Management of Council Gravel Pits in Country Areas - A case study

This TECHreport can be used by Councils who operate licensed mine gravel pits to better comply with their duty of care and be compliant with the legal framework required by the State Governments. Councils can build and maintain better sealed and unsealed roads using a system of materials extraction and blending from different pits to meet higher required performance standards. This report shows how Councils can achieve better whole of life costs and reduce budget expenditures for both sealed and unsealed roads.
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MANAGEMENT OF COUNCIL GRAVEL PITS

1 INTRODUCTION

1.1 General

This TECHrepot can be used by Councils that operate licensed mine gravel pits to more effectively execute with their duty of care and ensure compliance with the legal framework required by the State Governments. This TECHrepot provides guidance on how Councils can better manage their licensed gravel pits. Councils can learn from the experiences of other Councils to build and maintain better sealed and unsealed roads using a system of materials extraction and blending from different pits to meet the required performance standards. Each State will have different test specifications for selected materials to use for unsealed and sealed roads.

1.2 Problems with maintaining rural local roads

- Country Councils have both sealed and unsealed roads. Recent statutory legal changes such as the Civil Liability Acts, create obligations for Councils to be responsible for road asset management and to be accountable for design and construction of roads to meet the requirements of the road user.
- The Federal and State governments have permitted the trucking industry to use heavier, wider and longer trucks on public roads. 85% of these roads are Council local and regional roads and this proportion of the road networks accounts for over 50% of road accidents.
- Most of the taxes on trucks are not returned to local government commensurate with the damage that trucks do to Council roads.
- The exponential increase in the number of trucking axle loads is causing increased damage to roads built with substandard pit gravels from local Council pits.
- Due to the lack of funds Councils are persevering with gravels that are no longer fit for purpose. The materials used are redundant and without a range of stabilisation options, efficient geotechnical testing, gravel blending, and quality construction control.

1.3 Purpose of this TECHrepot

- The purpose of this report is to examine how Councils can meet the challenge with local gravels so that sealed roads are built with the whole-of-life target of 60 years, and unsealed roads with the target of 20 years, with fewer maintenance interventions. The aim is to build and maintain the roads for lower whole-of-life costs rather than focus on immediate material costs.
- This report referencing an ARRB spreadsheet to analyse blending of different materials for longer lasting unsealed roads requiring less resheeting interventions. Cassowary Coast Regional Council, for example, extended maintenance intervention from three months to three years using the ARRB model (GHD modified). Furthermore, potholes were reduced from hundreds in number down to one single pothole after a cyclonic rain event. The road was immediately usable after the rain.
- The Shire of Albany in Western Australia is home to some of the most highly used unsealed roads in Australia. Almost 40% of its 1,100 km unsealed network has over 50 vehicles per day, with up to 350 vehicles per day in some sections. As gravels found in the region are predominantly sandy with little to no plasticity, when used on unsealed roads, they require a high degree of maintenance grading to maintain acceptable serviceability. As a trial, one of the busiest roads was resheeted with a 20% clay stabilised gravel, and the results found that:
  - Maintenance grading consequently reduced from 40-50 times per year to twice per year.
  - There was no potholing along the crown of the road.
  - Dust was reduced by 20-25%.
  - Water did not penetrate due to impermeable pavement and dried more quickly after wet weather.
  - The surface did not become slippery when wet, or ravel or corrugate in hot weather.
  - Resheeting intervention increased from 3-5 years to 10-15 years.

1.4 Material Properties

- For many local Councils, particularly in rural areas, obtaining suitable materials for the effective construction and maintenance of road pavements is a continual challenge. As better quality materials often become scarce or inaccessible, using locally made and readily available materials is often required – professional, laboratory level testing and evaluation of materials is needed to achieve the best use of local materials. ARRB has therefore developed the spreadsheet with macros Road Base Test Kit to allow essential testing and evaluation on site, for local materials. The preferred option as an alternative is off site lab testing when immediate answers are not essential.
- A good unsealed road wearing course is influenced most significantly by particle size distribution. This results in low permeability (impermeable), resistance to ravelling and corrugations, and resistance to potholing.
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- Sieve gradings and linear shrinkage percentage testing are required for each input material characteristics for the ARRB spreadsheet and associated unsealed wearing coarse selection chart.
- To do a shire wide survey the use of Ground Penetrating Radar using a vehicle travelling at 100km per hour is a quick way to check the thickness of existing pavements. This should be followed up with selective Dynamic Cone Penetrating testing which will provide pavement and subgrade CBR in each test site.

1.5 Importance of Gravel Pits

The management of public road assets requires ready access to road building and maintenance gravel materials. The location of natural gravel pits close to the road job site reduces the damage to the roads caused by haulage trucks. Short haulage distances also reduce maintenance costs for roads and in particular, for unsealed roads. Councils over the years have developed local gravel quarries by:

- Directly owning the land and the connecting access track easement to the public road; or
- Agreement with the landowner and paying royalties per cubic metre loose in heap.

The latter method requires the Council to notify the landowner each time before entering the land for gravel extraction or trucking activity.

Both methods require tabulation of the amount of gravel taken from the pit using monthly truck haul sheets or as a total amount measured in heap after the screening and crushing contract.

1.6 Insurance Liability

Situations have occurred where gravel trucks and the landowner’s machinery have collided creating insurance responsibility disputes. One case was valued at $500,000 in damages claims with no persons killed or injured. Clear pit and easement ownership responsibility reduces likelihood of liability disputes in case of accidents. Accidents where death or serious injury occurs can cause the Council General Manager and/or Quarry Manager to be culpable.

In this case there are four parties involved: the landowner haulage contractor, Council (the pit licensee) and the NSW Department of Resources and Energy (R and E).

The R and E regards the access road as part of the mine license. In very few cases do Councils ensure that the access road is marked on the plan included with the Landowner agreement and the Safety Management System (SMS). To avoid negligence or culpability actions, Councils must significantly improve their management of mine licences. In NSW Work Health and Safety Mines Act 2013 and the NSW Work Health and Safety Mines Regulations 2014 focuses more emphasis on safety risk for licensees.

1.7 Abbreviations

- ARRB – Australian Road Research Board
- R and E – NSW Resources and Energy
- SMS – Safety Management System
- PI – Plasticity Index
- QM – Quarry Manager
- QO – Quarry Operator

1.8 Definitions

Reference: Austroads’

- Gravel pit – A site for the extraction and/or crushing of gravel.
- Pit-run gravel – Material obtained from a natural deposit of gravel without crushing or addition of other materials.
- Borrow pit – A road reserve excavation located outside the road formation limits used to obtain fill balance for the road construction. R and E regards roadside borrow pits as quarries.
2  NSW WORK HEALTH AND SAFETY (MINES) ACT (2013) AND REGULATIONS (2014)

2.1  Regulatory requirements

Councils are required to register and license their quarries as mines with the R and E in NSW, or equivalent in other States and Territories. This requirement exists whether the Council owns the land or uses the land by agreement with private landowners.

NSW Work Health and Safety Mine Regulations require Councils to identify all risks associated with activities at the quarry pits, for each pit, as part of the SMS.

