values are taken into account in the work
- the occurrence of rare and endangered flora are investigated within the project area

This Environmental Management Plan is designed to address these issues for construction of stage 1 of the gravity outlet main from Victoria pump station to Bickley Dam.

2. CONSTRUCTION PROGRAMME AND CONTROL OF WORKS

Construction of the above outlet main is planned to commence in January 1992 with the clearing of vegetation along the route, commencing at the western end of the pipeline. The pipeline construction works should take about 20 weeks to complete, with rehabilitation, weed control and drainage maintenance measures being carried out at appropriate times in the following months.

The officer in charge of construction activities is the Supervising Engineer, Project Management and Construction Branch, Mr Peter Mapstone (telephone 331 2000). The Environmental Management Plan has been prepared by Mr Bob Wark of the Water Resources Planning Branch, Dams Section (telephone 420 2929). On matters related to the Cultural Heritage of the area the contact will be Mr Tony Moulds (telephone 420 2196).

### 3. LIAISON WITH OTHER BODIES

The pipeline construction has been through the Water Authority's Preliminaries to works procedures and was finally approved in July 1990. This process involved contact with the City of Gosnells, the Shire of Kalamunda, CALM and the Department of Sport and Recreation. The proposal has been further developed since the early advice was given and these bodies have been advised that construction is to commence shortly. Discussions are proceeding with them.

### 4. PROPOSED CONSTRUCTION METHOD

#### 4.1 Route

The route is indicated in general terms on figure 1 and in more detail on the figure in Attachment 1, the Report on the Vegetation survey and Recommendations for the Environmental Management of the Project. As indicated in the CER for the Bickley Victoria Redevelopment Scheme, the new pipeline will be buried for most of its length and follows the route of the existing 610 mm main from New Victoria Dam. The existing main will be retained for use as the future pump back main from Bickley Dam.

#### 4.2 Techniques

Due to the nature and topography that will be encountered it is intended to use the excavated trench spoil to form working tracks. The proposed method of rock excavation is by the use of rock breakers where at all possible and blasting will only be used as a last resort.

The pipes will be laid in the trench and sand refill will be placed around the pipe for protection. The remainder of the trench will then be refilled with insitu material. Topsoil will then be respread and the area will be left in a clean and tidy condition after construction.

Rock obtained from the excavation will be used to reinforce the crossings where the road and trench cross a number of the water courses. Rock spalls will be placed in the creek inverts and on the road surface to minimise erosion.

#### 4.3 Clearing

The width of clearing corridors are indicated on the attached sketches, figure 2 and will be kept to an absolute minimum. Over much of the route little extra clearing will be required as the corridor has already been cleared for the existing pipelines and access track. Straight line clearing will be avoided where at all possible and tree outcrops will be left to break up clearing lines. Cleared vegetation will be stockpiled.

#### 4.4 Access

Access to the site for construction activities, supply of materials and the workforce will be along Hardinge Road while the works are concentrated in the lower portion of the valley. Later stages of the works will be accessed from the Victoria Pump Station access road.

Hardinge Road is quite narrow and has been earmarked for upgrading by the City of Gosnells in the next year or so. Local residents are being advised of the timetable for the works and discussions are proceeding with the City of Gosnells to determine measures for traffic management while the works are in progress. These are expected to involve local widening by temporarily filling in the shoulder drains during construction and reinstating them after the works are completed.

The existing pipeline route already has an access track alongside it. This is used for a variety of management issues. The existing track will be largely retained and upgraded using spoil and rock materials from the required excavation wherever possible.

#### 4.5 Sources of Materials

The only material to be imported to the site will be bedding material for the pipe. This will generally be a sand obtained from commercial sources.

#### 4.6 Temporary Stockpiles

Temporary stockpiles will be required for topsoil and materials excavated from the trench. Material from the trench excavation will generally be dumped alongside the trench as the excavation proceeds. The upper

portion of the trench will be backfilled from this material as the backfilling proceeds. Stockpiles of topsoil and vegetation will be made at selected locations where vegetation has already been cleared or is largely disturbed.

#### 4.7 Waste Disposal

Much of the material from the excavation will be used for refilling the upper portions of the trench and where the material is suitable the backfill will be mounded. However some of the materials, such as rockspoil are not suitable as backfill and will be used as a surface treatment for erosion and drainage control, such as through the creek and drainage crossings. Surplus rock from excavation will be disposed of in suitable stockpiles, with at least one located in the cleared area under the power lines near the Victoria pump station.

### 5. ENVIRONMENTAL REVIEW

Attachment 1 is a copy of the report from Mr J. Havel detailing the results of his vegetation survey of the pipeline route. The first three pages summarise the overall findings of the survey and give recommendations for rehabilitation. These will be discussed in more detail in later paragraphs.

One potential problem area that has been identified is an unidentified plant, possibly of Darwinia species, has been found at sections 60-61 and 62-63 (sheets 4 and 5). The status of this discovery is being investigated with CALM who may have to give a permit to move these plants if they cannot be avoided. The steps being taken and which will require to be taken are to;

- i confirm the identification of the plant and its conservation status,
- ii delineate where it occurs on site,
- iii decide whether the construction will disturb the species or whether the route can be modified to avoid the location
- iv if construction will affect the population, then apply for a permit to disturb the plants

Items i and ii are in hand and we hope to have them sorted out during early January. The last two steps will then have to follow in due course. No activities will be undertaken in these areas until this matter has been resolved.

A Category 2 species, Astroloma foliosum also occurs along the pipeline at a number of sections. CALM were advised of

this occurrence in June 1990 and we were advised that a permit to disturb the plant population was not necessary (July 19 1990).

## 6. REHABILITATION

Rehabilitation specifications involve the use of topsoil from the excavation for respreading over disturbed areas at the conclusion of the construction works. Topsoil will be excavated to a depth of 200mm in advance of the general excavation and either temporarily stockpiled as indicated earlier or in some cases, respread on already infilled sections of completed trench. The stockpiles will be constructed in a loose condition to a maximum height of 2.5 metres and protected from damage due to erosion and runoff. The intention is to try and limit the period of retention of material in the stockpiles to three months.

In areas in which a shrub understory has to be cleared, this will be taken out at the same time as the topsoil and either stockpiled with the topsoil or respread on the completed trench. The aim is for the seed store in pods on the vegetation to be retained within the topsoil/vegetation mix. If the vegetation is separated from the topsoil, the seeds will shed naturally and be distributed within the environment.

The Consultant has highlighted a number of sections in which the topsoil is deficient in native species or is contaminated with exotic weed species. These sections, Category three and four or red and yellow types, will be oversown with additional native seed mixes and the weed growth will be controlled by the use of a herbicide (Fusilade) which is specifically targeted towards the exotic weed species.

The spreading of topsoil and native seed mix will commence during April and will be largely complete by mid May. Further details on the exact seed mix will be discussed with CALM, but is likely to use a number of the species which have been already successfully used on the rehabilitation work around New Victoria Dam. One alternative raised by the Consultant was to gather native seeds from the area of the works for use in the rehabilitation. Two companies which may be able to do this would be Nindethana Seeds and Vaughans, although there are a number of other methods of gathering these seed materials.

The application of the herbicide will require the germination of the weeds to have taken place before it is applied. This implies that application should be made during late winter or spring. While the application of this specific herbicide near germinating native vegetation is



regarded as acceptable, its overall suitability for use near water courses and in the forest still has to be determined. This will be followed up with CALM and other authorities with expertise in this field and if it was determined that the application of the herbicide was not acceptable for use in this area then the application would be deleted from the treatment specification and other methods substituted.

#### 7. FIRE CONTROL

Due to the time of year and bush fire hazard, the necessary fire precautions will be taken and daily consultation will be made with the Shire of Kalamunda and the local bush fire control officer.

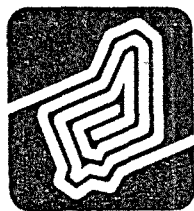
#### 8. DIEBACK CONTROL

CALM dieback restrictions will be followed by maintaining consultation with CALM office at Mundaring. The works are being constructed during the summer months which are essentially dry and all fill materials imported to the site will be dieback free materials.

#### 9. HERITAGE ISSUES

The area has a number of items of significant cultural heritage value, covering both the early development of the area and the water supply system for Perth. Background material is available on the significant sites of general interest, specifically the attached brochure from the WA Heritage Council on the Mason and Bird Heritage Trail. The disturbance of any of these areas is to be avoided wherever possible.

The area is also significant as the site of Perth's first water supply scheme. The main items of interest from the water supply aspect are the old pipe support blocks near Bickley reservoir, the site of the two break pressure tanks and part of the old cobbled portion of Hardinge Road. These are marked on the plans. Disturbance of these locations will be avoided where ever possible. If it is necessary to disturb a site, whether of a general type or a specific water supply interest, or if previously unknown sites are unearthed,



# Mason & Bird Heritage Trail

Retracing One of Western Australia's Oldest Timber Routes.



**PRICE LIST**

JARRAH Wood, in baulk, rough hewn, length from 26 to 30 feet, sizes from 12x12 to 24x24 at 1/2 cubic foot	1s.2d. to 1s.4d.
JARRAH Piles, Hewn, 12x12 to 14x14, from 20 to 35 feet lengths, 1/2 cubic foot	1s.2d. to 1s.6d.
Ditto, ditto, from 35 to 45 feet lengths	1s.6d. to 2s.
JARRAH, Sawn, lengths from 14 to 30 feet, 6in. x 6in., to 16in. x 16in., 1/2 cubic foot	1s.6d. to 2s.
JARRAH, Sawn, Boards and Scantlings for Building purposes, 1/2 cubic foot	1s.9d.
JARRAH, Sawn Telegraph Posts, 20 feet lengths, tapering, average 6in. x 6in.	8s.6d. each.
JARRAH, Sawn Railway Sleepers, 10ft., 10in. x 6in.	5s. each.
TUART Wood, Hewn, in baulk, as above, 1/2 cubic foot	1s.6d. to 1s.9d.
TUART Wood, Sawn, as above, 1/2 cubic foot	1s.9d. to 2s.3d.
SCENTED JAM Wood, 1/2 ton of 2240 lbs.	9s.
SANDALWOOD, 1/2 ton of 2240 lbs.	@ from 10s.

*Note—The Timber is delivered free on board at the above prices.  
Orders for shipment punctually attended to.*

## How To Get There

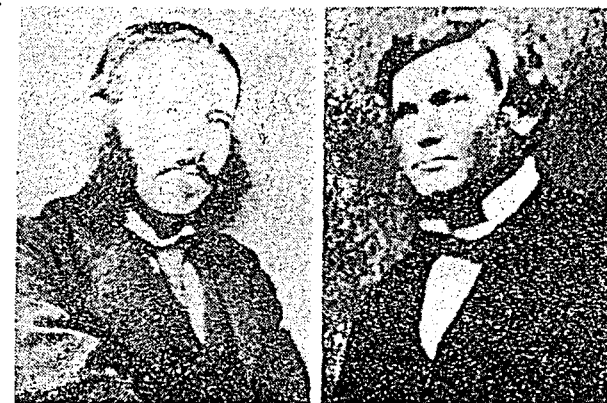
The Mason & Bird Heritage Trail commences opposite the gates of the Bickley Outdoor Recreation Centre, situated on the banks of Bickley Brook Reservoir (built in 1921) about 20km south-east of Perth on Hardinge Road (via Albany Highway and Maddington Road). Trail users are advised to park their cars at the picnic area west of the recreation centre.

The centre was officially opened as the Bickley Youth Camp in 1945 to promote healthy recreation for the youth of Australia.

The 4km (one-way) walk trail traces part of the route of the Mason & Bird Timber Company's tramway which linked its mill in Kalamunda with the jetty on the Canning River. Stopping points are marked by numbered posts which correspond to those in this brochure. At a leisurely pace, the trail will take about an hour to complete.

### Please note:

- Persons using this Heritage Trail do so at their own risk.
- Since the trail does not return to its starting point, it is advisable to arrange transport at the other end if users do not wish to retrace their tracks.



Left: Francis Bird (courtesy Battye Library 5809B/2).

Right: Benjamin Mason, c. 1852 (courtesy Kalamunda and Districts Historical Society).



A Commonwealth/State Bicentennial Project

# Introduction

In the early 1860s Benjamin Mason, a merchant of Perth, established a timber station on the Canning River at Mason's Landing (at the termination of Bickley Road, where River Road and Woodloes Street are today). Timber from the surrounding area was pit-sawn and then transported on flat-bottomed barges via the Canning and Swan rivers to Fremantle or Perth. Realizing the limited potential that the area held compared to the thick stands of jarrah available in the Darling Range, Mason applied for a licence to cut timber near Bickley Brook, in what is today the suburb of Carmel. Upon obtaining his permit in 1864 Mason built his second timber mill, the Hills Station (also known as Mason's Mill).

In 1870 Benjamin Mason took Francis Bird, a well-to-do young architect newly arrived from England, as a partner. Bird put some £25,000 into the business and is considered to have been the designer of the timber tramway which stretched from Mason's Landing to the Hills Station. The tramway closely followed the route mapped by Surveyor James Cowle in the 1860s, for a proposed railway to York.

The 14km track was built by convict labour and took seven months to complete, at an estimated cost of £300 per mile. The tramway was opened by Governor Weld on February 8th, 1872, and was the second railway to be opened in the State.

## 1. Mason & Bird Timber Tramway

The sharp bends noticeable along this section of the trail were part of the original tramway route designed to slow the carriages and prevent them from racing recklessly out of control. The general method for slowing carriages on the tramway was to pull a long lever attached to a blackboy heart, a tough and spongy material commonly used at that time as brakes on horse-drawn vehicles.

The three feet (0.9m) gauge tramway was made of jarrah rails cut five inches (13cm) square. These were deep set into grooves in the sleepers and held in place by wedges. The first 9km from the Canning River was over relatively flat ground, but then ascended

into the Darling Scarp. Three bridges were built - each over 30 metres in length. Only one of these remains (see Site 4).

The tramway was a relatively inefficient and dangerous means of transport, and many horses that pulled the trucks were killed on the dangerous curves and slopes. Valued at about £70 each, these horses represented the equivalent of a full year's wages for one labourer and therefore their deaths were an immense cost for the company.

## 2. Remains of the old Boy Scout Association Camp

These few buildings and timber sheds are all that remain of a former Boy Scouts' Camp.

## 3. Remains of the Boy's Brigade Camp

The foundations that remain here are thought to have supported a brick building that was used by the Boys' Brigade which was active here in the 1960s.

