

# Waggrakine Sewer Infrastructure Planning



Government of **Western Australia**  
Department of **Regional Development**



**ROYALTIES**  
FOR REGIONS

# Waggrakine Sewer Infrastructure Planning

Client: City of Greater Geraldton

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## Quality Information

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## Executive Summary

The City of Greater Geraldton (CGG) initiated a sewer infrastructure planning study for the recently re zoned Waggrakine Residential Development area (WRESP). The Waggrakine area is located approximately 7km north of Geraldton town centre and bounded by the North West Coastal Highway to the west, Chapman Valley Road to the south and Collins Road to the north. The area covers a number of large rural lots, all of which have been rezoned to R12.5 to encourage subdivisions and redevelopment of the Waggrakine region.

The purpose of this report is to address the options and feasibility for providing ministerial sewer infrastructure to the proposed development as well as providing indicative costing for the options and recommendations for improvement. The investigation is aimed at determining the suitability of the current Structure Plan layout and identifying the main issues anticipated for servicing the area with gravity sewerage. From this, an indicative cost has been calculated to demonstrate the most practical and suitable approach to developing Waggrakine. As it is not known at this stage the order that the various lots will be developed there is a focus on the staged development and the impact this has on the proposed sewer network.

The investigation begins with a study of the existing surrounding Water Corporation sewer assets and their capacity for additional waste water flows due to additional development. The Water Corporation has been approached for information on their current planning for the area which is used to determine if the existing networks are capable of supporting the proposed loading. Aligned with these discussions, options and suggestions for amendments to the Structure Plan are proposed, to assist with the cost effectiveness of the development.

To assist with the assessment of the sewer network design, current or proposed developments within the Waggrakine area needed to be assessed to ensure they are conducive to the overall development plan. There is currently only one confirmed development that is currently progressing which is the Seafields Development. There is speculation of another development on the western boundary of the study area where three lots have indicated they would be ready to subdivide in the near future. These two developments, as well as the surrounding Glenfield development have been considered in the study. The complexities that arise are related to the staged development of these proposals and the best way to service them with sewerage as they are required.

It was determined that the most cost effective way to develop Waggrakine in terms of sewer infrastructure is to connect all lots to the one system. The issue with this however is that this is not conducive to the timing of the Seafields Development. There are solutions proposed for excluding Seafields from the Waggrakine development without impacting the cost per lot significantly. This involves connecting part of the Seafields network to the sewer network south of Waggrakine, and as a result upgrades to existing pipework are required. This has been approved in principle by the Water Corporation and as such is a viable option. To service the entire Seafields subdivision from the network to the south of Waggrakine however, is a very inefficient and costly proposal. It has been confirmed that for this to occur major upgrades of existing pipework is required increasing the cost per lot for sewerage substantially.

The Water Corporation has confirmed that they are now required to subsidise any sewer mains of 300mm or larger at a rate of \$600/m. Whilst this may apply to certain sections of the proposed Waggrakine sewer network it is not considered applicable to upgrading sections of existing pipework should it not necessarily be required. This applies to the Seafields subdivision in that this development falls within the Water Corporations Waggrakine catchment area and if the development is chosen to be serviced from another catchment then the developer will be responsible for any necessary upgrades. The developers of Waggrakine however may be entitled to a reimbursement however, as the current Water Corporation planning indicates that the Waggrakine catchment is required to be serviced by a 300mm sewer main. This predicted contribution further enhances the advantages of servicing all lots within the Waggrakine Development from the same network. Whether the connecting section of main from Waggrakine to the existing network is funded by the Water Corporation, or through a contribution scheme arranged by the developers, it is anticipated that development will be encouraged for the existing lot owners.

The report concludes with a confirmation that the Waggrakine Development can be serviced with sewerage at a minimal cost and with no major works required. Suggestions have been made for amendments to the existing Structure Plan which will enable a convenient and practical staged approach subsequently reducing the overall cost of development and the provision of sewerage infrastructure.

## 1.0 Introduction

The City of Greater Geraldton (CGG) appointed AECOM to undertake an assessment of sewer infrastructure requirements in the re-zoned Waggrakine Residential Development area in accordance with the Waggrakine Residential Development Plan (WRESP).

Waggrakine land is located 7km north of the Geraldton Town Centre and incorporates existing rural lots bound between Chapman Valley Road to the south, North West Coastal Highway to the west, Collins Street to the north and Sutcliffe Road to the east. A locality map (based on Google Maps) is shown in Figure 1.1 and also included in Appendix A.