2.2  Council requirements in NSW

- The Council is required to arrange training for any nominated QM with the R and E. The R and E is required to approve and appoint the selected QM for competency testing based on training, work experience, examination and site interview audit of knowledge of all pits under the nominated person’s control. A document is then provided to the Council approving and certificating the person as QM for the nominated licensed pits.

- The Council can arrange for SMS certified contractors to provide drilling, blasting, dozer winning, crushing, screening, loading and gravel transport for all pits. The QM will need to induct the contractor and contract the works under the Council’s SMS. The contractor’s Safety Management System must match the Council’s SMS.

- A unique SMS is required for each pit due to variations in each pit’s geography and access road. These can be incorporated into one SMS document if required.

- The QM needs to train each property owner in their responsibilities under the MSMS. Further training may apply if the property owner changes. A written safety contract is required prior to each use of the pit with a QM diary reference.

- The Council needs a plan of each pit and the access road as part of the SMS.

- The pit must be properly defined to prevent accidental access by the landowner. A fence and locked gate is the preferred safety restraint. Mounding of earth is another barrier approved. The Landowner will be notified each time the pit is accessed, as outlined in the Landowner/QO agreement.

2.3  Safety of pit gravels across Australia- airborne and skin risks

Gravel pit operators need to test each licensed pit for the existence of toxic crystalline silica (RCS), which is found in rocks containing silica and can cause:

- Lung cancer due to silicosis, for RCS particle sizes less than 10 micrometers and a concentration in air above 0.1 mg/m³.

- Skin problems, caused by RCS particles greater than 5mm in size.

Workers in the open pit should wear P2 respirators, safety glasses, overalls and gloves, where testing shows crystalline silica exists in the gravel. Amorphous silica is not a problem.

Similar Airborne Crystalline Silica Exposure Groups- Level of dust exposure for workers

- Driller (high)
- Crusher operator (high)
- Loader operator in quarry (in a/c cabin) (moderate)
- Truck driver (in a/c cabin) (moderate)
- Quarry supervisor intermittent exposure (moderate to high)
- Excavator (in a/c cabin) (moderate)
- Pug mill operator on the job mixing gravels (high)
- On road job labourer measuring load spacings / site foreman (high)
- Water truck operator on road job (in a/c cabin) (moderate)
- Loader operator at the pug mill (in a/c cabin) (moderate)
- Grader operator on the road job (in a/c cabin) (moderate)

2.4  Regulatory requirements in other states

In Western Australia’s dry climate, the gravel material needs to withstand excessive degradation during construction and service. When subject to weathering processes, rocks can deteriorate over time (sometimes as little as 2 years). In the basecourse, shear failure can occur, leading to rutting, crocodile cracking and potholing. Disintegration can
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form excessive fines and loss of adhesion to the surface seal. The most common disintegrating rocks are quartzites, quartz gravels, sandstones, mudrocks and shales.

Main Roads WA Operational guidelines 96th is a generic document for gravel pit development that applies to all states in Australia. It gives guidance for:

- Contracts with landowners;
- Field investigations;
- Equipment;
- Testing recommendations for different usages;
- Evaluating deposits in detail;
- Sampling for the different materials used for base course, subbase etc.;
- Land ownership agreements with the landowner, including access easements; and
- Stormwater drainage, provision for local drainage outlet rather than ponding.

3 QUARRY GRAVEL EXTRACTION FOR COUNCILS (NSW CASE)

3.1 Existing Legal Situation in NSW Councils

In NSW Councils, the existing Mines Production Managers (MPM) are usually operational employees of the Council, nominated by the Council to R and E. The MPM reports to the R and E Inspectors for Safety Management within the pit and on the access road.

In 2013, a Work Health and Safety Mines Act and in 2014 a new Mines Work Health and Safety Regulation were created. The MPM is now called the Quarry Manager (QM) and the nominating Council is now called the Mine Operator (MO). The transition deadline is November 2018 for NSW Councils.

In amalgamating Councils' the old Council entities are redundant and thus the only legal entity remaining is the MPM. The new amalgamated Council needs to nominate itself as the MO and to nominate the QM's to R and E. The MO needs to upgrade the gravel pit Mines Safety Management Plan to the new required Safety Management System (SMS) as described in the Mines Regulations 2014.

3.2 Landowners

Newly amalgamated Councils have a public relations problem when the royalty payments paid in one Council area are much higher than the other Council areas. This can only be solved in one of two ways, either:

- The royalties are increased to the level of the better paying Council or
- The higher payment pits are acquired by compulsory land resumption or by negotiation.

In one amalgamation situation, one old Council paid royalties 3 times that of the other old Council.

In acquisition situations the Council should, before landowners are approached, complete any drilling investigations to determine future pit expansion possibility to enable the size of any land resumption to be planned.

4 CHANGES TO THE MINES ACT AND REGULATIONS

4.1 Objection to the NSW Work Health and Safety Regulation Enquiry 2014

Extract of a 3 page submission by Carrathool Council (Carrathool is a neighbour of Lachlan Council)

To quote “Carrathool Shire Council has recently (2014) completed a review of all gravel pits (including retired pits) to determine the future procedures required in the rehabilitation of these pits should this become necessary. This has been done as part of Council’s Gravel Pits Management Plan which identifies the current and future requirements of each of the pits under Carrathool Shire Councils jurisdiction. Most of Council’s gravel pits are located on private land with Council signing agreements for operation of the gravel pits. Council contracts specialist mining operators to complete drilling, blasting and crushing operations usually a couple of times each year but this may vary depending upon demand and work load. No Council employee enters the pits while this is being conducted. Stockpiles are generally not located within the gravel pit itself and Council operations are limited to loading and hauling of material.”

Councils generally have Safe Work Method Statements developed for all operations that are carried out including those associated with gravel pits and these are part of Local Governments focus on WHS as whole. Council believes that with 38 active gravel pits under the new regulation if gravel pits were to be treated as mines there would be a requirement for Council to have the same structure and procedures in place as are required in major mining operations which would place a greater burden on Council resources. Council’s currently have Mines
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General Manager and Mine Production Manager (Carrathool Shire Council has 4 Production Managers) which we believe adequately covers our gravel pit operations.” End quote. This submission was not accepted by the NSW government.

Footnote: The R and E has recently (Feb 2018) issued further explanatory guidelines in a bid to explain the requirements of the NSW Mines Act 2013 and the Regulations 2014 as it will affect Council gravel pits.

Councils in NSW like Carrathool are having difficulties with the onerous nature of legal responsibilities focus and interpretation by R and E. Hopefully this will be further clarified in upcoming training for Quarry Managers (conversion from Mine Production Managers under previous legislation)

5 TESTING OF GRAVEL PITS

5.1 General

Many Council single gravel pits (farmer pits) are described as providers of marginal road building materials. Collectively with blending of 2 or more adjacent pit gravels, the quality of the combined gravel may be improved to get better sealed and unsealed roads.

- Testing of gravels permits selections of materials for road building by comparison with the desired use of the road pavement. Modelling can be used with test results for mixing of materials both local and commercial to achieve improved structure, density and impervious, waterproofing with dry powdered polymers and foam bitumen, and a stronger road pavement. Not all pit gravel blending will be successful thus it requires a lot of trial and error with different mix testing to get the aim of filling of voids to achieve high density and impervious gravels with higher CBR and improved PI.