## 4. Munday Brook Bridge

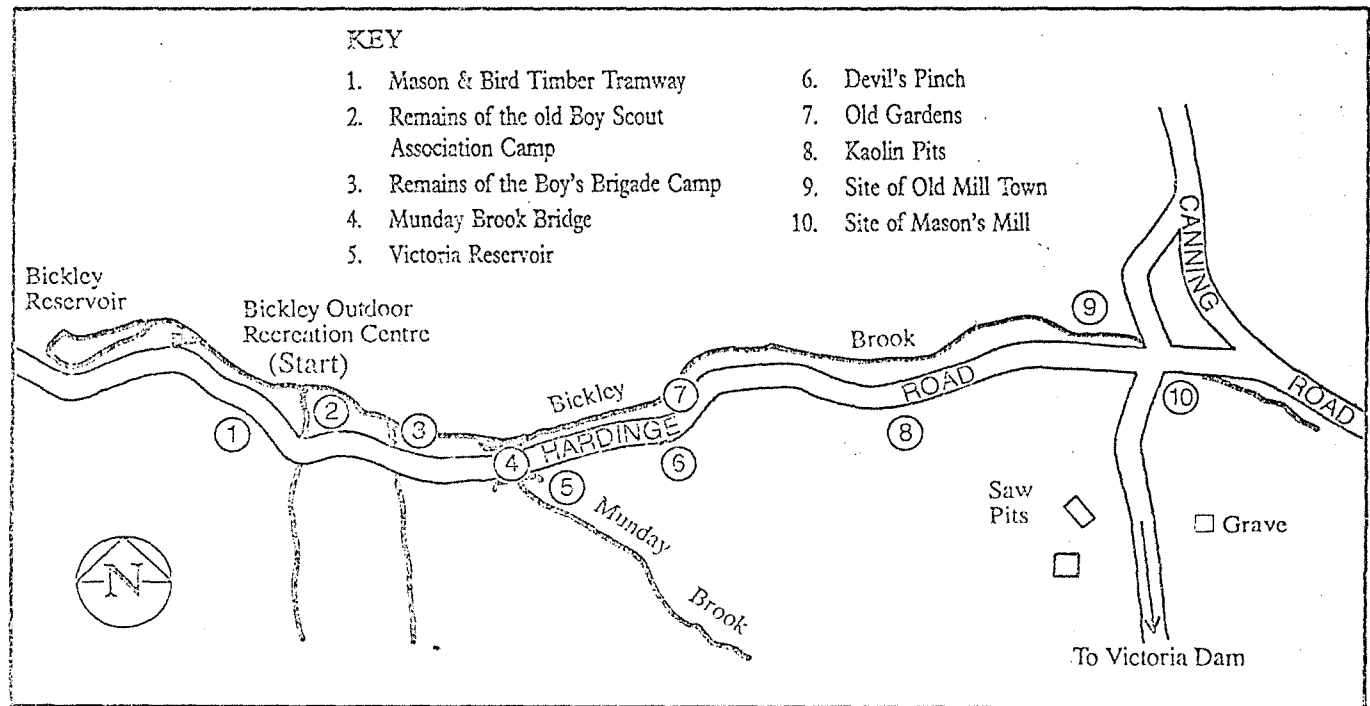
This bridge was built in 1871 as part of the original Mason and Bird timber tramway. The jarrah decking has been replaced but the piles below are thought to be the original wandoo which supported the jarrah rails and sleepers over Munday Brook. Remains of the convict-built embankment and roadway leading to the bridge are still visible.

## 5. Victoria Reservoir

The track to the right is the old access road (now closed) to Perth's first major water supply, the Victoria Reservoir, which was built between 1889 and 1891.

## 6. Devil's Pinch

This steep hill was commonly known as the Devil's Pinch by teamsters who used to drive the timber-laden carriages down to Mason's Landing. At this



Francis Bird's grandson David Bird described one of the accidents at this site as follows:

*...the team was not unhitched quickly enough on a downhill run and although they galloped there was no way that they could stay in front of the juggernaut and they were over-run and were thrown to the bottom of the rocky creek bed near the bridge ...*

A memorial to this accident is located in a tree near the bridge.

To the right of this point, down to Munday Brook, were the wheatfields of Jabez White who pioneered the Orange Grove district in 1862. He operated an innovative water-powered flour mill on his property below the Bickley Dam in the 1870s and 1880s which was rendered unworkable when the Victoria Dam opened in 1891 and cut off the supply of water from Munday Brook.

### 7. Old Gardens

On the left, on the banks of Bickley Brook, are the remains of the old gardens where fruit and vegetables were grown to supply mill workers at the Hill Station. Some of the old fruit trees can still be seen.

### 8. Kaolin Pits

Clay was taken from these pits during the 1960s for the Orange Grove Brickworks. Pockets of this white clay appear throughout this area.

### 9. Site of Old Mill Town

It is probable that the rose nursery on the left is the site of the houses, school, hall and other amenities erected by mill workers. Many interesting items have been uncovered from this site.

Some of the mill workers remained in the town after the closure of the mill and the first to build privately owned homes in the Kalamunda area were John and Emma Wallis and Richard and Mary Weston, in 1883. A few hundred metres from here, along the track leading to the Victoria Reservoir, is the small grave of the Weston's first child, Francis. Both this grave and the Wallis home are featured on the Cala Munnda Heritage Trail, a 42km driving circuit highlighting the development of the

Kalamunda district. The Mason & Bird tramway is also featured on the Kattamorda Heritage Trail, a 27km walk trail through State Forest from Mundaring.

### 10. Site of Mason's Mill

Directly ahead, at the end of the trail, is the site that is believed to have been the location of Mason's second mill. It is now a privately owned orchard.

At one time the mill was a thriving concern, employing a total male workforce of 138 (1% of the male population of the state at the time), 40 horses and 80 bullocks. In 1876 it was reported that 'the timber yard at the Hill Station abounds with huge logs, and an average of 6 bullock teams are daily employed in hauling at the mill'. At the peak years of production the mill produced 20,000 feet of timber per day.

Due to the number of accidents on the tramway, and other transportation problems which made the deliveries unreliable, the business of Mason, Bird and Co. was forced into bankruptcy in 1882. When the new railway opened from Perth to Midland in 1881, timber was diverted there by dray and use of the tramway was discontinued.

Although the Mason and Bird enterprise failed it had helped to stimulate growth in the timber industry and for a time provided a valuable source of income for workers and assisted in boosting the value of Western Australia's exports.

## Acknowledgements

The Mason and Bird Heritage Trail was developed by the City of Gosnells Historical Society which acknowledges and thanks the following:

- City of Gosnells
- Shire of Kalamunda
- Margaret Lefevre
- Riverton Library
- Russell Small - Bickley Youth Camp

Front cover: courtesy Riverton Library

## Further Reading

Harper-Nelson, John (ed.)

*A Line on Kalamunda* (The Nine Club, 1978)

Hickson, David and Slee, John

*The Mason and Bird Timber Company: 1862-1882* (Canning Districts Historical Society, 1978)

Slee, John

*Cala Munnda: A Home in the Forest* (Shire of Kalamunda, 1979)

McNamara, F.J.

*Kalamunda of the Dreamtime* (Paterson Brokensha, 1961)



## W.A. Heritage Trails Network

A Bicentennial Project for  
Community Participation

The Mason & Bird Heritage Trail is part of the Heritage Trails Network, a project for community participation devised by the Western Australian Heritage Committee. To commemorate the 1988 Bicentenary, the project established a statewide network of 'Heritage Trails' - routes designed to enhance awareness and enjoyment of Western Australia's natural and cultural heritage.

The Heritage Trails Network was jointly funded by the Commonwealth and Western Australian governments under the Commonwealth/State Bicentennial Commemorative Program.

Further Information:

W.A. Heritage Committee (09) 322 4375

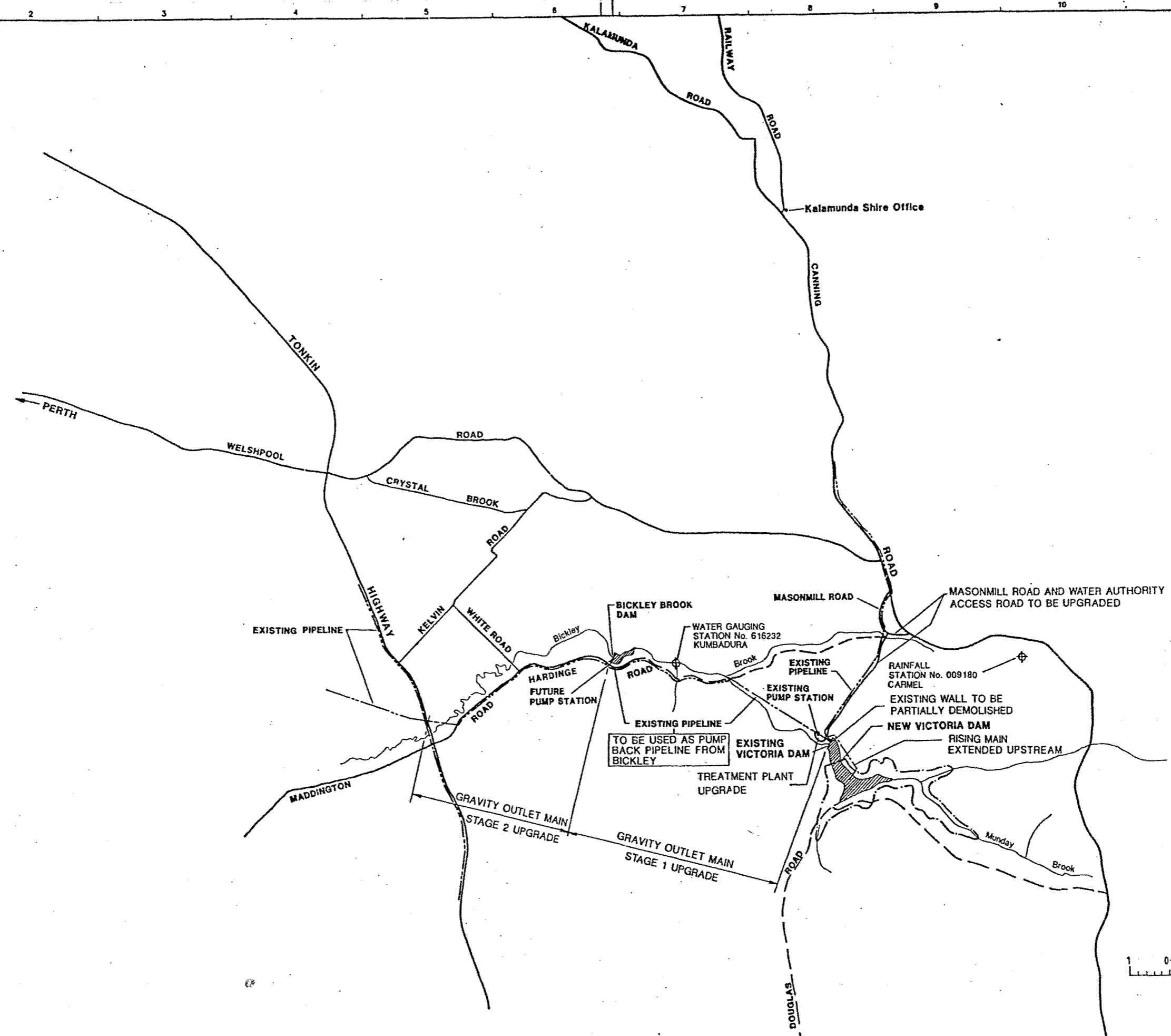
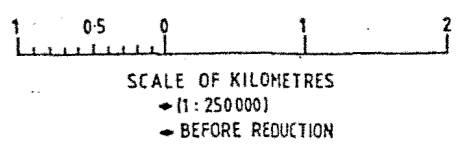
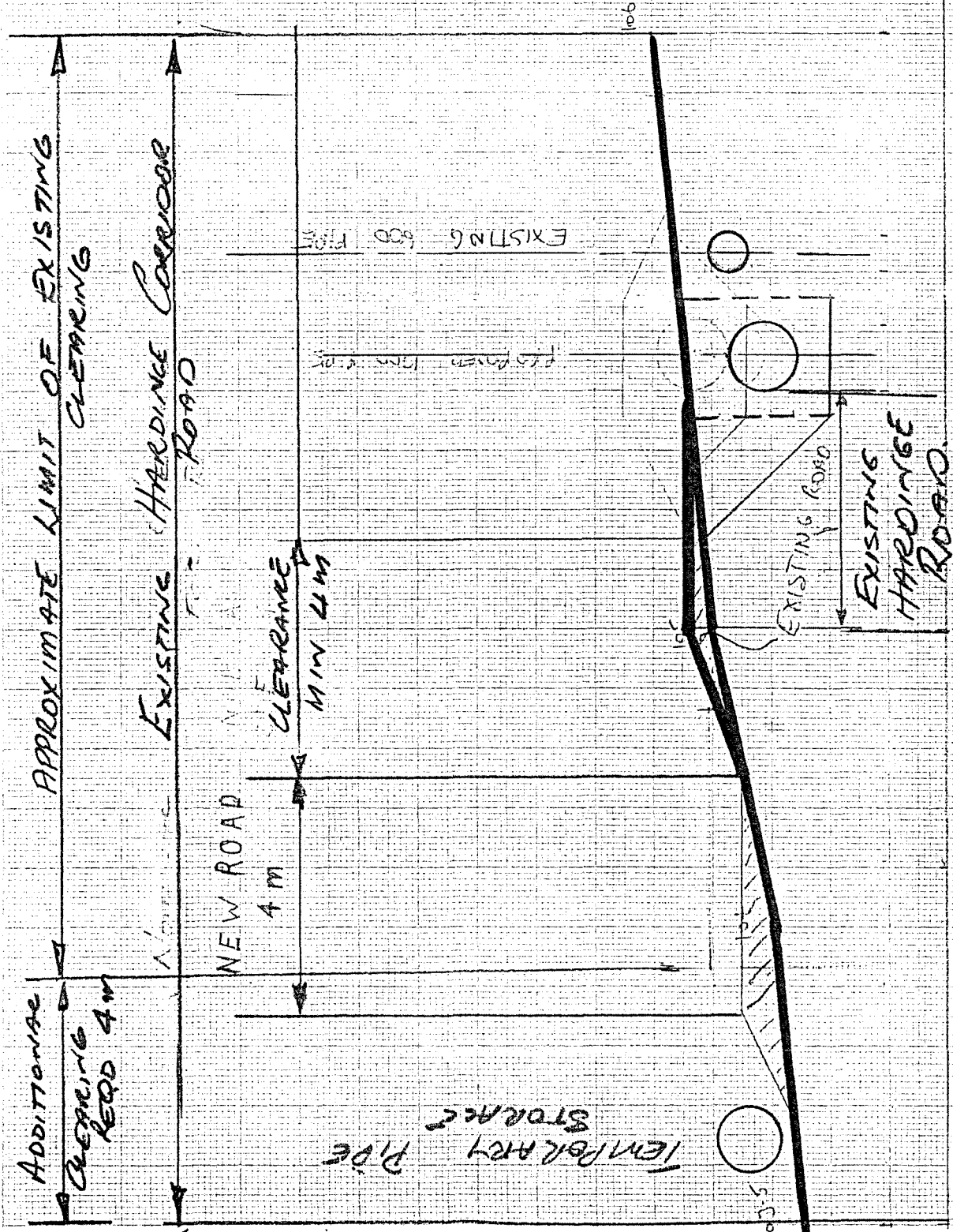


FIGURE 1



ISSUE		DATE	GP:ID	REVISION	DRN	CHD	APPD	SURVEY BOOKS	DATUM	DES	NORTH POINT	6/8/90 SUPERVISING ENGINEER AS CONSTRUCTED DRAWN - CHECKED ENGINEER		RECOMMENDED 11/3/90 PRINCIPAL ENGINEER DAMS APPROVED 19.5.90 MANAGER W.R. PLANNING			<b>VICTORIA - BICKLEY REDEVELOPMENT          NEW VICTORIA DAM - GENERAL ARRANGEMENTS          LOCALITY PLAN</b>			ORIGINAL SHEET SIZE <b>A1</b>
FILE	PROJECT	PLAN	ISSUE	CHD M. BOZ CHD P.M.			6/8/90 19.5.90	E.09-210	W.01-120	B055-10-1	20/3/90									

IP 41, RD 268-4



SECTION RD 268 M.