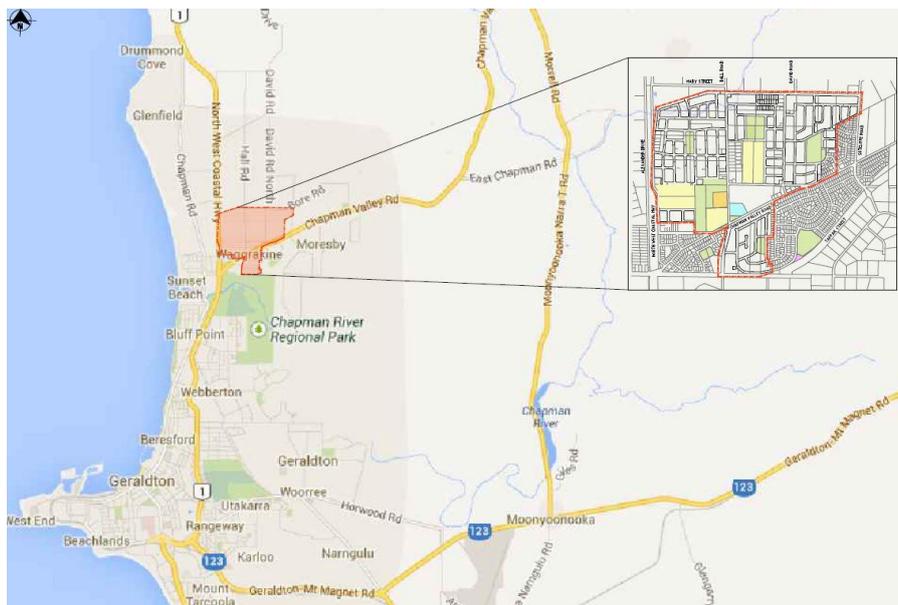


Figure 1.1 Waggrakine Locality Map

The existing landownership is fragmented consisting of approximately 50 large lots with an area in excess of 2000m<sup>2</sup> and a number of smaller lots. The current rural lot distribution can be seen in Figure 1.2 below.



Figure 1.2 Waggrakine Existing Rural Lot Layout

Waggrakine was re-zoned after the previous Waggrakine Guided Development Scheme (WGDS) was revoked in 2009 on the grounds that contemporary planning instrument was required for this area. To this end it was proposed to convert the WGDS into a Structure Plan pursuant to the provisions of Clause 5.17 of the City of Geraldton-Greenough Local Planning Scheme No. 5. The Structure Plan is shown in Figure 1.3 and also included in Appendix B. The plan covers a total area of 267 ha and provides approximately 200ha of net residential area for internal roads and housing lots. It shows the proposed super lots that could be subdivided into R12.5 lots, public open spaces, areas identified for future schools and other development and an indicative road layout.

The study area is limited to new development within the boundaries of this structure Plan.



**Figure 1.3 Waggrakine Structure Plan**

Subdivision of these lots to R12.5 and development is likely to take place on an as-needed basis rather than under one development application. The Scheme Text of the WGDS contains provisions requiring landowners who wish to subdivide to pay Scheme Costs to ensure an equitable distribution of costs from landowners across the Scheme Area for administration of the WGDS, provision of sewerage and other infrastructure.

This report includes an investigation into the existing sewers around the development area, strategies for servicing for planned development and the cost per lot to provide the sewer infrastructure. The contour plans show that the structure plan area falls gently from east to west at a gradient of about 2m in every 100m. This is ideal for a gravity sewer system and the Waggrakine system would be designed to follow the natural gradient towards the west. The Waggrakine area lies within the wider catchment of Water Corporation's sewage pump station No 2 north of Whitworth Drive. Therefore any sewer infrastructure option for the area within the structure plan will include a sewer system feeding into this pump station by gravity.

## 2.0 Objective

The scope of work requires a review of the existing infrastructure in the Waggrakine area and assessment of options for servicing the development with sewer infrastructure. The scope identifies the following as the items to be investigated:

- A context analysis of the overall sewerage network taking into consideration the ultimate relocation of the Glenfield Waste Water Treatment Plant, north to Oakajee.
- Possible scenarios for the implementation of such hard infrastructure, including capacity scenarios and associated facility (pipes and pumping station) locations. The scenarios should also consider any opportunities to service land west of the North West Coastal Highway in the Glenfield locality.
- Cost estimates and lot yield for each scenario.
- An investigation and review of current or proposed subdivisional plans for the area.
- Identifying any potential design issues with the current WRESP and providing alternatives.
- Staging options for development, including a review of the Water Corporation's sewer catchment areas and the potential for amendments to suit the staging of development.
- Advice on any opportunities or options available to developers to recoup or reduce costs for sewer construction including funding agreements between landowners/developers, using alternative service providers to Water Corporation, privately owned and maintained sewer infrastructure or alternative sources of funding or partnerships.