- Properties which are known to exert a major control on the performance of gravel are moisture content, density, strength and stiffness (a material's capacity to resist deformation under load). Testing methods include:
  - The CBR Test, for strength;
  - Laboratory triaxial tests or on-site Benkelman beam
  - Falling Weight Deflectometer test, for stiffness; and
  - The Clegg Impact Test, for both strength and stiffness.

6 FINANCIAL ARRANGEMENTS WITH GRAVEL EXTRACTION

6.1 Gravel as a stock item

It is ideal for gravel to be a stock item, subsidised by working funds. This arrangement allows for more gravel to be available for shorter haulage to the worksites, and for the blending of gravels from different pits. This reduces costs associated with unsealed roads and for construction of better sealed roads with close haul gravels.

Theft of stockpiled gravel and diesel fuel is an increasing problem. In the interests of the Council, access to use the gravel for farm tracks should be tightly controlled by the Quarry Manager. CCTV monitoring may also be utilised at the gate entrance and stockpile, to further minimise theft.

7 UNSEALED ROADS READY RECKONER EVALUATION

7.1 Paige and Green study (1989) and the ARRB Spreadsheet model

Paige and Green carried out a field study in 1989 to determine the performance of wearing course gravels in relation to material properties. The study found that the engineering geological classification of a material was insufficient for acute prediction of its performance in unsealed roads. Shrinkage product and grading coefficient are more appropriate for classification purposes. Blending wearing course materials known as mechanical stabilization is an effective method to utilize and enhance available materials while reducing road user operating costs and improve their properties and performance.

To assist local road practitioners, particularly in rural areas to make better use of their local materials ARRB has developed a road base kit. The kit provides a practical and low-cost method for assessing the suitability of natural gravels for pavements and requires to conduct six separate tests to measure soil and water properties. The results are then entered into the spreadsheet to derive material properties and assess against given specifications. The spreadsheet has the capability to undertake mix design enabling blending of up to three marginal materials.

Each local Council gravel pit has different grading and shrinkage characteristics. Any given pit rarely has the exact requirements for an unsealed road wearing course. Modifications may be desirable to achieve better whole-of-life cost savings and extend resheeting intervention timing.
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From the geotechnical laboratory report or the ARRB Road base kit, identify each gravel for suitability for wearing course gravel to minimise defects and extend the life of the unsealed roads between resheeting of the wearing course. If the gravel has particular defects, use the ARRB model for blending of different gravels to rectify the defects, as well as for granular blending, stabilisation and increasing time between grading interventions.

For more information, see TECHnote DES 035 Improvement and Stabilisation of Unsealed Roads.

The ARRB spreadsheet model is freely available by directly contacting the ARRB office.

8 GRADING INTERVENTION FREQUENCY AND GRAVEL RESHEETING LIFE

According to Austroads Guide to Pavement Technology Part 6 Unsealed Pavements Clause 9.2.3, while increasing grading intervention beyond 12 months has little impact on life cycle costs, increasing resheeting life reduces lifecycle costs significantly. Processes such as blending gravel materials or stabilisation that increases resheeting life can have a drastic whole-of-life cost benefit, even though the initial set-up costs are greater.

9 BLENDING OF MATERIALS

9.1 Step by Step process

There is a step by step design approach needed to examine how Council can improve the Council gravel pits by examining the geotechnical test results from all pits in the local government area and examine those pits close to the required construction job:
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Step 1: A comprehensive geotechnical testing audit is required for all Council pits for use for both unsealed roads and sealed roads. In this case the test results are for sealed roads construction.

Step 2: Gain test results of nearest commercial quarry by lower cost product materials such as DGS20 or crusher dust. Tests required include sieve gradings, soaked and unsoaked CBR%, Atterberg Limits including Plasticity Index, Linear Shrinkage, Unconfined Compressive Strength (UCS), Maximum dry density (t/m³), and Optimum Moisture Content.

Step 3: Use the free ARRB Spreadsheet Mix model for unsealed roads to draw grading graphs of mix combinations in various percentages totalling 100%. Try to use gravels with high CBR and opposite plasticity for both gravels. Consider screening one of the gravels for all plastic gradings below 0.425mm to achieve a Plasticity of 7 or less and a CBR above 70.

Step 4: Try laboratory testing the blending use of the closest pit gravel 80% by weight with say 20% commercial DGS20 gravel with all the gradings below 0.425mm removed from the commercial DGS20 at the quarry before delivery.

Step 5: Do comprehensive lab testing of all % trial and error variations to determine whether the complying CBR% and Plasticity Index can be created, and other bitumen seal complying testing can produce a gravel suitable for long life basecourse pavement layers.

Assuming you do get a suitable base gravel then the materials should be delivered on the construction site in heaped areas for blending with a pugmill with the two gravels and water at 2% below optimum and possibly some lime stabilent if required.

Blended base gravel from a pugmill will triple the daily production and achieve better quality of compaction due to better moisture control and thus higher compaction densities. The extra costs of material inputs and double handling at the pugmill will be financially offset with substantially lower construction costs per tonne.

This use of better materials science and better construction management will lead to longer pavement life and lower amortised whole of life costs per annum.

10  MAINTENANCE AND REHABILITATION

10.1 Pugmills

Pugmills are increasingly used by commercial quarries to create higher performing compliant gravels to permit the commercial quarry to charge higher costs per tonne for each pit.

A pugmill costs about $260,000 and can be used for blending for both unsealed and sealed roads. A pugmill should be a standard item of maintenance equipment in Councils or shared by groups of Councils.

A pugmill can be used at a job site for mixing different gravels with water and lime stabilent, at up to 400 tonne per hour.

An average day of production with grader, watercart and rollers is 500 tonnes per day. Production with a pugmill can reach up to 2000 tonnes per day on the job spread and compacted.

When the water is controlled to 2% below optimum, it arrives on the job mixed and ready for immediate placement and compaction. Lime can also be added in the pugmill if required. A Speedy moisture tester can achieve moisture control within 0.5%, with regular sampling at the pugmill.
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Blending of compatible gravels, especially with blue metal, creates a dense and impervious gravel with lower plasticity and higher CBR%. The dense pavements reduce water percolating down to the weaker subgrade material limiting the opportunity for potholing defects. Maximum Dry Density (MDD) can increase from 1.9 to 2.3 due to the filling of voids. Higher density improves pavement strengths and creates impervious gravels. The increased speed of construction can offset the extra costs of importing materials and the double handling of materials with the loader and pugmill. This process extends pavement life and lowers annual whole-of-life costs.

The blending with a pugmill ideally could occur on a prepared roadside surface close to the construction site, allowing trucking materials import to occur from the various material sources prior to construction. This removes the delay of mixing material on site whilst the grader waits for the trucks to arrive, and substantially reduces grader and roller construction cost per tonne placed on the job by increasing the daily tonnage productivity.

10.2 Standard grader gang
Mixing with conventional maintenance equipment takes extra time and with less quality control depending on the experience of the grader operator however it will be better than what Councils have now. Cassowary Coast Regional Council use the standard grader gang with the mix designed by the ARRB model ready reckoner calculator with macros. They blended 3 materials which is more difficult with just a grader gang.

Cassowary Coast Council (refer DES035) was rewarded with extended resheeting intervention life and less defects such as potholes.