FIGURE 2 A.

IP 48 RO 1680.5

SECTION  
RD 1680

Nominal Limit of  
Existing Distressed Areas. 18m.

TEMPERARY PIPE STORAGE

NEW  
ROAD WIDTH  
4m

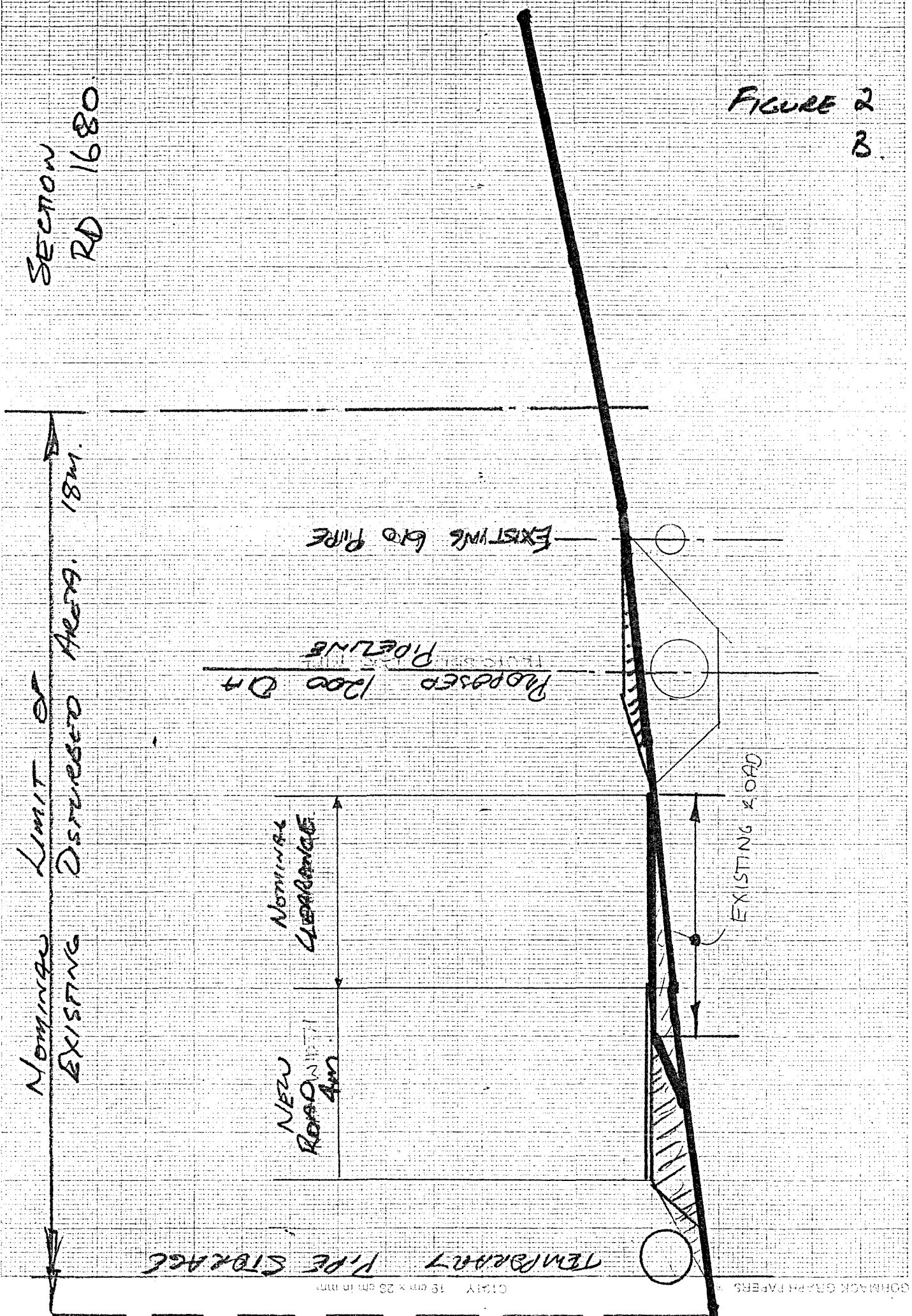
Nominal  
Clearance

Proposed  
1200 Dia  
Pipe

EXISTING 600 PIPE

EXISTING ROAD

FIGURE 2  
B.



SECTION RD 2205

EXISTING DISTURBED AREA 25 m.

(CONTAINS SOME TREES.)  
SELECTED ADDITIONAL CLEARING  
REQUIRED WITHIN CORRIDOR

TEMPORARY PILE  
STORAGE

EXISTING  
ROAD

ROAD WIDENED  
TO 4m AND  
DASHED  
BORDER

EXISTING 535  
PIPE

Proposed  
1200 main

30 m

EXISTING GROUND  
SURFACE

FIGURE 2  
7



FP 68

RP 3106.0

SECTION RD 3106

TOTAL WIDTH OF CLEARANCE 21 m

NOMINAL EXISTING (EXISTING DETERMINED) CORRIDOR WIDTH 14 m AREA

CORRIDOR WIDTH 4 m

TEMPORARY PIPE STORAGE

EXISTING CARPENTER ROAD

MINIMUM ROAD WIDTH 4 m MIN. CLEARANCE

TRENCH WIDTH

CLEARANCE

PROPOSED 1200 S PIPE

EXISTING 525 PIPE

TRENCH SPOLIC

REPOSITION ROAD

151

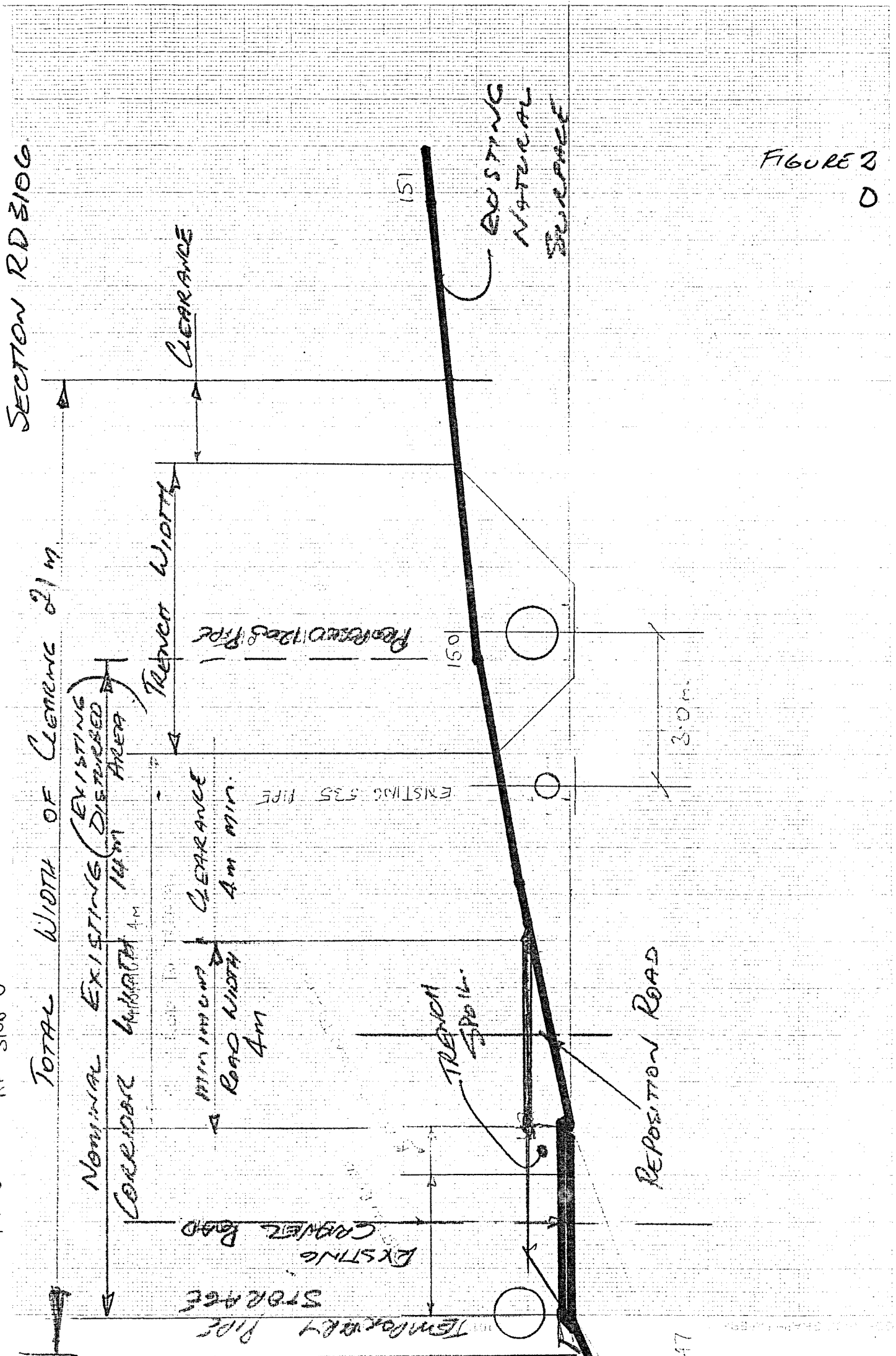
150

EXISTING NATURAL SURFACE

3.0 m

47

FIGURE 2  
D



SECTION RD 3290

CLEARING EXTENSION 10m. LIMIT OF EXISTING CLEARING AREA -

MIN 3m

MINIMUM 4m ROAD TO TRENCH

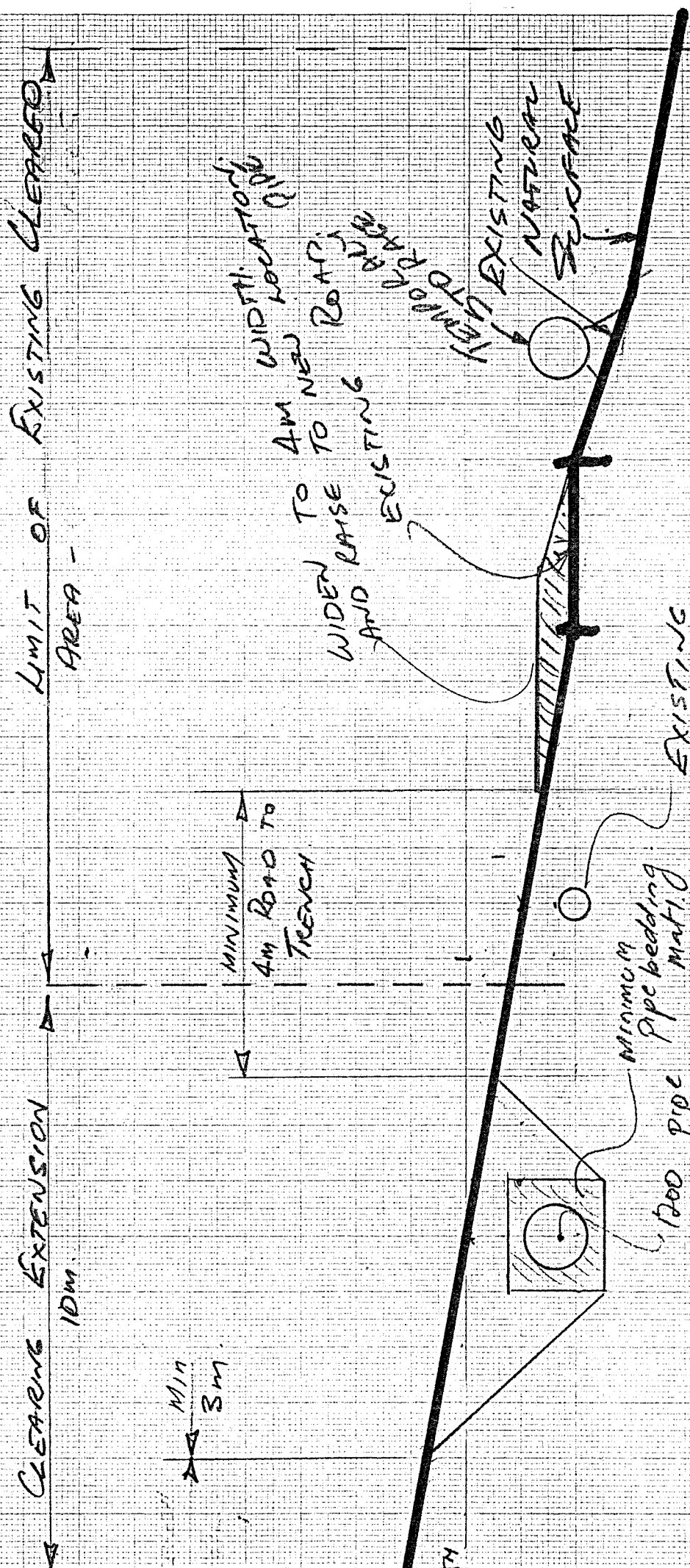
WIDEN RAISE TO 4m WIDTH TO NEW ROAD AND RAISE TO EXISTING ROAD SURFACE

EXISTING NATURAL SURFACE

1200 PIPE  
MINIMUM PIPE BEDDING MAT'L  
EXISTING 535 PIPE

NB TRENCH SHALL BE STEEL PIPED IN EXISTING CLEARING

FIGURE 2 E



ATTACHMENT 1

**BICKLEY TO VICTORIA**

**PROPOSED 1200MM PIPELINE ROUTE**

**REPORT ON THE VEGETATION SURVEY**

**AND**

**RECOMMENDATIONS FOR THE**

**ENVIRONMENTAL MANAGEMENT OF THE PROJECT**

## ATTACHMENT 1

### **BICKLEY TO VICTORIA PROPOSED 1200MM PIPELINE ROUTE REPORT ON THE VEGETATION SURVEY AND RECOMMENDATIONS FOR THE ENVIRONMENTAL MANAGEMENT OF THE PROJECT.**

#### **ENVIRONMENTAL FACTORS.**

##### **Landforms and Soils.**

The proposed pipeline is entirely located in the strongly dissected Helena and Darling Scarp landforms. This means that the lateritic mantle has been totally stripped and that the slopes are, on the whole, much steeper than on the surrounding plateau. This has been compensated to a degree by the location of the pipeline, which makes maximum use of milder slopes of the valley floors, raised alluvial and colluvial terraces and broad spurs. Nevertheless, the pipeline ascends quite steeply from Bickley Reservoir toward the junction of Bickley and Munday Brooks, crossing several minor gullies and spurs.

The other significant consequence of the dissection is the shallowness of the soils, which will affect the ease of construction and rehabilitation. A considerable number of the segments of the pipeline have extensive rock outcrops. Few segments have a rock-free depth of soil sufficient to bury the pipeline, and much rock spoil will be generated in developing the trench for this purpose.

In view of the absence of lateritic mantle, the soils are on the whole more fertile than the soils of the surrounding plateau, being freshly derived from the country rock [granite and dolerite], rather than from reworked materials such as gravels and sands. They tend to be loamy in nature, though they are rarely free from rock fragments. Their greater fertility is highly relevant to rehabilitation, as it favours the invasion of exotic weeds, which are less successful in invading the infertile lateritic gravels of the uplands. The light-brown sandy loams derived from granite are less cohesive and hence more subject to erosion than the red-brown loams derived from the dolerite, which in turn are more erodible than the lateritic gravels of the uplands.