## 3.0 References

This review has been carried out with the information that has been made available at the time of writing this report. This information includes but is not limited to the following:

- Structure Plan Final Report, GRA Ref 5773 June 2012, (included in Appendix K).
- Waste Water Scheme Planning – Waggrakine SD168 – Conceptual Planning Long Term Scheme –Nov 2011 (Included in Appendix K).
- Communication with Mark Wilson – Development Planner, Water Corporation, Geraldton (Included in Appendix K).
- AECOM letter – “Waggrakine Development Scheme Preliminary Sewer Costing” 2007 (included in Appendix K).

## 4.0 Development Strategies

### 4.1 Context Analysis

The Waggrakine Development is located on the eastern side of the North West Coastal Highway and north of Chapman Road. There is existing sewer infrastructure immediately on the western side of the highway and the southern side of Chapman Road and the Water Corporation has completed a planning study for the area. The existing infrastructure to the west includes an established network with a pump station and the Glenfield Waste Water Treatment Plant (WWTP).

Enquires were made to the Water Corporation in Geraldton and the Infrastructure Planning Branch in the Water Corporation's head office to understand the likelihood of relocation of the Glenfield Wastewater Treatment Plant (WWTP) to Oakajee. It was confirmed that the Glenfield WWTP will not be relocated in the foreseeable future.

Having reviewed the existing sewer infrastructure in west and northwest of Waggrakine, it is highly unlikely that the proposed sewerage strategy will change even if the WWTP was relocated to the north. This is because the proposed sewer network has to be first directed to the pump station (PS2) north of Whitworth Drive which then delivers sewage north to the existing WWTP. The Water Corporation has advised that this pump station has spare capacity. If the WWTP was moved further north, then the likely scenarios for the Water Corporation would be to either extend the pumping main to the new plant or provide intermediate pump stations.

Since the WRESP area falls gently to the west, any sewerage option in Waggrakine will have its trunk sewers running from east to west. The potential for gravity sewerage has been reviewed and it is confirmed that the entire area between Beattie and Sutcliffe Roads north of Chapman Valley Road can be gravity fed into the existing access chamber before PS2, north of Whitworth Drive. This means that only gravity sewer infrastructure is required for the Waggrakine development and no pump stations will be required.

The Water Corporation has confirmed that there is sufficient spare capacity in the network to the west to accommodate the predicted flow from the Waggrakine development, provided the entire development is connected to the existing manhole in Whitworth Drive.

There is a potential option for the current and proposed subdivision in the eastern end of Waggrakine to connect to the existing sewer infrastructure south of Chapman Valley Road. However, the Water Corporation has confirmed that if this is required, sections of the existing pipework will need to be upgraded. This is discussed further in the sections below.