10.3 Mixing with stabiliser machine
Again, on the job with the standard grader gang however with extra cost of the stabiliser. Productivity is dependent on delivery of gravels on site with mixing and incorporation of water and lime an extra task. Less productive and lesser quality control than a pugmill. More variation occurs with control of water and lime by this method.

This method allows improvement of subgrade by incorporation of some of the clay subgrade material into a stablent/gravel subbase mix to get a high density impervious base pavement.

10.4 Management of unsealed roads
Councils’ pit materials have remained static in strength, CBR% and plasticity, as singular gravel sources cannot improve without stabilisation or cross-pit blending, including blending with commercial by-products from blue metal quarries. The average natural pit gravels are CBR% 25 or less unsoaked, with plasticity 15 with variations. The desirable target for an unsealed wearing course is over CBR% 40 unsoaked, plasticity index between 9 and 13, and MDD of over 2.2. The MDD needs to be high to create an impermeable gravel blend and eliminate potholes.

10.5 Long term/whole-of-life target
Many Councils are resisting stabilisation and blending because it is an additional prime cost per tonne paid up front with additional materials, transport, and purchase costs. These Councils do not properly consider reduced construction costs using high output mixing, reduced maintenance costs with longer maintenance intervention intervals, and reduced whole-of-life costs per annum due to longer pavement life.

10.6 Blue metal filler
A screened blue metal (under 0.425mm removed) added 20% to the local pit gravel using a pugmill can increase the CBR% by up to 300%, compared with adding local ingredient gravels. Mixing water on site with the pugmill can
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triple the daily trimmed and compacted tonnage on the job. Mixed material can be provided from a roadside pugmill mixing area with a short haul to the road job.

10.7 Mixing trials

A local pit gravel may have a CBR% of 30 and blended with another local pit gravel of CBR% 20 and 1.5% lime could increase CBR% to 70+ due to grading compatibilities and plasticity stabilising due to the lime. This needs testing in the laboratory. Some gravels mix better than others.

10.8 ARRB sample modelling for blending

At Cassowary Regional Council (QLD), the mixture of three different local pit gravels using the ARRB spreadsheet-modelled design mix reduced potholing and other defects and extended the intervention maintenance time from three months to three years.

Mixing occurred using a grader; however, a pugmill would have been more efficient and effective.

For more information, see NATSPEC TECHnote DES 035 Improvement and stabilisation of unsealed roads.

- The ARRB spreadsheet model could be used to get the right blended percentage mix for unsealed roads to get longer wearing course sheeting life, reduced whole-of-life costs and better unsealed road usability performance satisfaction.

- Where roads are subject to occasional flood inundation, the pavements should be stabilised with a dry powdered polymer and lime mix or foam bitumen, for waterproofing purposes. Samples of the underlying pavement and existing base pavement can be sent to suppliers for private testing and design recommendations.

11 CASE STUDY: LACHLAN SHIRE COUNCIL, NSW

11.1 Introduction

The Lachlan Shire is a local government area in the Central West region of New South Wales. The entire shire area encompasses 14,965 km$^2$ with a population of 6,194 (2016). Its largest town is Condobolin with a population of 3,486 (2016).

Lachlan Shire has 31 natural gravel pits and 40 disused pits in its local government area, with access to three blue metal quarries at West Wyalong, 110km south of Condobolin; Forbes, 90 km to the east; and Roache, 48km to the north.

The breakdown of Lachlan Shire’s roads in kilometres is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Sealed</th>
<th>Unsealed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional</td>
<td>596</td>
<td>75</td>
<td>671</td>
</tr>
<tr>
<td>Local</td>
<td>380</td>
<td>3071</td>
<td>3451</td>
</tr>
<tr>
<td>Total km</td>
<td>984</td>
<td>3146</td>
<td>4121</td>
</tr>
</tbody>
</table>

11.2 Gravel pits

Of the 31 working pits and 40 disused pits, 21 have stored gravel stocks.

For this stored gravel, which is a sunk investment cost of $2.6 million as at July 2017, the Council has created close access from the quarries to the job sites and short haulage for road maintenance.

Interest holding costs on the gravel stocks are offset by savings from shorter truck hauls and reduced damage costs to the existing local road when the gravel stocks are transported to the job site.

The large number of pits allows more defect rectification opportunities by proportional blending of gravels from different pits, aided by the ARRB model.

Most of the pits require drilling and blasting so there is a lead time needed to procure gravel with drilling and blasting contractors. A larger purchase quantity reduces the cost per tonne in establishment costs for crushing and screening.

Contractors usually prefer contract job lots of 5,000 cm$^3$ loose, with minimum quantity 3,000 cm$^3$. The larger the job lot quantity, the cheaper the total cost per cubic metre due to establishment and disestablishment costs.
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11.3 Geologist’s report
Lachlan Council commissioned a geologist to do an assessment review of the 31 current Council-operated gravel pits. The report is comprehensive and documents basic geological interpretation, an operational overview that includes site access, pit sizes, historic volumes extracted, current mining methods, and the amount of gravel observed as stockpiles for use by council.

The geologist created a table of pit rankings based on observed geology and material hardness. Geotechnical testing of crushed material samples however has not been undertaken – testing of crushed and screened gravel can produce very different results in comparison with the geologist’s interpretations.

Locations for drilling investigations for best pit expansion have also been recommended and should be included in pit mapping in the landowner’s agreement and gravel pit license with the state mining authority.

Five of the pits with vertical walls are considered slope stability safety risks and require drilling and blasting to create a 45 degree slope batter.

11.4 Future options
For a spreadsheet that tabulates information from the geologist’s report regarding the 31 operating gravel pits in Lachlan Shire, see SPREADSHEET- Lachlan Shire Gravel Pits

- Lachlan Shire Geotechnical testing results for crushed and screened gravel only exist for seven of Lachlan Shire’s pits, and not in a complete or comprehensive way. The tests need redoing to include linear shrinkage percentage for use on the ARRB unsealed roads blending spreadsheet.

- The Council needs to more efficiently select its road materials. The first step is to comprehensively test each of the 31 used pits, 40 disused pits, and non DGB20 by-product materials from any local blue metal commercial quarry. Tests required include sieve gradings, atterberg limits, plasticity index, soaked and unsoaked CBR%, linear shrinkage percentage, optimum moisture content, unconfined compressive strength, aggregate durability, repeated load triaxial tests, Clegg impact factor, and maximum dry density.

- The consultant geologist’s suggestions should be utilised by developing a drilling investigation plan for all 31 pits for future pit expansion. Drilling and blasting soil samples for geotechnical testing could be undertaken, for example, to create safety barriers in the suspect pits. Further consultation with a geologist may be required.

- The geotechnical drilling and testing results may be used to determine an extent for future pit expansion. It is important to become aware of each pits potential by planning for future extension. The alternative is cancelling the pit licence which triggers pit rehabilitation requirements from environmental legislation. Typical rehabilitation costs are approximately $100,000.
11.5 Mix design trial – Pit A and Pit B gravels. Reference graph abovementioned.

The abovementioned mix design is the final selected trials of different blends of Pit A and Pit B pit gravels located in Lachlan Shire.