##### **Vegetation - tree overstorey.**

The nature of the soils is reflected in the structure and composition of the overstorey. Structurally the vegetation along the pipeline route is inferior to that of the adjacent uplands. Only in the more favorable situations on the slopes and floors of the valleys does it reach the density and height of a woodland. Elsewhere it is reduced by the shallowness of the soils to either a very open woodland,

shrubland, herbfield or even moss and lichens on otherwise bare rock.

The composition of the overstorey also reflects the greater shallowness and greater fertility of the soil. Jarrah [*Eucalyptus marginata*], which is dominant in the open forests of the adjacent uplands, is absent, being replaced by Marri [*E. calophylla*] and wandoo [*E. wandoo*] in mixtures of varying proportions, and in some locations with higher groundwater table, by WA flooded gum [*E. rudis*].

#### **Vegetation - shrubs and herbs.**

The shrubs occur either as an understorey to the trees, in which case the stratum tends to be more open, or where the depth of the soil is sufficient to support shrubs but not trees, as a dense shrubland one to two meters high. Similarly the herbs occur either as understorey to trees or shrubs, or as continuous or broken herbfields on shallow soils.

#### **Site vegetation types.**

The vegetation falls mostly into Havel's site-vegetation types G and R, with a narrow band of type C on creek banks. The more common species are *Grevillea bipinnatifida*, *G. endlicheriana*, *G. biloba*, *Calothamnus quadrifidus*, *Tricoryne elatior*, *Acacia pulchella*, *Stypandra glauca*, *Goodenia fasciculata*, *Hibbertia hypericoides*, *Hypocalymma angustifolia*, *Hakea erinacea*, *H. lissocarpha* and *H. trifurcata*.

Two species occurring along the pipeline that are sufficiently rare to warrant listing as being in need of protection or monitoring are *Astroloma foliosum* and an as yet unidentified *Darwinia* species. The former occurs mainly near the confluence of the Bickley and Munday Brooks, the latter in the valley of the Munday Brook below the stream crossing.

#### **Degree of preservation of indigenous vegetation and invasion by exotics.**

As the landscape has been under various forms of European impact in excess of one hundred years, there is considerable degree of disturbance. This is reflected both in the reduction of indigenous vegetation and in the invasion by exotic weeds. The more serious weeds occurring along the pipeline are Paterson's Curse [*Echium plantagineum*], *Watsonia* sp. and African Love Grass [*Eragrostis curvula*], but the numerous species of annual grasses such as Wild Oats [*Avena*] and Blowfly Grass [*Briza*] are also effective in competing with and displacing native species and in increasing fire risk.

## **RECOMMENDATIONS ON THE CONSTRUCTION AND REHABILITATION OF THE PIPELINE.**

### **General considerations.**

Inasmuch as the materials generated by the construction of the pipeline are, or can be used in subsequent rehabilitation, it is important to consider the two stages together.

The usefulness of the soil dug up in the construction of the trench for the laying of the pipeline is largely determined by how well its qualities, such as texture, fertility, humus content and seed content of indigenous species and exotic weeds, are known. It is also important in what sequence it is dug up, how it is stored and how it is returned.

The efficiency of the whole process depends on the minimization of costs. It is, for instance, more efficient to replace the topsoil dug up immediately on an adjacent, already completed segment of the pipeline, than to store it for a long time and then return it, after double handling and with depleted seed store, following the laying of the entire pipeline. The seed store depletion is only significant in the moving of topsoil, as subsoil lacks a seed store in the first place and should ideally be covered by the topsoil.

This is even more significant in dealing with biologically inert substances, such as rock thrown up in blasting of the trench through a rocky segment. One possible use for this material is in strengthening rehabilitation in difficult areas, e.g. utilising the rocks from stony ridges in the crossing of the near-by gullies. This should make it possible to reduce the steepness of the pipeline gradient and reduce the risk of erosion and siltation.

The presence of the seed store is only beneficial if it contains the right propagules. Topsoil with abundance of exotic seeds can be looked upon as having a negative value, as the weeds brought in with it will hinder the development of any indigenous species sown or planted in it. This is why weed control is such an important component of revegetation of pastures by trees. Number of segments of this pipeline are former pastureland, partly naturally revegetated since the resumption of the property during the construction of the Bickley Reservoir. As in this case the most common weeds are exotic grasses, control with a selective herbicide such as Fusilade is the most promising method.

### **Specific recommendations.**

In the attached appendix [Appendix 1] the individual segments are described so as to facilitate decision making

for rehabilitation. This is summarized on the attached set of maps [appendix 2], in which each segment is colour coded so as to indicate the ease of rehabilitation. The four categories are as follows:

Category 1 - blue code.

Dense development of indigenous species, few exotics. Revegetation can be achieved by return of topsoil. The segment can be used as source of seeds. The segments falling into this category are 36 to midway between 41 and 42, eastern 2/3 of 43 to 44, 44 to 45, central part of 55 to 56, 58 to 64.

Category 2 - green code.

Moderate development of indigenous species and exotics. Marginally suitable for revegetation by return of topsoil or as source of seeds. The segments falling into this category are eastern half of 41 to 42, western 1/3/ of 43 to 44, 45 to 47, western 1/4 of 47 to 48, eastern 1/3 of 54 to 55, eastern and western ends of 55 to 56, 56 to 58, 64 to 70.

Category 3 - yellow code.

Poor development of indigenous species, considerable development of exotics. Revegetation by return of topsoil alone unlikely to be successful, an outside source of seeds is needed. The segments falling into this category are 33 to 35, 42 to 43, 47 to 52.

Category 4 - red code.

Poor development of indigenous species, strong development of exotics. Sowing of indigenous seeds and control of exotic weeds essential for success. The segments falling into this category are 30 to 33, 35 to 36, 52 to 54, western 2/3 of 54 to 55, 70 to 72.

The map also indicates which stony ridges can be used as sources of stone for facing fill in gullies [sinks]:

Sources of stone - 33 to 34, 41 to 42, 48 ton 49, 53 to 54, 55 to 56, 70 to 71.

Sinks for stone - 34 to 35, 42 to 44, 45 to 47, 49 to 52, 64 to 65.

#### CONCLUSION.

In view of the great diversity of topography, soils and vegetation, as well as differences in past land use, there are great differences in the ease with which the individual segments can be rehabilitated. A sequential approach to construction and rehabilitation that recognises these differences, fits the rehabilitation treatment accordingly and minimizes the effort, is recommended.

## APPENDIX 1

### DETAILED ENUMERATION OF INDIVIDUAL PIPELINE SEGMENTS.

#### SEGMENT

Up to 31

#### Topography

Mainly steep road embankment of the road to Bickley Reservoir

#### Soils

Yellow-brown clayey subsoil with boulders in the embankment, chocolate brown loam on the natural slope below the embankment.

#### Overstorey

Absent on the embankment, scattered marri [*Eucalyptus calophylla*] and wandoo [*E. wandoo*], of varying ages and size, from young coppice to 0.3.m diameter and 15 m height, on the slope below.

#### Understorey

Strongly disturbed, mainly composed of exotic weeds [grasses and *Plantago lanceolata* ], but with a few residual native sedges and *Stypandra glauca* on the natural surface below the embankment.

#### Recommendations

Restore embankment to milder slope, with topsoil on the surface, sow local indigenous shrubby species such as *Thomasia macrocarpa*, *Hakea erinacea*, *Grevillea glabrata* and *Daviesia horrida*.

#### SEGMENT

31 to 33

#### Topography

Bitumen surface of the road to Bickley Reservoir

#### Soils

Yellow-brown clayey subsoil with boulders in the embankment, chocolate brown loam on the natural slope below the embankment.

#### Overstorey

Absent on the road, scattered marri [*Eucalyptus calophylla*] and WA flooded gum [*E. rudis*] and paperbark [*Melaleuca raphiophylla*] of varying ages and size between the road and the Bickley Reservoir.

#### Understorey

None on the road surface, but downslope from it a well developed shrub stratum mainly composed of local indigenous shrubby species such as *Thomasia macrocarpa*, *Thysanotus dichotomus*, *Grevillea glabrata* and *Daviesia horrida*, but also exotic weeds [grasses and *Plantago lanceolata*].

#### Recommendations

Minimise damage due to pipe placement and road relocation to the vegetation between the road and the reservoir. Restore embankment to milder slope, with topsoil on the surface, sow local indigenous shrubby species such as *Thomasia macrocarpa*, *Hakea erinacea*, *Grevillea glabrata* and *Daviesia horrida*.

#### SEGMENT

33 to 34

#### Topography

Steep stony slope



**Soils**

Grey-brown sandy loam with granitic boulders and outcrops .

**Overstorey**

Open woodland composed mainly of stunted WA flooded gum [*E. rudis*].

**Understorey**

Open shrubland of *Jacksonia stenbergiana*, *Acacia saligna*, *Phyllanthus calycinus*, *Chorizema dicksonii*, *Calothamnus sanguineus*, *Stypandra glauca* and *Grevillea bipinatifida*.

**Recommendations**

Pipe placement at prescribed depth will prove difficult and generate much rock. Suggest use of the rock in terracing the cutting and sowing of local indigeneous shrubby species such as *Grevillea bipinnatifida*, *Chorizema dicksonii*, *Calothamnus sanguineus* and *Daviesia horrida*. *Jacksonia stenbergiana* and *Acacia saligna* are ecologically atypical here and are suspected to be colonizers of the existing road disturbance.

**SEGMENT**

34 to 35.

**Topography**

Partly a minor gully, partly slope with rock outcrops. The gully enters the Bickley Reservoir only 30 m to the north.

**Soils**

Grey-brown to red-brown loam with granitic boulders and outcrops .

**Overstorey**

In the gully an open woodland WA flooded gum [*E. rudis*], on the slope scattered marri and wandoo.

**Understorey**

A ground cover of exotic grasses with a scattered shrub storey of *Acacia saligna* in the gully, on the slope exotic grasses with scattered shrubs of *Hypocalymma angustifolium*, *Hibbertia hypericoides*, *Grevillea bipinatifida*, *Calothamnus sanguineus*, *Xanthorrhoea preissii* and *Thomasia foliosa*.

**Recommendations**

Pipe placement and culvert construction in the gully have potential to generate silt for deposition in the reservoir. Suggest use of the rock in facing of the fill and the sowing of local indigeneous shrubby species such as *Grevillea bipinnatifida*, *Chorizema dicksonii*, *Calothamnus sanguineus* and *Hypocalymma angustifolium* over all disturbed surfaces.

**SEGMENT**

35 to 36.

**Topography**

A mild slope with few diorite outcrops.

**Soils**

Red-brown loam with dioritic boulders.

**Overstorey**

A very variable open woodland of marri and WA flooded gum [*E. rudis*], with abundant marri regeneration.

**Understorey**

A ground cover of exotic grasses with some broadleaved weeds such as *Plantago lanceolata* and clovers. Scattered indigeneous shrubs such as *Calothamnus sanguineus*, *Acacia pulchella* and *Hakea erinacea*.

## **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. Given the strong development of exotic grasses, the sowing of local indigenous shrubby species such as *Grevillea bipinnatifida*, *Chorizema dicksonii*, *Calothamnus sanguineus* and *Hypocalymma angustifolium* may need to be followed up with the spraying of the selective weedicide Fusilade in spring.

Station 36 is located in the carpark of the Bickley Recreation Camp, at the commencement of the Kattamorda Heritage Trail, highlighting the strong probability of conflict between the pipeline and recreation in the region. This needs to be taken into consideration in planning the execution of the project, especially as the pipeline and the access track either coincide or are adjacent to one another.

## **SEGMENT**

36 to 37

### **Topography**

A mild slope with few granitic boulders.

### **Soils**

Light brown gravelly sandy loam.

### **Overstorey**

Low open woodland of marri.

### **Understorey**

Strongly developed shrubby story of *Calothamnus quadrifidus*, *Melaleuca radula*, *Goodenia fasciculata* and *Hypocalymma angustifolium*.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigenous shrubby species, especially the Myrtaceae and the Proteaceae, have persistent woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar, but have strongly disturbed vegetation.

## **SEGMENT**

37 to 38

### **Topography**

A mild but stony slope

### **Soils**

Light brown gravelly sandy loam, with a spring approx. 50 m from 37.

### **Overstorey**

Largely treeless, but with occasional marri.

### **Understorey**

Strongly developed shrubby story of *Grevillea bipinnatifida*, *G. endlicheriana*, *G. biloba*, *Calothamnus quadrifidus*, *Tricoryne elatior*, *Acacia pulchella*, *Goodenia fasciculata*, *Hakea erinacea* and *Billardiera coeruleo-punctata*.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigenous shrubby species, especially the Myrtaceae and the Proteaceae, have persistent woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

38 to 39

### **Topography**

A descent into a minor gully

### **Soils**

Light brown gravelly sandy loam.

### **Overstorey**

Open woodland of marri.

### **Understorey**

Strongly developed shrubby storey of *Grevillea bipinnatifida*, *G. biloba*, *Calothamnus quadrifidus*, *Acacia pulchella*, *Goodenia fasciculata*, *Hakea erinacea*, *Darwinia citriodora* and *Hakea trifurcata*.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigenous shrubby species, especially the Myrtaceae and the Proteaceae, have persistent woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

39 to 40

### **Topography**

An ascent from a minor gully

### **Soils**

Light brown gravelly sandy loam.

### **Overstorey**

Open woodland of marri and wandoo

### **Understorey**

Strongly developed shrubby storey of *Grevillea bipinnatifida*, *G. biloba*, *Calothamnus quadrifidus*, *Acacia pulchella*, *Goodenia fasciculata*, *Hakea erinacea*, *Darwinia citriodora* and *Hakea trifurcata* but with a grassy patch SE of station 39.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigenous shrubby species, especially the Myrtaceae and the Proteaceae, have persistent woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

40 to 41

### **Topography**

A mild stony slope

### **Soils**

Light brown gravelly sandy loam.

### **Overstorey**

a low open woodland of marri and wandoo.

### **Understorey**

Strongly developed shrubby story *Darwinia citriodora*, *Calothamnus quadrifidus*, *Acacia dentifera*, *Goodenia fasciculata*, *Hakea erinacea* and *H. trifurcata*.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigeneous shrubby species, especially the Myrtaceae and the Proteaceae, have persistant woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

### **SEGMENT**

41 to 42

#### **Topography**

A mild stony slope

#### **Soils**

Light brown gravelly sandy loam.

#### **Overstorey**

A low open woodland of marri and wandoo, strongly disturbed by the coming together of two tracks near 42.

#### **Understorey**

Change from a strongly developed shrubby story near 41 to a strongly disturbed one near 42.

### **Recommendations**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The rehabilitation of the area disturbed by the pipeline and tracks should utilise seed or slash from the well developed shrub stratum west of 41.

### **SEGMENT**

42 to 43

#### **Topography**

A descent into an eroding broad gully.

#### **Soils**

Light brown gravelly sandy loam, changing to a reddish-brown loam in the gully.

#### **Overstorey**

An open woodland of marri, changing into a woodland of wandoo in the gully, strongly disturbed by the tracks and pipelines crossing the gully.

#### **Understorey**

A strongly disturbed shrubby shrub and herb storey, especially on the gully floor. Open shrubland of *Hakea lissocarpa* and *H. trifurcata*, *Calothamnus quadrifidus*, *Acacia pulchella* and *Thomasia macrocarpa*. Herb storey is a mixture of indigeneous *Lepidosperma* spp. and *Stypandra glauca* with exotic grasses. This is also the western edge of the type population of *Astroloma foliosum*, that is that variety which has an upright form and vividly coloured red and green corolla.

### **Recommendations**

The past crossings of this gully have been done carelessly - there are three of them joined by other tracks and bare parking areas. The culverts have been constructed without an adequate consideration of the erosive power of concentrated streamflow. The entire gully needs attention - elimination and rehabilitation of unnecessary crossings and culverts, properly designed crossing and culvert for the proposed new pipeline, rehabilitation with indigeneous species and control of the grasses.

## **SEGMENT**

43 to 44

### **Topography**

A steep ascent from the gully on to a stony ridge with numerous granitic outcrops.

### **Soils**

Light brown to grey-brown gravelly sandy loam.

### **Overstorey**

A very open woodland of marri, with density reflecting the depth of soil.

### **Understorey**

A strongly developed shrub storey of *Grevillea biloba*, *Calothamnus quadrifidus*, *Acacia pulchella*, *Hibbertia hypericoides*, *Goodenia fasciculata* and on the shallower soils a low shrub storey of *Baekea camphorosmae*, *Phyllanthus calycinus*, *Loxocarya flexuosa*, *Borya* and *Stylidium* spp, the fern *Cheilanthes tenuifolia* and the herb *Isotoma hypocrateriformis*. There are also exotic grasses such as *Briza minor*.

### **Recommendations**

In this section the digging of the trench will prove difficult and will generate considerable amount of rock, part of which may be useable for the rehabilitation of the near-by gully. The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigeneous shrubby species, especially the Myrtaceae and the Proteaceae, have persistant woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

44 to 45

### **Topography**

A near level to mildly sloping broad ridge.

### **Soils**

Yellow-brown gravelly sandy loam.

### **Overstorey**

A woodland of marri, with variable density reflecting the depth of soil. Few small wandoos.

### **Understorey**

A strongly developed shrub storey of with similar species to that of the previous segment, e.g. *Grevillea biloba*, *Calothamnus quadrifidus*, *Acacia pulchella*, *Hibbertia hypericoides* and *Goodenia fasciculata*, but also *Hakea undulata* and *Thomasia macrocarpa*.

### **Recommendations**

In this section the digging of the trench will generate some rock, part of which may be useable for the rehabilitation of the near-by gullies. The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigeneous shrubby species, especially the Myrtaceae and the Proteaceae, have persistant woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

45 to 46

### **Topography**

A descent into a gully. The gully itself, at 46, is moderately incised.

### **Soils**

Near 45 very shallow soils among rock outcrops, becoming deeper near 46, yellow-brown gravelly sandy loam.

### **Overstorey**

Nearly treeless near 45, progressively developing into an open wandoo-marri woodland.

### **Understorey.**

In the treeless segment strong development of tall [1 m] dense shrubland composed of *Grevillea biloba*, *Calothamnus quadrifidus*, *Acacia pulchella*, *Hibbertia hypericoides*, *Darwinia citriodora*, and the indigenous grass *Danthonia caespitosa*.

Nearer 46, in the gully, the shrub storey less strongly developed and vegetation is more strongly disturbed, with greater proportion of exotic grasses, but also indigenous sedges and the shrubs *Thomasia foliosa*, *Phyllanthus calycinus*, *Dryadra nivea* and *Hypocalymma angustifolium*.

### **Recommendations**

In this first section of this segment the digging of the trench will generate some rock, part of which may be useable for the rehabilitation of the gully in the second section. The crossing of the gully should be such as to avoid steepening of the gradient, which may aggravate erosion. The earlier crossings of the gully are good examples of what not to do - there are too many culverts incorrectly constructed, too many tracks, too much disturbance of the vegetation.

The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. As many of local indigenous shrubby species, especially the Myrtaceae and the Proteaceae, have persistent woody fruits, their seeds will be released on drying of the slash and should therefore be utilised in the rehabilitation of the area disturbed by the pipeline in segments which are topographically and edaphically similar but have strongly disturbed vegetation.

## **SEGMENT**

46 to 47

### **Topography**

An ascent from the gully. In most aspects reverse pattern of soils and vegetation to the preceding segment.

## **SEGMENT**

47 to 48

### **Topography**

A continuation of the ascent from the gully to a ridge for the first 50 m, then relative levelling off into a broad gently sloping ridge.

### **Soils**

Variable, mainly yellow-brown gravelly loam develop from granite, but with two doleritic intrusions resulting in red-brown loam.

### **Overstorey**

Mainly a disturbed open wandoo-marri woodland on the ascent, then taller wandoo woodland. Near 48, a strong localised development of WA flooded gum.

**Understorey.**

On the ascent from the gully there is disturbed shrubland composed of *Calothamnus sanguineus*, *Hakea lissocarpa*, *Acacia pulchella* and *Hibbertia hypericoides*, invaded by the exotic weed *Watsonia bulbifera*. On the broad ridge mostly grassy understorey, but containing scattered shrubs of *Darwinia citriodora*, *Grevillea biloba*, *Calothamnus quadrifidus*, *Astroloma foliosum*, *Xanthorrhoea preissii*, the tall herb *Isotoma hypocrateriformis* and the indigenous grass *Danthonia caespitosa*. Invasion by the exotic love grass [*Eragrostis curvula*] in progress.

**Recommendations**

In this first section of this segment the digging of the trench will generate some rock, part of which may be useable for the rehabilitation of the near-by gully. The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of the broad ridge top soil replacement will be much less effective, and sowing of the species enumerated above, especially the rare *Astroloma foliosum*, followed by control of the grasses by the herbicide Fusilade, will be necessary.

**SEGMENT**

48 to 49

**Topography**

A minor rise with rock outcrops.

**Soils**

Mainly ellow-brown gravelly loam over granite, but with some red-brown loam over a doleritic intrusion.

**Overstorey**

Mainly a disturbed open wandoo-flooded gum woodland.

**Understorey.**

Mostly grassy understorey, but containing scattered shrubs and the indigenous grass *Danthonia caespitosa*.

**Recommendations**

The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of this segment top soil replacement will be much less effective, and sowing of the shrub species enumerated for the 47-48 segment, especially the rare *Astroloma foliosum*, followed by control of the grasses by the herbicide Fusilade, will be necessary.

**SEGMENT**

49 to 50

**Topography**

A low ridge.

**Soils**

Yellow-brown to red-brown gravelly sandy loam with boulders.

**Overstorey**

Mainly a disturbed open wandoo woodland.

**Understorey.**

Mostly grassy understorey, but containing scattered shrubs of *Darwinia citriodora*, *Thomasia macrocarpa*, *Phyllanthus calycinus*, *Astroloma foliosum*, *Trymalium floribundum* and *Acacia pulchella*.

### **Recommendations**

The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of this segment top soil replacement will be much less effective, and sowing of the shrub species enumerated above, especially the rare *Astroloma foliosum*, followed by control of the grasses by the herbicide Fusilade, will be necessary.

## **SEGMENT**

50 to 51

### **Topography**

A moderately incised valley of the Munday Brook, with rocky streambed and numerous rock outcrops on the adjacent slopes.

### **Soils**

Red-brown gravelly sandy loam with boulders.

### **Overstorey**

A disturbed open woodland of wandoo, WA flooded gum and marri.

### **Understorey.**

A very open shrubland of *Darwinia citriodora*, *Astartea fascicularis*, *Phyllanthus calycinus*, *Hakea undulata*, *Trymalium floribundum* and *Acacia pulchella*, interspersed with some indigenous *Lepidosperma* spp. and exotic grasses such as *Briza* and *Avena*.

### **Recommendations.**

In view of the close proximity of this creek crossing to the historic railway bridge, which has been recently restored, a better standard of finish and tidying up is needed than has been the case on the previous occasion, when discarded original pipeline was left in the creek bed just upstream of the pipeline crossing. Use of the rocks generated by trenching in the near-by segments with rock outcrops should be considered for creating pipeline abutments near the creek that are aesthetically pleasing, structurally sound and effective in preventing streambank erosion. The visual impact of the stonework could be broken up by planting of shrubs and indigenous creepers such as the *Kennedia* spp. below and adjacent to the stonework.

## **SEGMENT**

51 to 52

### **Topography**

A mild lower valley slope of the Munday Brook.

### **Soils**

Red-brown loam with boulders.

### **Overstorey**

An open woodland of wandoo.

### **Understorey.**

A very open shrubland of *Darwinia citriodora*, *Thomasia foliosum* and *T. macrocarpa*, *Grevillea biloba*, *Phyllanthus calycinus*, *Hakea undulata*, *Astroloma foliosum*, *Trymalium floribundum* and *Acacia pulchella*, interspersed with some indigenous *Lepidosperma gladiatum* and *Stypanandra glauca*. A strong development of exotic grasses in between the native species.



**Recommendations.**

The better quality spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of this segment top soil replacement will be much less effective, and sowing of the shrub species enumerated above, especially the rare *Astroloma foliosum*, followed by control of the grasses by the herbicide Fusilade, will be necessary.

**SEGMENT**

52 to 54

**Topography**

A very mild lower valley slope of the Munday Brook.

**Soils**

Red-brown loam .

**Overstorey**

An open woodland of marri with some admixture of wandoo.

**Understorey.**

Mostly grassy understorey, but containing scattered shrubs of *Darwinia citriodora*, *Billardiera variifolia*, *Phyllanthus calycinus*, *Astroloma foliosum*, *Trymalium floribundum*, *Macrozamia riedlei*, *Acacia pulchella* and *A. dentifera*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of this segment top soil replacement will be much less effective, and sowing of the shrub species enumerated above, followed by control of the grasses by the herbicide Fusilade, will be necessary.

**SEGMENT**

54 to 55

**Topography**

The first 120 m of this segment is very mild lower valley slope of the Munday Brook. Beyond this the pipeline climbs toward a steep ridge.

**Soils**

Red-brown gritty loam with occasional doleritic boulders.

**Overstorey**

For the first 120 m open woodland of marri-flooded gum with a few wandoos. It appears to be a former parkland clearing for pasture now being invaded by a new generation of trees. Beyond 120 m marri-wandoo woodland.

**Understorey.**

For the first 120 m mostly grassy understorey, but containing scattered shrubs of *Xanthorrhoea preissii*, *Hibbertia rhadinopoda*, *Trymalium floribundum*, *Macrozamia riedlei* *Acacia dentifera*. Also some *Stypandra glauca*.

Beyond 120 m the shrub stratum is better developed, containing in addition to the above species also *Grevillea biloba*, *Thomasia foliosum* and *T. macrocarpa*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of this segment top soil replacement will be much less effective, and sowing of the shrub species enumerated above, followed by control of the grasses by the herbicide Fusilade, will be necessary.

## SEGMENT

55 to 56

### Topography

The pipeline here crosses a major ridge running from the Munday-Bickley divide toward the Munday Brook. The steepest slope, and the sharpest fall from the ridge to the Munday Brook is between 75 to 150 m after 55, that is between 2250 and 2300m running distance.

### Soils

Red-brown gritty loam with occasional doleritic boulders.

### Overstorey

Wandoo woodland of variable density, except near 56 where marri and flooded gum become prominent.

### Understorey.

For the first 75 m mostly grassy understorey, but containing scattered shrubs of *Xanthorrhoea preissii*, *Darwinia citriodora*, *Gonocarpus cordiger*, *Gompholobium marginatum* and *Acacia dentifera*. Also some *Lepidosperma gladiatum*.

Between 75 and 150 m dense shrubland of *Hakea undulata*, *Grevillea biloba*, *Thomasia macrocarpa*, *Chorizema dicksonii* and *Stypandra glauca*.

Beyond 150 m dense shrub stratum *Hakea undulata*, *Grevillea biloba*, *Thomasia macrocarpa*, *Chorizema dicksonii*, *Thomasia foliosum*, *Hypocalymma angustifolium*, *Hibbertia rhadinopoda*, *Acacia pulchella*, *Petrophile seminuda* and *Stypandra glauca*.

Near 56 the exotic grasses and *Plantago lanceolata* become once more prominent.

There is also a stronger development of indigenous sedges and grasses, such as *Lepidosperma* and *Tetraria*.

### Recommendations.

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In the strongly disturbed vegetation of first 75 m topsoil replacement will be much less effective, and sowing of the shrub species enumerated for the remainder of the segment, followed by control of the grasses by the herbicide Fusilade, will be necessary. Between 75 and 150 m special care needs to be taken that rocks and soil from the trench excavation do not spill down the steep slope into the Munday Brook.

For the remainder of this segment the indigenous shrubs are well developed and topsoil replacement should be adequate to ensure adequate regeneration.

## SEGMENT

56 to 58

### Topography

Mildly sloping shelf above the Munday Brook

### Soils

Red-brown to brown sandy loam.

### Overstorey

Relatively tall and dense woodland of WA flooded gum, with some admixture of marri and wandoo.

### Understorey.

Predominantly grassy ground storey from former pasture, but also strong development of indigenous sedges [*Lepidosperma*, *Isolepsis*] and shrubs such as *Hakea lissocarpa* and *Calothamnus cp rupestris*.

### Recommendations.

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In this segment the indigenous shrubs and sedges are probably sufficiently well

developed to ensure that topsoil replacement will be adequate to ensure adequate regeneration.

### **SEGMENT**

58 to 59

#### **Topography**

A minor low spur above the Munday Brook.

#### **Soils**

Brown sandy loam with granitic boulders.

#### **Overstorey**

Wandoo-marri woodland of variable age.

#### **Understorey.**

Shrubland of *Hakea undulata*, *H. lissocarpha*, *Thomasia foliosa* and *Petrophile seminuda*. Relatively free from exotic grasses.

#### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline.

### **SEGMENT**

59 to 60

#### **Topography**

A moderate lower slope of the Munday Brook valley.

#### **Soils**

Brown sandy loam with granitic boulders.

#### **Overstorey**

Scattered small marris with occasional wandoo.

#### **Understorey.**

Well developed shrubland of *Grevillea glabrata*, *Hakea undulata* and *H. lissocarpha*, *Thomasia foliosa* and *Petrophile seminuda*.

#### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline.

### **SEGMENT**

60 to 61

#### **Topography**

A mild lower slope of the Munday Brook valley.

#### **Soils**

Light-brown sandy loam with granitic boulders.

#### **Overstorey**

Scattered fire- and drought-damaged mature marri trees with younger regeneration.

#### **Understorey.**

Well developed, dense shrubland of *Grevillea bipinnatifida*, *Hakea trifurcata*, *H. erinacea* and *H. lissocarpha*, *Calothamnus* sp. *rupestris* and *C. sanguineus*, *Thomasia foliosa*, *Darwinia citriodora* and *D. sp.*, *Melaleuca scabra*, *Dampiera*

*linearis*, *Gonocarpus cordiger*, *Oxylobium capitatum*, *Dryandra nivea* and *Pimelea sylvestris*, also the sedges *Mesomelaena stygia*, *Lepidosperma sp.* and *Patersonia occidentalis*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline. Care should be taken not to relocate the access track too far south toward the creek, where it would impinge on the as yet unidentified but possibly rare *Darwinia sp.*

**SEGMENT**

61 to 62

**Topography**

A mild lower slope of the Munday Brook valley.