Single pit gravel graphs for each individual gravel were produced that allowed assessment of the best percentage mix blend with the aim of getting the red triangle in the centre of the “good” portion of the graph. The mix 30% Pit B and 70% Pit A was selected by that trial and error design process. The above graphics is the mix result.
12 BETTER CONSTRUCTION METHODS WITH BLENDED MATERIALS FOR LACHLAN SHIRE

12.1 Current pits

- Presently, Lachlan’s natural gravels are approximately CBR% 30 with plasticity 12, subject to more geotechnical testing.

- Blending with small percentages of screened DGS20 (e.g. 20%) and lime at 1%, should produce minimum CBR% 70 and plasticity 6 or 7, which is suitable for sealing. A further option to assist achieving a lower Plasticity Index is to remove, by screening, less than 0.425mm fines at the commercial pit before transporting the remnant larger gradings DGS20 gravel to the job site.

- Blending for Pit A in the laboratory with 1.5% lime increased from CBR 30 to CBR 60.

- Prepare pit plans and build fence surround

- Prepare a pit site plan with aerial photo overlay for each of the 31 current pits and 40 disused. Include the access road to the closest Council public road as a map base for the MSMS for each pit. Include contours if lidar is available to extract contour information. Otherwise, drones can be used to survey the quarries and surrounds. Use the plan to construct new boundary fencing as a safety item.

- Identify new cadastral plans for each pit, to create new boundaries based on future expansion evaluations.

- If resumption is selected due to failed landowner negotiations, arrange purchase of land and access easements, by compulsory acquisition resumption and gazettal.

- Arrange construction of boundary fencing to the new pit boundaries, including a gate with only a Council gravel pits master lock and a lock interconnected with the farmers lock when farmer access is permitted by the landowner/Council agreement. Arrange suitable signs at the public road access identifying the name of the pit and ownership.

12.2 Mine risk management plan

There are 3 reports:

- Geologist report, geotechnical report, and a safety report

Actions required:

- Reference the geologist report with slope stability risks on about five pits.

- Prepare a new safety pit batter plan for all the identified unsafe pits for submission to DPIM.

12.3 Sealed road base pavement

There is a need to increase the quality of the local pit gravels using a blending of blue metal gravel with the local pit material.

Try laboratory test blending using a by-product blue metal DGS20 from Millers West Wyalong pit or Millers Forbes pit or Roaches Pangee Road pit 47 km south west of Nyngan. From test results do a blending model for selected local pits to create a qualifying road base for bitumen sealing. Use AUS-SPEC worksections 0042 Pavement Design and 1141 Flexible pavement base and subbase construction.

Select local pits in close proximity to programmed new sealed roads identified in works programmes by the Asset Manager for sealed reconstruction and rehabilitation.

12.4 Disused pits

It is recommended that some of the 40 disused pits be identified and selectively tested (should it be required) near roads that have wearing course defects. Information is not available as to exactly why these pits became disused pre 1962. Potential causes include the gravel being too plastic or drilling and blasting being required and more accessible materials being available elsewhere. If it is clayey and plastic, the pit could be used to improve other nearby pit gravels that have low plasticity with associated ravelling and corrugation problems for unsealed roads.

12.5 Estimated cost for geotechnical testing of 31 gravel pits at Lachlan

The estimate is $46,000 for one comprehensive suite of tests per pit, assuming tender work is done with provisional items for extra testing if required with unused pits and blue metal quarries. Extras also will include trialling 20% screened West Wyalong DGS20 (remove/screen material sieve material below 0.425mm) mixed with 80% Council pit gravel.
MANAGEMENT OF COUNCIL GRAVEL PITS

13 CENTROC COUNCILS (AND OTHERS) QUESTIONNAIRE RESPONSES

Quarry management forms the basis of the provision of quality roads services. Quarries are a key part of this service however they are inherently a high risk for Councils. Control of quality and risk in quarries should be key performance control targets for Councils’ day-to-day management.

A number of Councils in central NSW were invited to respond to a questionnaire conducted by AUS-SPEC, regarding methods of quarry pit management in their local government area. AUS-SPEC was prompted by the introduction of a new NSW Mines Act 2013 and Mines Regulations 2014 that affected NSW Councils regarding the management of their gravel supply for roads maintenance and construction.

AUS-SPEC is developing a new rural worksections package called Rural Roads Package for Country Councils to be released October 2018. These documents will be available to new and existing AUS-SPEC subscribers.

Councils that responded to the questionnaire include Wagga, Cowra, Gilgandra, Parkes, Bathurst, Lachlan, Weddin, Forbes, Cabonne, Blayney, Bogan, Wellington and Dubbo (separate Quarry Managers for Dubbo Council).

13.1 Summary of the survey responses

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of gravel pits controlled by Council</td>
<td>Ranging from 0 at Bathurst to 31 at Lachlan.</td>
<td></td>
</tr>
<tr>
<td>Length of unsealed Council roads</td>
<td>Ranging from 166 km at Bogan to 3000 km at Lachlan.</td>
<td></td>
</tr>
<tr>
<td>Length of sealed Council roads</td>
<td>Ranging from 370km at Blayney to 1000 at Lachlan.</td>
<td></td>
</tr>
<tr>
<td>Gravel stocks funded by stock item or direct allocated annual budget job costs?</td>
<td>5 Councils fund as a stock item, and 6 Councils produce gravel with direct budgets. Stock items create consistent production funding from working funds, producing efficiency savings on haulage distances from closer pit stocks.</td>
<td></td>
</tr>
<tr>
<td>How much total gravel in stock (cm$^3$ loose)?</td>
<td>Ranging from 3500 cm$^3$ at Bogan to 222,000 cm$^3$ at Lachlan. Interest costs on stock reserves are offset from savings in haulage to the needy sites.</td>
<td></td>
</tr>
<tr>
<td>Do you have full geotechnical tests for each pit?</td>
<td>Yes – 5 Councils; no – 4 Councils.</td>
<td></td>
</tr>
<tr>
<td>Do you have linear shrinkage tests for each pit?</td>
<td>Yes – 2 Councils; no – 9 Councils. Linear shrinkage is needed for unsealed roads.</td>
<td></td>
</tr>
<tr>
<td>Do you have sieve gradings for each pit?</td>
<td>Yes – 3 Councils; no – 6 Councils. Sieve gradings are needed for both sealed and unsealed road design.</td>
<td></td>
</tr>
<tr>
<td>Do you have soaked and unsoaked CBR% for each pit?</td>
<td>Yes – 2 Councils; no – 8 Councils. Soaked CBR% is needed for suitability for roads that are subject to occasional flood inundation. Unsoaked CBR% for other roads.</td>
<td></td>
</tr>
<tr>
<td>Do you have Plasticity Index for each pit?</td>
<td>Yes – 3 Councils; no – 8 Councils. Plasticity Index and CBR% are key road gravel design indicators.</td>
<td></td>
</tr>
<tr>
<td>Do you use closest pit principle for maintenance of unsealed roads?</td>
<td>All Councils said yes. Wagga stipulated “unless quality is a problem.”</td>
<td></td>
</tr>
<tr>
<td>Do you blend or stabilise gravels for improving unsealed roads?</td>
<td>Yes – 7 Councils; no – 4 Councils. It is unclear whether it is a mixing of different gravels or chemical stabilising. The largest cost item for unsealed roads is resheeting. Gravel blending can extend wearing course life, improve defects and ratepayer satisfaction, and reduce unsealed roads maintenance expenditure.</td>
<td></td>
</tr>
<tr>
<td>Do you use ARRB test kit for designing unsealed roads wearing course?</td>
<td>All Councils said no.</td>
<td></td>
</tr>
</tbody>
</table>
### MANAGEMENT OF COUNCIL GRAVEL PITS

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you blend or stabilise gravels for improving sealed roads?</td>
<td>All Councils said yes.</td>
<td>Councils have an opportunity to blend different gravels to achieve a longer life for their sealed roads, and compliance for base course selection.</td>
</tr>
<tr>
<td>Do you have blue metal quarries in your Council area or nearby?</td>
<td>Yes – 8 Councils; no – 3 Councils.</td>
<td>There is considerable opportunity to create high density and strength base course materials by blending small percentage blue metal with products with local pit gravels. A key benefit of blending is the increase in dry density, creating impervious base and subbase gravels to reduce potholing. See relevant AUS-SPEC worksections and TECH notes for more information.</td>
</tr>
<tr>
<td>Do you own all the pits in your Council area?</td>
<td>Cowra owns all three of their pits. Other Councils, except Bathurst, lease pits by royalty agreement with the landowner and mines license with DPIM.</td>
<td>Bathurst is the only Council that totally purchases all gravel from contract pits without owning or operating any pits. The expenditure for their gravel and extra haulage costs has not been disclosed.</td>
</tr>
<tr>
<td>If no, how many pits from total of pits do you own?</td>
<td>Very few pits where the Council is the landowner.</td>
<td>Comprehensive agreements between the Councils and landowners are needed. A selection of reference landowner agreements from various Councils is available in attachments. Another more comprehensive agreement is available by contacting Marsdens Lawyers at Campbelltown.</td>
</tr>
<tr>
<td>How many pits do you have a DPI quarry license for?</td>
<td>Ranging from 3 at Cowra to 31 at Lachlan.</td>
<td></td>
</tr>
<tr>
<td>How much royalty to the landowner do you pay per cm$^3$ loose?</td>
<td>Ranging from $0.60 at Lachlan to $3.00 at Wellington.</td>
<td>Some Councils, such as Wagga, pay an additional annual fee of up to $2000 per annum. Other Councils allow the landowner to obtain a limited amount of free gravel for their farm roads. This is not recommended where the farmer uses their own loader and trucks unsupervised. Council is the Quarry operator and is directly responsible to DPIM for any unsafe actions by the landowner.</td>
</tr>
<tr>
<td>How much do you pay for crushing and screening per cm$^3$ loose?</td>
<td>Ranging from $6.60 to $10 per cm$^3$ loose in heap.</td>
<td>Lachlan Council has a contractor doing drilling, blasting, winning, crushing and screening for $13.50 per cm$^3$ loose, measured in heap.</td>
</tr>
<tr>
<td>What is the minimum crushing and screening quantity required by your contractor?</td>
<td>Ranging from 2000 cm$^3$ to 6450 cm$^3$.</td>
<td>Lower quantities are priced higher to reflect establishment and disestablishment costs.</td>
</tr>
<tr>
<td>Do you do drilling and blasting?</td>
<td>Yes – 5 Councils; no – 6 Councils.</td>
<td></td>
</tr>
<tr>
<td>What is your establishment cost for drilling and blasting by your contractor if known?</td>
<td>Two councils responded: $1200 and $1693 per site.</td>
<td></td>
</tr>
</tbody>
</table>
MANAGEMENT OF COUNCIL GRAVEL PITS

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the cost per cu m$^3$ loose for material sourced by drilling and blasting, excluding establishment or disestablishment costs?</td>
<td>One response: $4.79 per cm$^3$ loose, blasted and uncrushed compared with $4.31 per cm$^3$ loose ripped and won by dozer only.</td>
<td>This is dependent on the remnant size of rocks that may need further work with a rock hammer to get rocks down to an acceptable size for the crusher jaws.</td>
</tr>
<tr>
<td>Have you had a geological safety inspection of your pit walls for slope stability?</td>
<td>Lachlan, Weddin and Cabonne said yes.</td>
<td></td>
</tr>
</tbody>
</table>

14 DISCUSSION OF THE SURVEY SUBMISSIONS FROM THE QUESTIONNAIRE:

14.1 Discussion on survey submissions

- Councils in most cases (except Bathurst) need to upgrade their legal agreements for access to private land for quarry and quarry access track. The Marsden Lawyers draft template should be a considered detail. This agreement can be obtained from Marsden Lawyers. Alternatively, with the permission of the Councils use the Blayney, Wagga (new) Lockhart generic or Upper Lachlan Council policies and templates.
- Councils use Local Government Act procurement AS 2124 contracts for drilling, blasting, winning, crushing and screening and stockpiling for payment measurement. This requires the appointment of a Contract Superintendent as a separate position to Quarry Manager.
- The position of Mines Production Manager or the new position of Quarry Manager in the new Mines Act does not recognise the authority of a Contract Superintendent within the boundaries of the pit and access road license. The solution is to make the Quarry Manager the Contract Superintendent for any contract within the Quarry license area including quarry access road.
- The position of Quarry Manager is a statutory position for each pit or all of Councils licensed pits and is a position appointed only by R and E based on only a nomination from Council.
- Councils should ensure that any person nominated and appointed as extra Quarry managers/decision makers within the pits Mine Safety Management Plan are appointed and approved persons by R and E in writing by a formal instrument from R and E.
- All the activities and procedures such as drilling, blasting, winning, crushing, screening, loading, and trucking should be documented within the Mines Safety Management System.
- Councils operational staff or contractors should gain approval from Councils Quarry Manager before entering any quarry. Entry Permit Documentation should be created as a Pro-forma or a Quarry Diary be used to document all access and site inductions. It may be best to nominate an operational supervisor as the Quarry Manager rather than an office-based person.
- In some Councils it is best practice to appoint multiple Quarry Managers where multiple works depots (amalgamated Councils) are used for operational control. This is required in amalgamated Councils where former Council works depots are retained. Amalgamated Councils need to reapply to R and E as a single Mines Operator and to rename date Mines Production Managers as Quarry Managers if applicable.
- All pits should be evaluated for future expansion and quality and quantity surveyed. This will require drilling and testing of samples by geotechnical laboratories. This should be followed up with a revised pit map from GIS maps for the enlarged area plus the access road. Alternatively use a stand-alone drone survey of all pits and access road. These actions are essential to guard against any future disputes that may occur between Council and the landowners with change of land ownership.
- When the expansion mapping is completed for all pits it is recommended that all landowners be sent the new upgraded legal agreement.
- It is anticipated that many landowners may require upgraded annual rentals as an extra to royalty payments per cubic metre loose. This then will be a decision for Council however it is inevitable in the long term as individual landowners get more assertive and talk together. This was the problem at Wellington Council and resulted in the Council being forced to pay $3.00 per cubic metre loose as royalty to all 14 landowners. The new amalgamated Dubbo Regional Council has now inherited a differential royalty problem with $3.00 per cm$^3$ loose royalty at Wellington and $1.00 at Dubbo (the old Councils).
- Council should be aware that if the Council and Landowner cannot reach agreement and Council elects to withdraw from the pit license then Council will be liable for pit rehabilitation as defined by State legislation. This will likely cost a minimum of $100,000 per pit.
MANAGEMENT OF COUNCIL GRAVEL PITS

- An alternative is compulsory acquisition under the Local Government Act. An alternative to rehabilitation expenditure is a combination strategy of pit expansion and land resumption.