**Soils**

Light-brown to red-brown gravelly loam with a few boulders.

**Overstorey**

Open woodland of marri with a few wandoo.

**Understorey.**

Tall shrub storey less well developed than on previous segment, but a stronger development of low shrubs. The species include *Grevillea bipinnatifida*, *Hakea trifurcata*, *H. erinacea* and *H. lissocarpha*, *Calothamnus sanguineus*, *Thomasia foliosa*, *Darwinia citriodora*, *Melaleuca scabra*, *Dampiera linearis*, *Gonocarpus cordiger*, *Oxylobium capitatum*, *Dryandra nivea* and *Pimelea sylvestris*, also the sedges *Mesomelaena stygia*, *Lepidosperma sp.* and the monocots *Patersonia occidentalis* and *Thysanotus multiflorus*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline.

**SEGMENT**

62 to 63

**Topography**

A mild lower slope of the Munday Brook valley.

**Soils**

Light-brown to red-brown gravelly loam with a few boulders.

**Overstorey**

A well developed woodland of marri and wandoo.

**Understorey.**

Discontinuous tall shrub storey of *Grevillea glabrata*, *Hakea undulata*, *H. erinacea* and *H. lissocarpha*, *Calothamnus cp rupestris*, *Thomasia macrocarpa*. A strongly developed low shrub storey of *Darwinia sp.*, *Calothamnus sanguineus*, *Dryandra nivea*, *Hypocalymma angustifolium*, *Dampiera linearis*, *Gonocarpus cordiger*, *Oxylobium capitatum*, *Dryandra nivea* and *Pimelea sylvestris*, also the sedges *Lepidosperma* and *Tetraria spp.* the monocot *Thysanotus multiflorus*. and the indigenous grass *Tetrarrhena laevis*.

sedges *Lepidosperma* and *Tetraria* spp. the monocot *Thysanotus multiflorus*. and the indigenous grass *Tetrarrhena laevis*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline.

**SEGMENT**

63 to 64

**Topography**

Approach to the crossing of the Munday Brook.

**Soils**

Ligth-brown to red-brown gravelly loam with a few boulders.

**Overstorey**

To the south of the pipeline dense woodland of marri, flooded gum and wandoo on the banks of the Munday Brook, to the north poorly wooded rocky slope.

**Understorey.**

On the streambank tall dense shrubland of *Grevillea glabrata*, *Trymalium floribundum* and *Thomasia macrocarpa*. On the rocky slope a dense shrub shrubland of *Grevillea bipinnatifida*, *Hakea erinacea* and *Darwinia citriodora*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. The floristic richness of the shrub stratum is so great here that maximum effort should go into seed collection for use in the more disturbed segments of the pipeline. Special care is needed to avoid damage to the narrow band of streambank vegetation between the access track and the Munday Brook.

**SEGMENT**

64 to 65

**Topography**

-Crossing of the Munday Brook.

**Soils**

Mostly artificial materials - stones, pipes, concrete.

**Overstorey**

Strongly disturbed along the pipeline and access track, away from these marri-wandoo woodland.

**Understorey.**

On the streambank tall dense shrubland of *Grevillea glabrata*, *Trymalium floribundum* and *Viminaria denudata*, on the edge of the streambed *Astartea fascicularis* and *Lepidosperma gladiatum*.

**Recommendations.**

In view of the proximity of the stream, special care is needed to minimize damage to the streambank vegetation. Higher standard of construction, possibly using stone facing on the abutment of the crossing, is needed compared to the previous crossing, which has been seriously damaged by floods and is an unsightly and possibly unsafe mess.

## **SEGMENT**

65 to 66

### **Topography**

A rise from the crossing of the Munday Brook.

### **Soils**

Red-brown gravelly loam with dioritic boulders.

### **Overstorey**

To the north of the pipeline a string of marri, flooded gum and wandoo on the banks of the Munday Brook, to the south well developed woodland of wandoo on a steep rocky slope.

### **Understorey.**

On the streambank tall shrubland of *Viminaria denudata*, *Grevillea glabrata* and *Trymalium floribundum*. On the rocky slope a dense shrub shrubland of *Grevillea glabrata*, *Hakea lissocarpha*, *Xanthorrhoea preissii* and *Stypantra glauca*.

### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. Special care is needed to avoid damage to the narrow band of streambank vegetation between the access track and the Munday Brook. Given the likely steepness of the cutting on the southern side, stonework facing using materials excavated in digging the pipeline trench may be desirable.

## **SEGMENT**

66 to 67

### **Topography**

A cutting into a steeply sloping ridge.

### **Soils**

Light-brown gravelly loam with granitic boulders.

### **Overstorey**

Widely spaced woodland of wandoo on a steep rocky slope.

### **Understorey.**

A dense, tall shrubland of *Hakea lissocarpha*, *H. undulata*, *Darwinia citriodora* and *Thomasia macrocarpa*.

### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. Given the likely steepness of the cutting on the southern side, stonework facing using materials excavated in digging the pipeline trench may be desirable.

## **SEGMENT**

67 to 68

### **Topography**

A cutting into a steeply sloping ridge.

### **Soils**

Mostly light-brown gravelly loam with granitic boulders, but with wet patch of red-brown loam and clayey subsoil over a dioritic dyke.

### **Overstorey**

Widely spaced woodland of wandoo on a steep rocky slope.

### **Understorey.**

A dense, tall shrubland of *Hakea lissocarpa*, *H. undulata*, *Darwinia citriodora* and *Thomasia macrocarpa*, with a localised development of *Viminaria denudata* below the wet patch.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. Given the likely steepness of the cutting on the southern side, stonework facing using materials excavated in digging the pipeline trench may be desirable. Provision for drainage underneath the pipeline and the access track is needed at the wet patch.

**SEGMENT**

68 to 69

**Topography**

A steep rise toward a knoll, across contours.

**Soils**

A mixture of light-brown gravelly loam with granitic boulders and red-brown loam over a dioritic dyke.

**Overstorey**

Poorly developed stratum of marri and wandoo .

**Understorey.**

A dense, tall shrubland of *Grevillea glabrata*, with a lower stratum of *Darwinia citriodora*, *Hypocalymma angustifolium*, *Thomasia macrocarpa* and the sedge *Lepidosperma gladiatum*.

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. Given the steepness of the rise, good surfacing of the access track may be desirable to minimise erosion.

**SEGMENT**

69 to 70 †

**Topography**

Further rise toward a knoll, across contours.

**Soils**

Light-brown gravelly loam with granitic boulders.

**Overstorey**

Well developed stratum of marri and wandoo .

**Understorey.**

Medium height shrub stratum of *Macrozamia riedlei*, *Xanthorrhoea preissii*, *Pimelea sylvestris*, *Petrophile serruriae*, *Acacia pulchell*, *Leucopogon capitellatus*, *Thomasia foliosa*, *Dryandra nivea* and *Hibbertia hypericoides*. Near 70 strong development of exotic weeds such as grasses, *Plantago lanceolata* and *Echium plantagineum* [Paterson's curse].

**Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. The indigenous shrubs are well developed and topsoil replacement should be sufficient to ensure adequate regeneration. Given the steepness of the rise, good surfacing of the access track may be desirable to minimise erosion. Near 70, control of exotics may be necessary.

## **SEGMENT**

70 to 71

### **Topography**

Gradual descent from the knoll, with gradients both along and across the pipeline.

### **Soils**

Brown to red-brown gravelly loam.

### **Overstorey**

Very strongly disturbed, with some residual marri trees.

### **Understorey.**

Heavily disturbed, with indigenous shrubs largely replaced by strong development of exotic weeds such as grasses, *Plantago lanceolata* and *Echium plantageneum* [Paterson's curse].

### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In view of the strong development of the exotic weeds, sowing of indigenous species will be essential. Control of exotics by the selective weedicide Fusilade will be necessary. As this is the most strongly disturbed segment of the pipeline, with the disturbance dating to earlier pipeline construction, rehabilitation cannot be confined just to the pipeline location.

## **SEGMENT**

71 to 72

### **Topography**

Completion of the descent from the knoll to Munday Brook, with mild gradients both along and across the pipeline.

### **Soils**

Red-brown gravelly loam with boulders near the stream.

### **Overstorey**

Very strongly disturbed, with some residual marri trees, but also exotics [*Malus* - apple].

### **Understorey.**

Disturbed, with indigenous shrubs largely replaced by strong development of exotic weeds such as grasses, *Plantago lanceolata*, *Watsonia bulbifera* and *Echium plantageneum* [Paterson's curse] except on the streambank, where there are residual shrubs such as *Agonis linearifolia*, *Viminaria denudata*, *Astartea fascicularis* and *Lepidosperma* sedges, including *Lepidosperma tetraquetrum*.

### **Recommendations.**

The spoil from the pipeline trench should be replaced with the topsoil uppermost. In view of the strong development of the exotic weeds, sowing of indigenous species will be essential. Control of exotics by the selective weedicide Fusilade will be necessary. As this is a strongly disturbed segment of the pipeline, with the disturbance dating to earlier pipeline construction, rehabilitation cannot be confined just to the pipeline location. Care needs to be taken in crossing the Munday Brook. The dumping of soil on the opposite bank, with steep embankment without adequate protection of the streambank, needs to be remedied.





508/5/478 M.S.C.L PIPE  
CONNECT TO 535 DIA GRAVITY MAIN

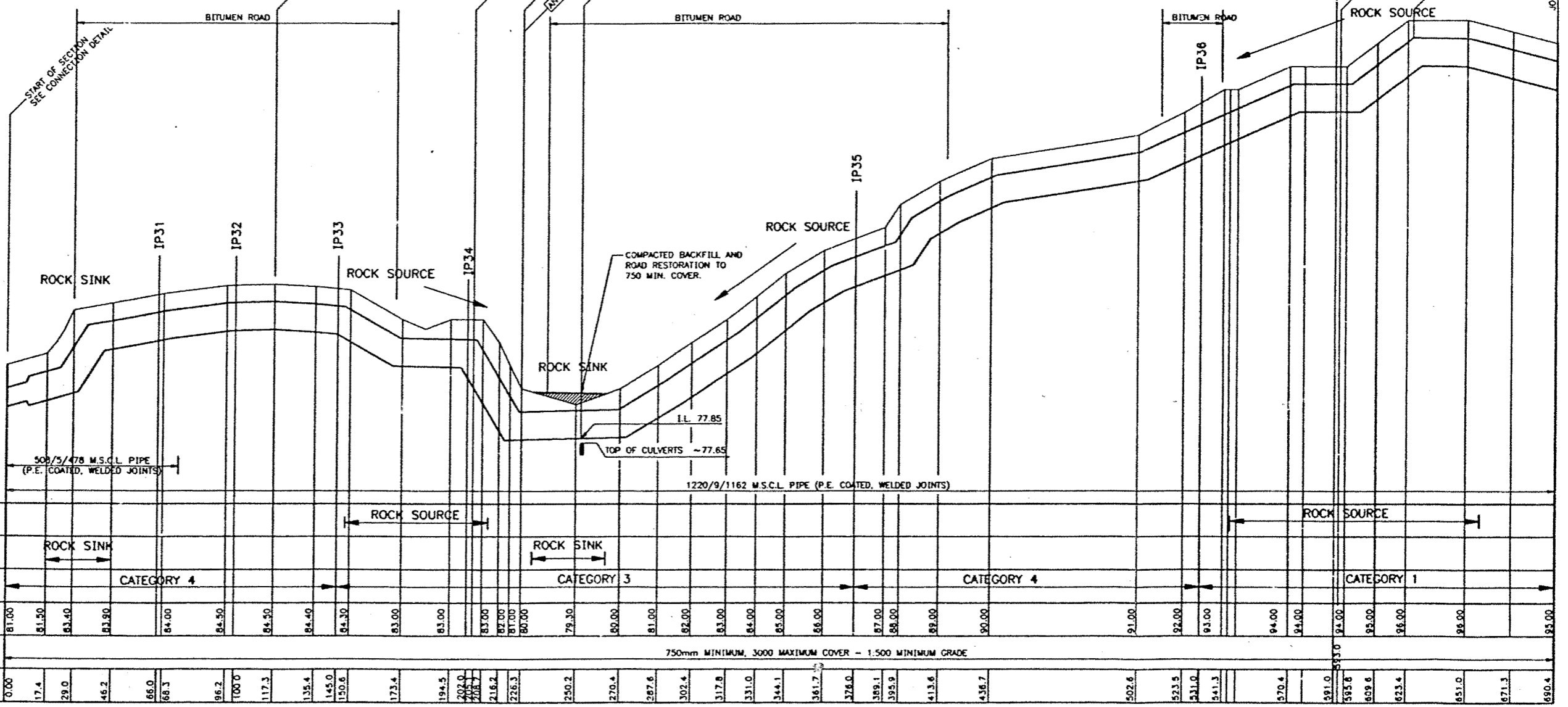
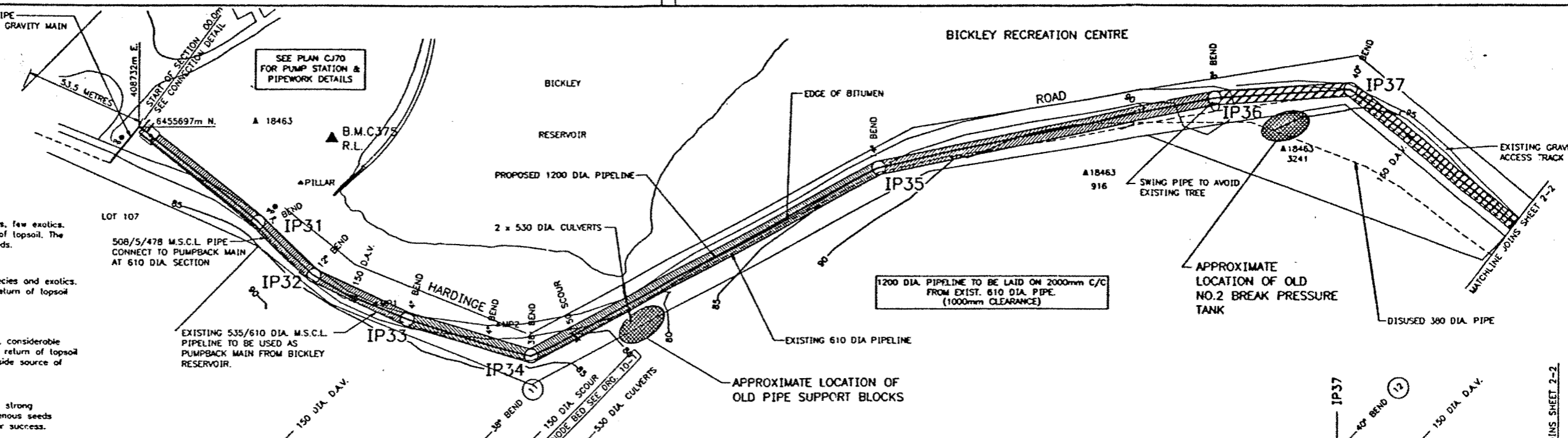
SEE PLAN CJ70  
FOR PUMP STATION &  
PIPEWORK DETAILS

BICKLEY RECREATION CENTRE

**LEGEND**

- CATEGORY 1 - BLUE CODE  
Dense development of indigenous species, few exotics. Revegetation can be achieved by return of topsoil. The segment can be used as source of seeds.
- CATEGORY 2 - GREEN CODE  
Moderate development of indigenous species and exotics. Marginally suitable for revegetation by return of topsoil or as source of seeds.
- CATEGORY 3 - YELLOW CODE  
Poor development of indigenous species, considerable development of exotics. Revegetation by return of topsoil alone unlikely to be successful, an outside source of seeds is needed.
- CATEGORY 4 - RED CODE  
Poor development of indigenous species, strong development of exotics. Sowing of indigenous seeds and control of exotic weeds essential for success.

**NOTE:**  
NAILS OR PEGS HAVE STAMPED AL TAGS WITH  
IP31, IP32 etc.



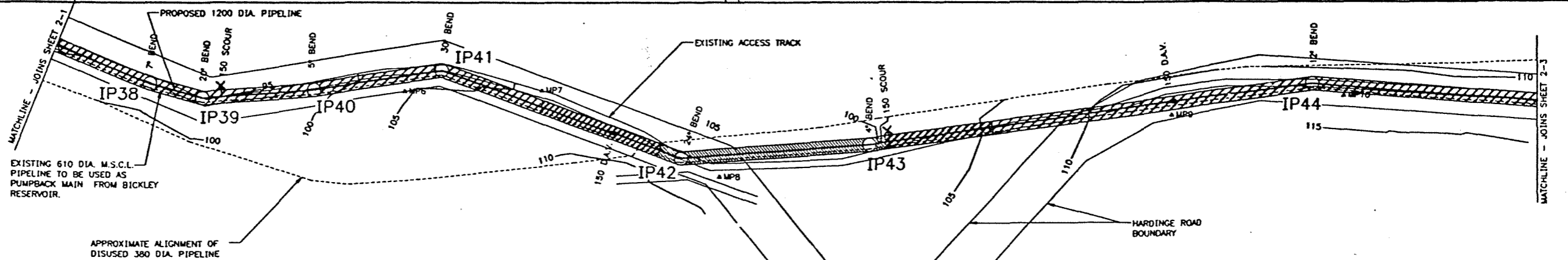
REHABILITATION TREATMENT	75m ABOVE DATUM	
	ROCK SOURCE	ROCK SINK
REHABILITATION CATEGORY	CATEGORY 4	CATEGORY 3
NATURAL SURFACE LEVEL	81.00	81.00
INVERT LEVEL OF PIPE	81.50	81.00
RUNNING DISTANCE	0.00	0.00

LONGITUDINAL SECTION

10 5 0 10 20 30 40 50 60 70 m (1:1000)  
HORIZONTAL  
10.5 0 1 2 3 4 5 6 7 m (1:100)  
VERTICAL

FOR GENERAL NOTES SEE DRG. 1-1

ISSUE	DATE	CRID	REVISION	DRN	REC	APPD	SURVEY BOOKS DBIC	DATUM AHD	DES CALC W.S.D. DES CHD	DES REF W 7011	DRN K.B. & M. BOZ	Q.C. CHD	NORTH POINT	Environmental Management Plan prepared by Water Resources Planning Dams Section based on original drawings which were a Product of Water Supply Design Branch	RECOMMENDED Principal Engineer OAM APPROVED Manager W.R. PLANNING	Water Authority of Western Australia	METROPOLITAN WATER SUPPLY 1200 DIA. VICTORIA DAM OUTLET MAIN - STAGE 1 ENVIRONMENTAL MANAGEMENT PLAN - SHEET 1	FILE A 24768	PROJECT W01.1220M	PLAN CF72-12-1	CAD ISSUE A	ORIGIN SHEET SIZE A1
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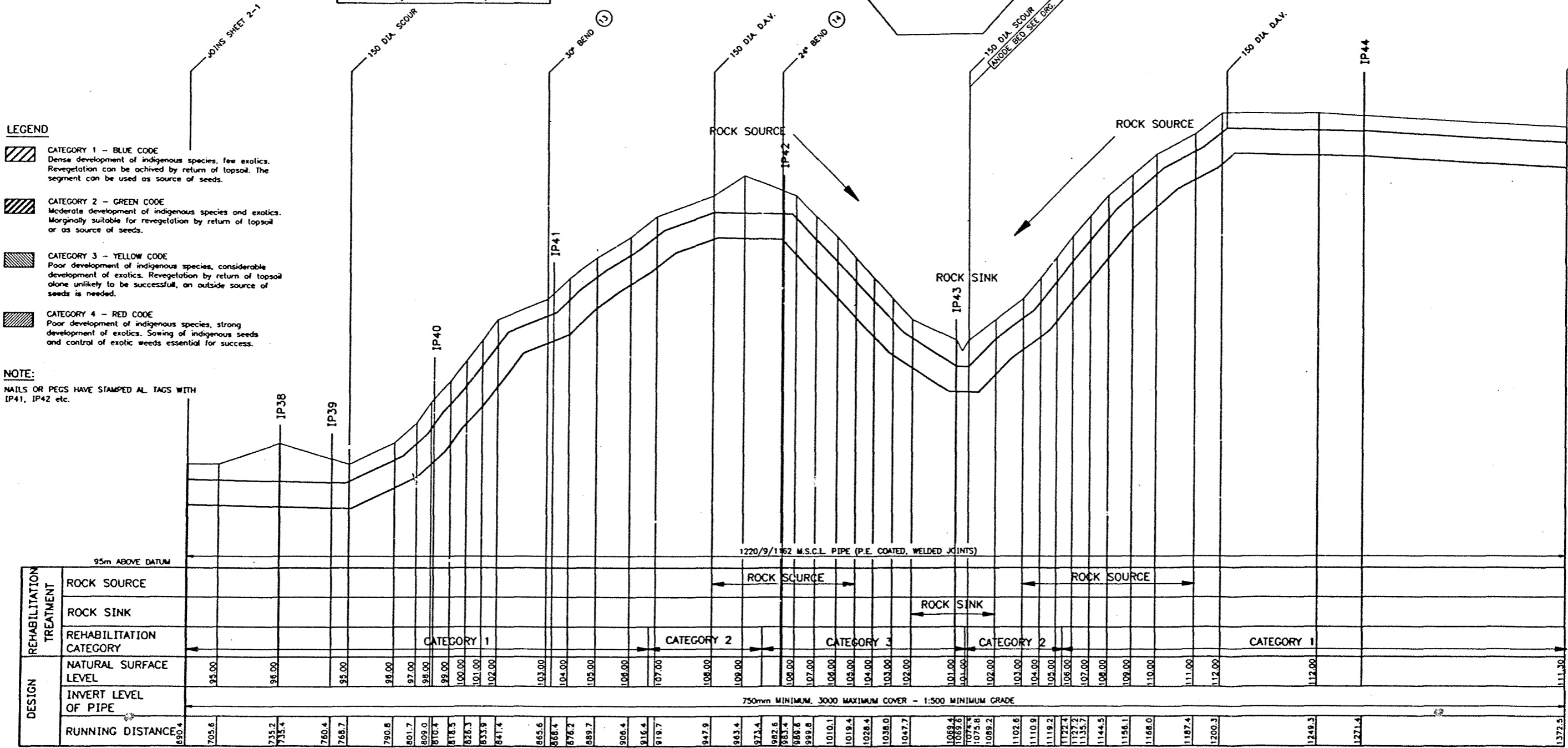
1200 DIA. PIPELINE TO BE LAID ON 2000mm C/C FROM EXIST. 610 DIA. PIPE. (1000mm CLEARANCE)

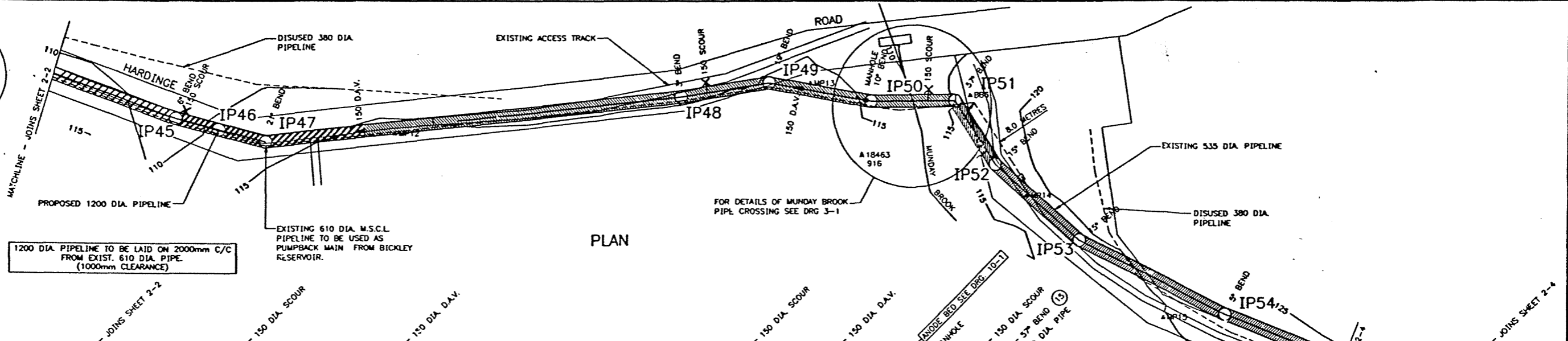
PLAN

LEGEND

- CATEGORY 1 - BLUE CODE  
Dense development of indigenous species, few exotics. Revegetation can be achieved by return of topsoil. The segment can be used as source of seeds.
- CATEGORY 2 - GREEN CODE  
Moderate development of indigenous species and exotics. Marginally suitable for revegetation by return of topsoil or as source of seeds.
- CATEGORY 3 - YELLOW CODE  
Poor development of indigenous species, considerable development of exotics. Revegetation by return of topsoil alone unlikely to be successful, an outside source of seeds is needed.
- CATEGORY 4 - RED CODE  
Poor development of indigenous species, strong development of exotics. Sowing of indigenous seeds and control of exotic weeds essential for success.

NOTE:  
NAILS OR PEGS HAVE STAMPED AL TAGS WITH IP41, IP42 etc.



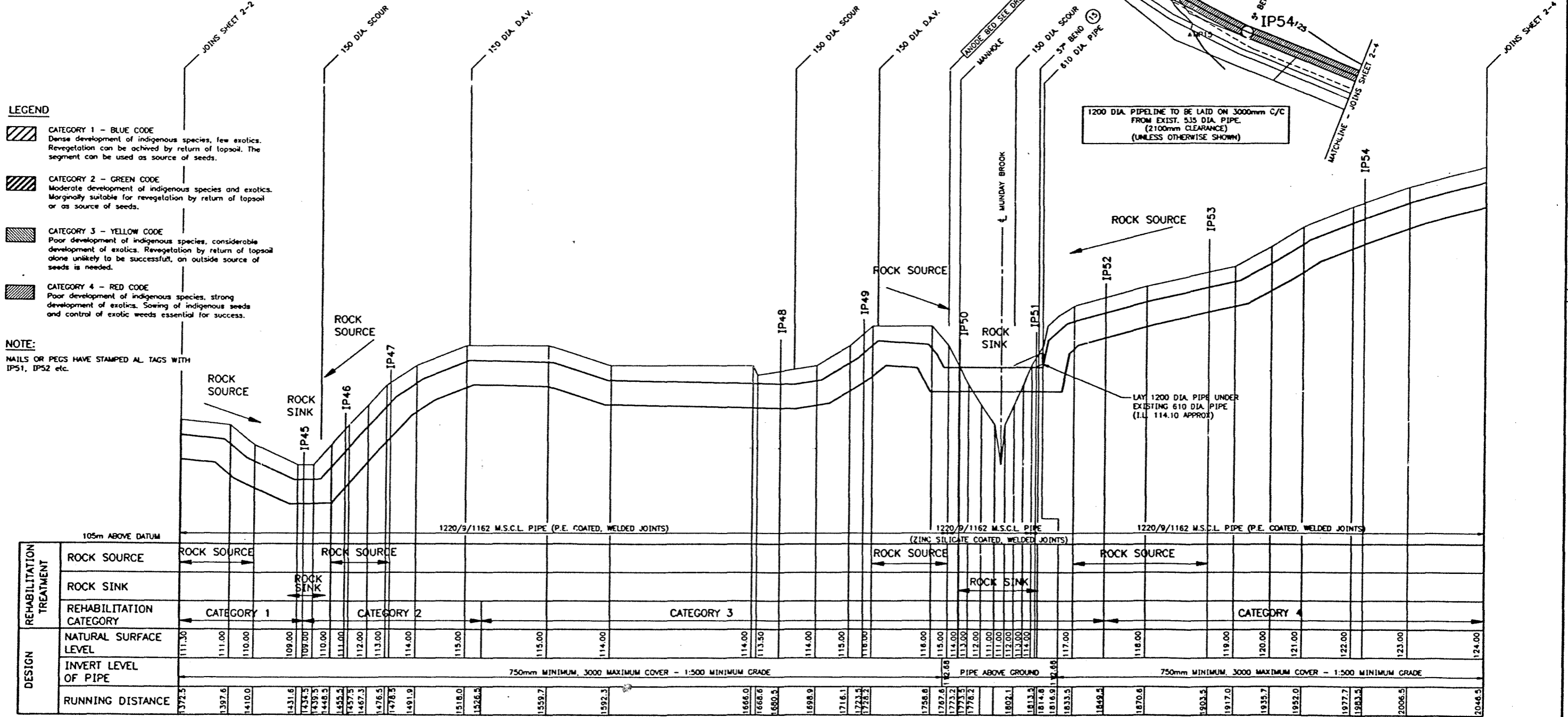


PLAN

LEGEND

- CATEGORY 1 - BLUE CODE  
 Dense development of indigenous species, few exotics. Revegetation can be achieved by return of topsoil. The segment can be used as source of seeds.
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- CATEGORY 4 - RED CODE  
 Poor development of indigenous species, strong development of exotics. Sowing of indigenous seeds and control of exotic weeds essential for success.

NOTE:  
 NAILS OR PEGS HAVE STAMPED AL TAGS WITH  
 IP51, IP52 etc.