- Cowra Council now only operate and own 3 licensed pits that are low PI and high CBR pits. They abandoned the use of “farmers pits” for use on unsealed roads more than 15 years ago due to onerous environmental regulations and fear of the cost of environmental reports and the Council Development Application process. The farmers pits provided a good source of plastic gravel however low CBR%. The farmer pits are closer to the worksites thus reducing haulage costs. They have problems with their existing 3 low plasticity pits with some of their unsealed roads displaying defects such as ravelling, corrugations and potholes thus Cowra may need to revisit farmers pits to enable use of blending to improve the quality and plasticity (PI) and lower the whole of life operating costs of their unsealed roads. Blending of high CBR / low PI gravels with low CBR / high PI gravels farmer pits is an option to be considered to achieve a target PI between 9 and 13. Higher dry density and accordingly improved impermeability (and reduced potholes) is a further bonus for blending.

- Bathurst Council advise of a substantial amount of potholes and ravelling on all their unsealed roads. They need to do testing of their pits and contract supply pits and utilise the ARRB spreadsheet model for blending mixes of different farmer pit gravels to improve density and increase PI to get reduced defects and longer resheeting lifecycle. This approach needs time and some testing monies. Not all blending gets results so be prepared for failures. Keep persevering. The results will be worth it.

- Amalgamated Councils may have gravel royalty problems. The constituent Councils may have substantially different history of royalty amounts per cubic metre loose in heap. If this becomes a problem then the new Council may need to acquire the land and access road for higher royalty priced pits to regain royalty control.

- Landowner Access Agreements Wagga Wagga City Council. See Appendices 15.3 to this report.

14.2 Summary and conclusion of survey questionnaire from Councils

- All Councils need to do comprehensive geotechnical and slope stability testing of each gravel pit.

- Quarry Manager should be appointed Contract Superintendent (AS 2124) for contractors working in the licensed gravel pits.

- Quarry Manager is a R and E appointed position under the NSW Mines Act 2013 and needs to be notified of all movements in and out of any licensed pit.

- All pits should be surveyed, tested and mapped for future expansion including access track and the gravel pit information template should be prepared for each pit as per Section 15.2 of this report.

- Revised landowner agreements (select better agreement wordings) should be prepared with proper mapping that includes access road and new expanded pit areas for future pit growth.

- Farmer pits (disused pits) should be re-evaluated for blending opportunities to get improved gravel performance.

- Use of gravels from commercial blue metal quarries may be tested and considered for blending with Council pits or disused pit gravels.

- The contractor activities such as drilling, blasting, winning, crushing, screening, loading and trucking should be controlled for safety and risk in the quarries by matching Councils Mines Safety Management Systems within the Contractors Safety Management Plans.
15 ANNEXURES

15.1 SPREADSHEET- Lachlan Shire Gravel Pits (July 2017)

<table>
<thead>
<tr>
<th>Gravel Pits</th>
<th>Amount extracted (cm³)</th>
<th>Existing loose gravel stockpile (cm³)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Good quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davis</td>
<td>21,000</td>
<td>200</td>
<td>Hard rock, sandstone, unstable walls.</td>
</tr>
<tr>
<td>Glencoe</td>
<td>40,000</td>
<td>11,000</td>
<td>Pitwalls unstable, requires land resumption.</td>
</tr>
<tr>
<td>L'Estrange</td>
<td>63,000</td>
<td>200</td>
<td>Remnant stockpiles require testing.</td>
</tr>
<tr>
<td>May</td>
<td>24,000</td>
<td>10,500</td>
<td></td>
</tr>
<tr>
<td>Todd</td>
<td>0</td>
<td>0</td>
<td>Needs short drill program, good prospect.</td>
</tr>
<tr>
<td>2. Moderate Quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 Mile</td>
<td>54,000</td>
<td>2429</td>
<td>Close to road, good pit expansion prospect.</td>
</tr>
<tr>
<td>Beatie</td>
<td>62,700</td>
<td>25,000</td>
<td>Testing and samples needed, no limits.</td>
</tr>
<tr>
<td>Bolam</td>
<td>145,000</td>
<td>10,000</td>
<td>Unstable pit wall, good expansion prospect.</td>
</tr>
<tr>
<td>Bryant</td>
<td>50,000</td>
<td>0</td>
<td>Silt stone clays, CBR with 1% lime increases to 50.</td>
</tr>
<tr>
<td>Dwyer</td>
<td>46,000</td>
<td>8500</td>
<td>Relocated road, hard rock.</td>
</tr>
<tr>
<td>Elwin</td>
<td>116,000</td>
<td>17,000</td>
<td>Variable material.</td>
</tr>
<tr>
<td>Fair</td>
<td>20,000</td>
<td>15,000</td>
<td>One of two pits abandoned due to water.</td>
</tr>
<tr>
<td>Medcalf</td>
<td>44,000</td>
<td>200</td>
<td>Requires testing.</td>
</tr>
<tr>
<td>Mooney</td>
<td>27,500</td>
<td>2300</td>
<td>Requires testing.</td>
</tr>
<tr>
<td>Quade</td>
<td>10,000</td>
<td>0</td>
<td>Requires drilling and geotech testing.</td>
</tr>
<tr>
<td>Reid</td>
<td>15,000</td>
<td>0</td>
<td>Won by dozer, near LG boundary.</td>
</tr>
<tr>
<td>Rigney</td>
<td>88,000</td>
<td>12,700</td>
<td>Increase to CBR 60 with 1% lime, alternative trial testing with 20% by-product blue metal DGS20 fines screened out ex pit then cart reduced DGS20 for onsite granular blending for sealing road base material.</td>
</tr>
<tr>
<td>Stanley</td>
<td>11,000</td>
<td>0</td>
<td>Softer material won by dozer, near LG boundary.</td>
</tr>
<tr>
<td>Wilson</td>
<td>0</td>
<td>0</td>
<td>Requires drilling and geotech testing.</td>
</tr>
<tr>
<td>Worthington (north end)</td>
<td>45,000</td>
<td>0</td>
<td>South east corner of pit is promising.</td>
</tr>
<tr>
<td>3. Poor Quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fox- Ashwin</td>
<td>62,000</td>
<td>3600</td>
<td>Unstable walls, soft rock, good prospect for expansion.</td>
</tr>
<tr>
<td>Glenlee</td>
<td>47,000</td>
<td>20,000</td>
<td>Needs testing.</td>
</tr>
<tr>
<td>Harding</td>
<td>68,500</td>
<td>10,400</td>
<td>Not used for a number of years. Needs testing. Large stockpile needs using.</td>
</tr>
<tr>
<td>Hope</td>
<td>0</td>
<td>2,100</td>
<td>Not required due to Glencore pit nearby.</td>
</tr>
<tr>
<td>Martin</td>
<td>14,000</td>
<td>23,000</td>
<td>High clay content, needs access track upgrade.</td>
</tr>
</tbody>
</table>
## MANAGEMENT OF COUNCIL GRAVEL PITS