LONGITUDINAL SECTION

REHABILITATION TREATMENT	105m ABOVE DATUM																																										
	ROCK SOURCE					ROCK SOURCE								ROCK SOURCE								ROCK SOURCE																					
ROCK SINK					ROCK SINK								ROCK SINK								ROCK SINK																						
REHABILITATION CATEGORY	CATEGORY 1				CATEGORY 2				CATEGORY 3				CATEGORY 3				CATEGORY 4				CATEGORY 4																						
NATURAL SURFACE LEVEL	111.30	111.00	110.00	109.00	109.00	109.00	110.00	111.00	112.00	113.00	114.00	115.00	114.00	113.50	114.00	115.00	116.00	115.00	114.00	113.00	112.00	111.00	112.00	113.00	114.00	117.00	118.00	119.00	120.00	121.00	122.00	123.00	124.00										
INVERT LEVEL OF PIPE	750mm MINIMUM, 3000 MAXIMUM COVER - 1:500 MINIMUM GRADE																																										
RUNNING DISTANCE	372.5	397.6	410.0	431.6	434.5	439.5	444.5	455.5	457.5	467.3	476.5	478.5	491.9	516.0	526.5	559.7	592.3	666.0	666.6	680.5	698.9	716.1	723.5	728.2	738.6	767.6	772.2	773.5	776.2	807.1	811.8	816.9	833.5	849.5	870.6	903.5	917.0	935.7	952.0	977.7	983.5	2006.5	2046.5

ISSUE DATE GRID REVISION DRN REC APPD

SURVEY BOOKS DBIC

DATUM AHD  
 DES REF W 7011

DES CALC W.S.D. DES CHD  
 DRW K.B. & M.BO. O.C. CHD

NORTH POINT

Environmental Management Plan prepared by Water Resources Planning Dams based on original drawings which were a Product of Water Supply Design Branch

RECOMMENDED  
 PRINCIPAL ENGINEER DAMS  
 APPROVED

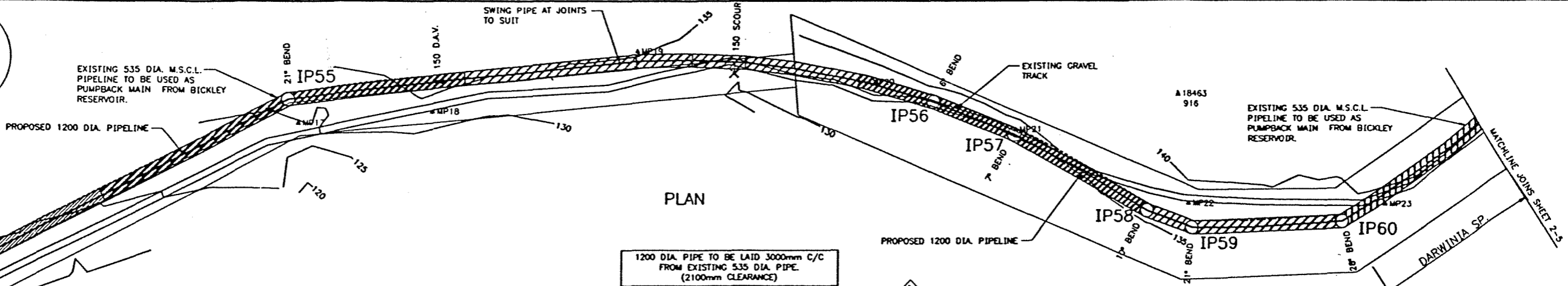
Water Authority of Western Australia

METROPOLITAN WATER SUPPLY  
 1200 DIA. VICTORIA DAM OUTLET MAIN - STAGE 1  
 ENVIRONMENTAL MANAGEMENT PLAN - SHEET 3

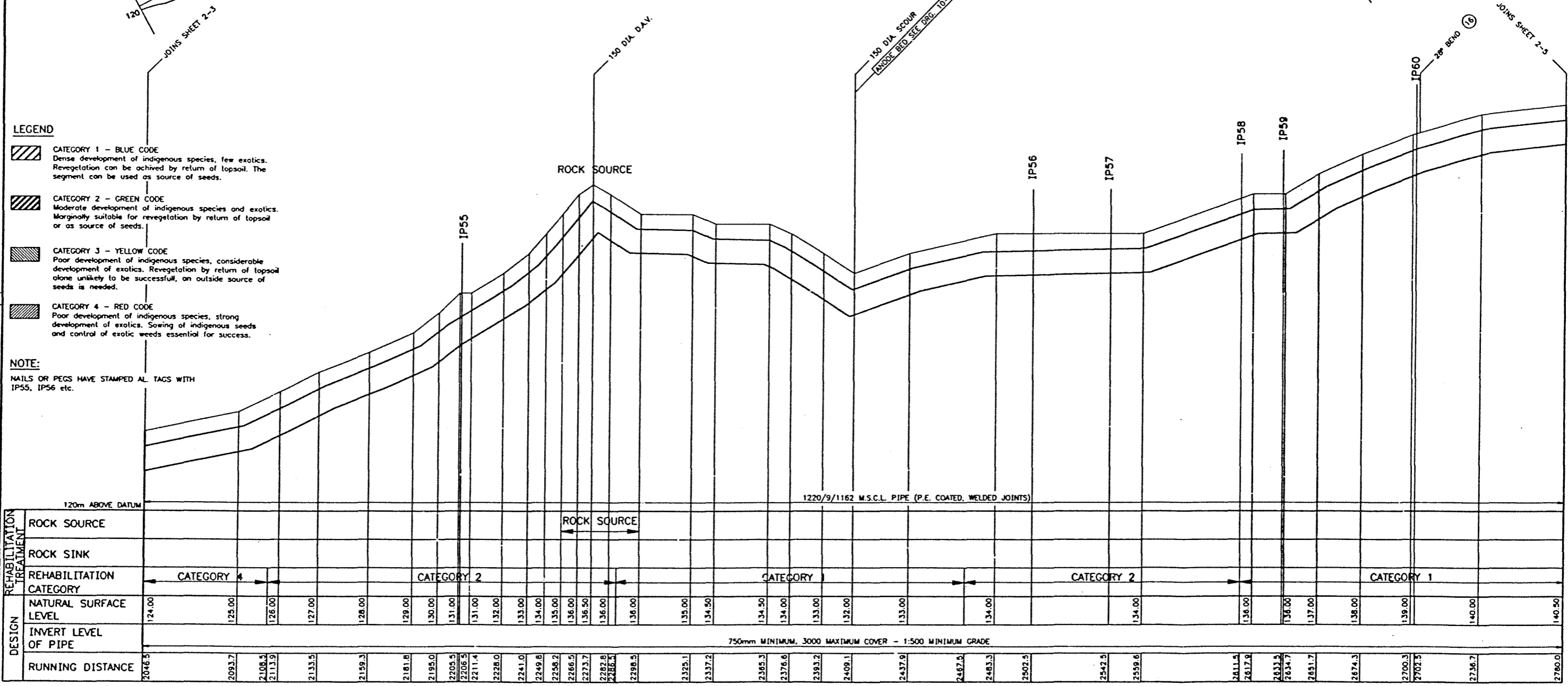
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**A1**

FILE A 24786 PROJECT W01.122CM PLAN CF72-12-3 CAD ISSUE A

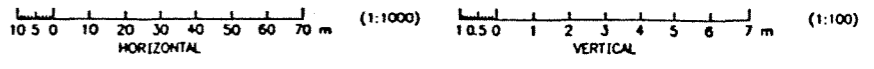
10.1.92



- LEGEND**
- CATEGORY 1 - BLUE CODE  
Dense development of indigenous species, few exotics. Revegetation can be achieved by return of topsoil. The segment can be used as source of seeds.
  - CATEGORY 2 - GREEN CODE  
Moderate development of indigenous species and exotics. Marginally suitable for revegetation by return of topsoil or as source of seeds.
  - CATEGORY 3 - YELLOW CODE  
Poor development of indigenous species, considerable development of exotics. Revegetation by return of topsoil alone unlikely to be successful, an outside source of seeds is needed.
  - CATEGORY 4 - RED CODE  
Poor development of indigenous species, strong development of exotics. Sowing of indigenous seeds and control of exotic weeds essential for success.
- NOTE:**  
NAILS OR PEGS HAVE STAMPED AL TAGS WITH IP55, IP56 etc.

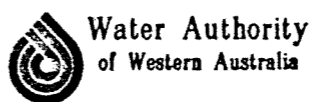


LONGITUDINAL SECTION



FOR GENERAL NOTES SEE DRG 1-1

ISSUE	DATE	GRID	REVISION	DRN	REC	APPD	SURVEY BOOKS DBIC	DATUM AHD	DES CALC R.J.W. DES CHD	NORTH POINT	RECOMMENDED	METROPOLITAN WATER SUPPLY 1200 DIA. VICTORIA DAM OUTLET MAIN - STAGE 1 ENVIRONMENTAL MANAGEMENT PLAN - STAGE 4	ORIGINAL SHEET SIZE
									DRN M BOZICOVIC O.C. CHD		APPROVED	FILE A 24768 PROJECT W01.122GM PLAN CF72-12-4 CNO	A1
Environmental Management Plan prepared by Water Resources Planning Dams Section based on original drawings which were a Product of Water Supply Design Branch											ISSUE	A	
											DATE	19/11/02	



Water Authority of Western Australia

Principal Engineer Dams: *[Signature]* 10.1.99

Manager W.R. Planning: *[Signature]* 10.1.99

Project: W01.122GM

Plan: CF72-12-4

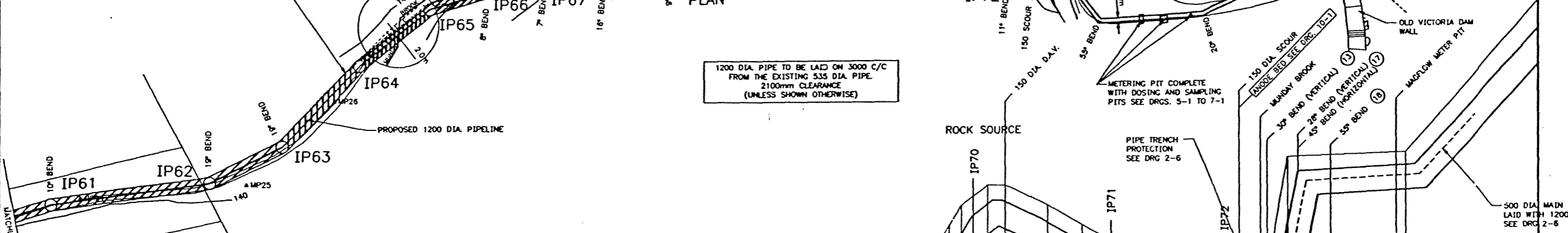
Issue: A

Date: 19/11/02



PROPOSED FLOODWAY  
EXISTING DIA. 535 PIPE TO BE  
RELAID WITH 500 DIA. PIPE  
SEE DETAIL DRG. 3-2

EXISTING 535 DIA. M.S.C.L.  
PIPELINE TO BE USED AS  
PUMPBACK MAIN FROM BICKLEY  
RESERVOIR.



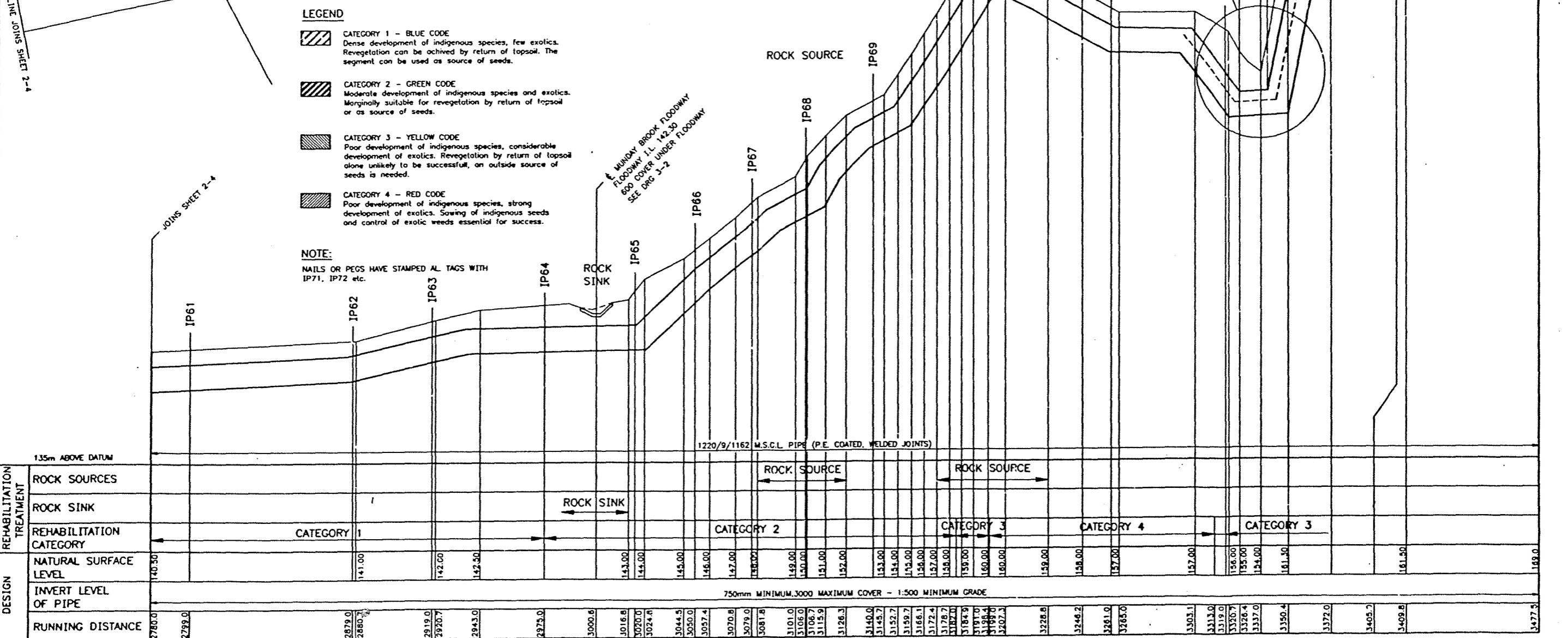
1200 DIA. PIPE TO BE LAID ON 3000 C/C  
FROM THE EXISTING 535 DIA. PIPE.  
2100mm CLEARANCE  
(UNLESS SHOWN OTHERWISE)

**LEGEND**

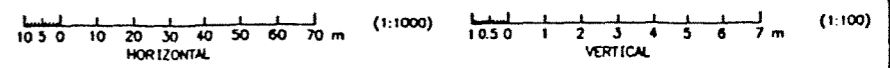
- CATEGORY 1 - BLUE CODE  
Dense development of indigenous species, few exotics.  
Revegetation can be achieved by return of topsoil. The  
segment can be used as source of seeds.
- CATEGORY 2 - GREEN CODE  
Moderate development of indigenous species and exotics.  
Marginally suitable for revegetation by return of topsoil  
or as source of seeds.
- CATEGORY 3 - YELLOW CODE  
Poor development of indigenous species, considerable  
development of exotics. Revegetation by return of topsoil  
alone unlikely to be successful, an outside source of  
seeds is needed.
- CATEGORY 4 - RED CODE  
Poor development of indigenous species, strong  
development of exotics. Sowing of indigenous seeds  
and control of exotic weeds essential for success.

**NOTE:**

NAILS OR PEGS HAVE STAMPED AL TAGS WITH  
IP71, IP72 etc.



**LONGITUDINAL SECTION**



FOR GENERAL NOTES SEE DRG. 1-1

ISSUE		DATE		GRID		REVISION		DRN		REC		APPD		SURVEY BOOKS DBIC.		DATUM AHD		DES. CALC W.S.D. DES. CHD		NORTH POINT		RECOMMENDED PRINCIPAL ENGINEER DAMS		Water Authority of Western Australia		METROPOLITAN WATER SUPPLY 1200 DIA. VICTORIA DAM OUTLET MAIN - STAGE 1 ENVIRONMENTAL MANAGEMENT PLAN - SHEET 5		ORIGINAL SHEET SIZE A1	
DES. REF W 7011		DRN K.B. & M. BOZ		Q.C. CHD		APPROVED		MANAGER W.R. PLANNING		FILE A 24768		PROJECT W01.122GM		PLAN CF72-12-5		CAO		ISSUE A											