<table>
<thead>
<tr>
<th>Location</th>
<th>Volume</th>
<th>Depth</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Condo</td>
<td>72,000</td>
<td>23,000</td>
<td>Unsafe walls requires EIS for expansion 50 CBR unsoaked and 19 CBR soaked. Needs stabilisation or granular blending to reduce effects of moisture.</td>
</tr>
<tr>
<td>Sanson</td>
<td>85,000</td>
<td>14,000</td>
<td>Clay and siltstone, requires testing and drilling to assess extent and depth.</td>
</tr>
<tr>
<td>SR103</td>
<td>10,000</td>
<td>200</td>
<td>Small piles of uncrushed material needs lab crushing and testing.</td>
</tr>
<tr>
<td>Turner</td>
<td>35,000</td>
<td>2,500</td>
<td>Recent mining, unstable pit walls, different rock types require testing, angled drill program on walls for safety.</td>
</tr>
<tr>
<td>Webb</td>
<td>28,000</td>
<td>9,100</td>
<td>High clay content, requires shot drilling, walls unstable.</td>
</tr>
<tr>
<td>Winter</td>
<td>31,000</td>
<td>0</td>
<td>High clay content, requires test drilling, requires EIS.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,334,700</strong></td>
<td><strong>222,929</strong></td>
<td>Future pit expansion capacity needs determining for each pit</td>
</tr>
</tbody>
</table>

Value @ $12/cm³: $16,016,400 | $2,675,148
15.2 Gravel pit information template

<table>
<thead>
<tr>
<th>Sample PIT INFORMATION FORM</th>
<th>Council</th>
<th>ABC Council</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit Number</td>
<td>Pit Name</td>
<td>Pit Location</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitude</td>
<td>Latitude</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nearest cross road and distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner &amp; Postal Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td>Has Council and the Landowner signed an access agreement?</td>
<td>Has Council completed a Safety Management Plan for this pit?</td>
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<td></td>
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</tr>
<tr>
<td>Area of Pit</td>
<td>Depth of Gravel</td>
<td>Estimated Quantity (m$^3$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sale to outside sources (m$^3$ per year)</td>
<td>Price external loose per metre cubed ex bin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crushed and Screened 20mm</td>
<td>$</td>
</tr>
<tr>
<td>Gravel Type</td>
<td>20mm or 40mm</td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>Linear Shrinkage %</td>
<td>Plasticity Index</td>
</tr>
<tr>
<td>Date Tested</td>
<td>Date Tested</td>
<td>Date Tested</td>
</tr>
</tbody>
</table>
MANAGEMENT OF COUNCIL GRAVEL PITS

<table>
<thead>
<tr>
<th>% passing sieve size mm</th>
<th>Target 20 mm nominal for unsealed road wearing course</th>
<th>Target 20mm nominal for base course under wearing coarse unsealed roads</th>
<th>% passing this sample pit dated ...............</th>
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</thead>
<tbody>
<tr>
<td>53</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>37.5</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>26.5</td>
<td>100%</td>
<td>100%</td>
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<tr>
<td>19.0</td>
<td>100</td>
<td>95 -100</td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>60 - 90</td>
<td>70 - 92</td>
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<tr>
<td>4.75</td>
<td>40 - 75</td>
<td>50 -76</td>
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<tr>
<td>2.36</td>
<td>25 - 65</td>
<td>35 - 63</td>
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<tr>
<td>0.425</td>
<td>10 - 45</td>
<td>15 - 40</td>
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<tr>
<td>0.075</td>
<td>5 - 30</td>
<td>4 - 25</td>
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</table>

15.3 Quarry layout and locations

"[Insert quarry layout]"

"[Insert shire map and quarry locations]"

15.4 Owner and location pit information

<table>
<thead>
<tr>
<th>Pit No.</th>
<th>Pit Name</th>
<th>Pit Address</th>
<th>Owner</th>
<th>Postal Address</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Area</th>
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</tbody>
</table>

15.5 Wagga Wagga City Council quotes regarding landowner agreements.

Quote: A 10 year agreement has been almost unsaleable. Shorter terms such as 3 years are much easier but less desirable operationally. The negotiation process and agreement terms seems to be influenced by the prevailing seasonal conditions and the general current farming outlook.
MANAGEMENT OF COUNCIL GRAVEL PITS

The Council try to get a caveat on the land to get carryover of the quarry agreement when the land is sold. This has been a difficult clause to get approved with resistance from the banks and lawyers representing the land mortgage. The annual license fee is a popular incentive for landowner agreement. I used DPI/Ag gross margin data as a guide based on farm enterprise and the amount of land locked up for quarry use hence lost agricultural production. The advice from the valuer probably better reflects reality. A minimum of $500 to $1000 is required for placing a document in front of a landowner for consideration. It’s likely that legal advice will be sought by the landowner on the document. The landowner access agreements don’t explicitly state the number of extensions permissible, hence several of the shorter termed ones have been extended numerous times now. At Wagga we are happy with the license terms and conditions and the landowner is not seeing any need to revisit the agreement with legal advice.

At Wagga the setting of royalties is not in staff delegation control. It requires a resolution of Council to adjust them (indexing is allowed), hence a consistent rate across council operations. Not all pit sites are fenced nor gates locked due to location and land holder wishes. Maintaining a low profile operation in the rural area assists with site security and landholder concerns re trespass. This conflicts with the mines requirements for signage at entrances. Where possible the signs are set back from the roads if possible and or have them at the pit gate if the site is in a paddock a bit removed from the public road.

Rehabilitation liability: I use the mines “bond calculator” for accounting purposes. Domain areas are determined from google earth/aerial imagery. It’s a reasonable first step for assessing the expenses involved in rehabilitating a site in the event of an unplanned closure. The government is enforcing rehabilitation in commercial mining activities and it is highly probable that Councils will need to pay rehabilitation costs where landowner agreements cannot be negotiated. Mines advised us to conduct our own risk assessment in regards to type of fencing provided on site as a deterrent to trespass. A rural site is usually less concern than one closer to an urban area. Locally sourced gravel result in savings of about 50% on material supply relative to more remote commercial suppliers based closer to the urban area.” End quote

16 REFERENCE DOCUMENTS


Australian Road Research Group, Road Base Testing Kit, accessed November 2017, supplied by ARRB


Main Roads Western Australia, 2017, Operational Guideline 96 Searching for Gravel www.mainroads.wa.gov.au

Main Roads Western Australia, 2014, Operational Guideline 95 Extracting Road Building Materials from Land in WA www.mainroads.wa.gov.au


Main Roads Western Australia, 2003, A Guide to the Selection and Use of Naturally Occurring Materials as Base and Subbase in Roads in Western Australia, accessed date link

Blayney Shire Council, 2013, Memorandum of Understanding template, date supplied by Blayney Shire Council

Gravel Pit Information Form, 2012, date supplied by source

Agreement to Quarry Road Construction Materials from Mine template, date supplied by source

1 Pavement design and materials ARRB ARRB unsealed roads manual 3rd edition March 2009 Section 3.32

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