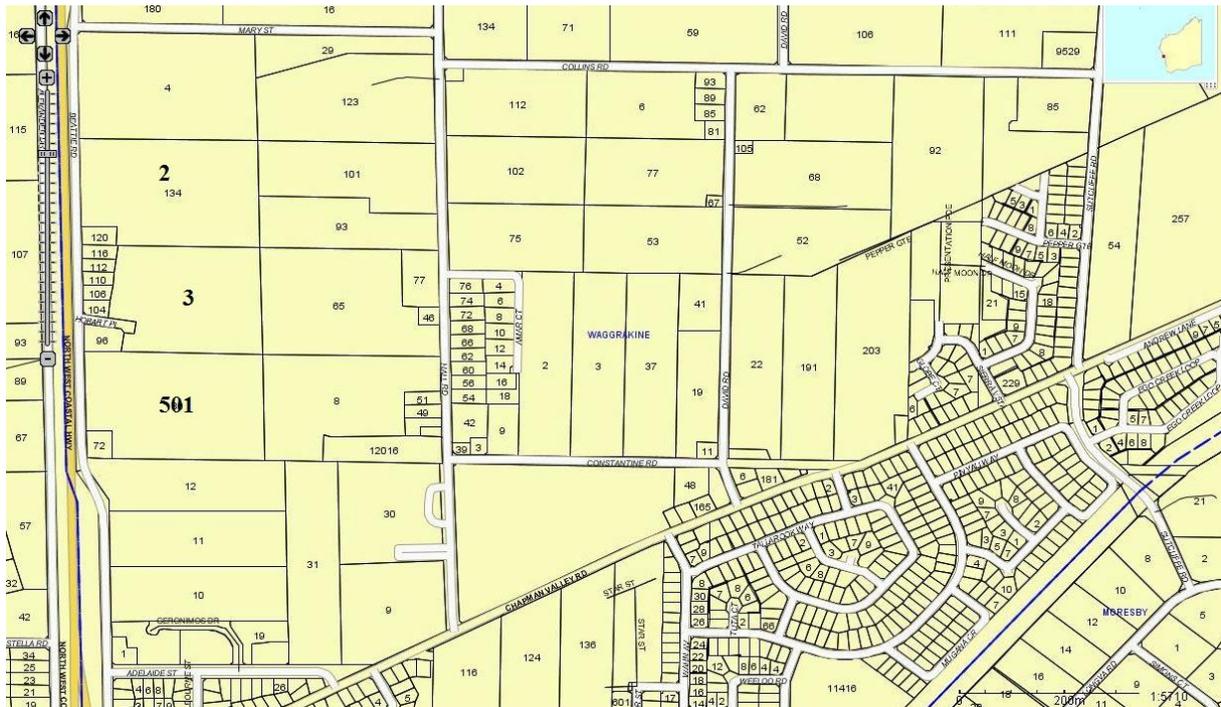
### 4.2 Existing Subdivision Proposals

Inquiries were made to CGG and the Water Corporation to determine if they have received any development applications from landowners in the area of the Structure Plan. The only current development application was that for Stage 2 of the Seafields subdivision in the eastern end of Waggrakine. The proposed Stage 2 Seafields development is shown in Figure 4.3 and attached in Appendix E.



Figure 4.3 Seafields Stage 2

It was also confirmed by the CGG that there is a possibility that existing lots 501, 2 and 3 may be subdivided and developed in the near future, as per the current structure plan. These lots are located in the western boundary of the Structure Plan area bordering Beattie Road. Figure 4.4 shows the existing rural lot layout and these lots.



**Figure 4.4 Existing Rural Lots with CGG Lot numbers**

Efforts were made to contact individual developers by mail after analysing the rate payers list and identifying their lots according to CGG lot numbers. CGG saw potential difficulties in obtaining reliable information through this process and agreed for this part of the work to be left out from the scope.

On this basis, the only option available to proceed with this investigation was to assume that all subdividable lots will be developed some time in the future.

The Glenfield Development area immediately west of the Waggrakine Development area has a potential influence on the sewerage scheme for Waggrakine. The contribution from the proposed Glenfield development has been considered in estimating the sewage flows and pipe sizing west of Glenfield.

## 4.3 Scenarios for Implementation and Staging

### 4.3.1 Waggrakine Residential Development

A sewer concept design has been developed for the entire Waggrakine development to determine the best option for the site which is conducive to the proposed development phasing. This has been completed in consultation with the Water Corporation and with consideration to their current planning for the area. When designing the proposed sewer network the following factors were considered:

- Proposed street alignments to locate the sewer within the verge.
- Existing lot boundaries to minimise disruption to existing lots if a future sewer is to be installed before that lot subdivides.
- Hydraulic factors such as grades, to ensure the sewer doesn't become too deep for it to connect to the existing manhole in Whitworth Drive.

Stage 2 of the Seafields subdivision is currently progressing and construction of this development is anticipated to commence shortly. The current proposal for servicing this stage with sewer is to connect it to the existing network south of Chapman Valley Road. If however, construction of the Seafields Development is delayed, it may be viable to connect the sewer reticulation to the future Waggrakine sewer network, if the Structure plan is finalised at this time. As such, two options have been prepared to demonstrate the possibilities in development. These are further detailed in Section 4.3.2. In short, the two options prepared for the Waggrakine sewer design are as follows:

- Option 1 – Excluding 50 lots for the Seafields subdivision, Appendix C;
- Option 2 – Including 50 lots for the Seafields subdivision, Appendix D.

The network has been designed by dividing the development up into sub catchments of which each one has a sewer main running through it to collect the waste water. These collector mains run in an east-west direction as this is the direction the ground slopes. If a main runs too far in a north-south direction, and is going across the contours, the main becomes too deep and this should be avoided.

Ideally the area should be developed in a west to east direction as the sewer is installed only as needed. This also removes the complexities of constructing sewers through existing lots before they are subdivided. Where possible, the proposed sewer lines have been designed along the existing boundaries that will become road reserves in Structure Plan. This is preferred as it limits the disturbance to existing lots that aren't developing at the time that other lots are. Unfortunately, there aren't sufficient roads in an east-west direction following the existing lot boundaries to avoid this. If lots to the east are developed first then some existing lots will require sewer easements to be created or some lots deleted which is not preferred. Alternatively, alterations can be made to the Structure Plan to assist in a staged development. This is further discussed in Section 4.5.

**4.3.2 Seafields Estate**

The Seafields Estate is an existing subdivision proposal situated in the north-east corner of the Waggrakine Development area. Ultimately the subdivision will include 174 lots however at this stage it is only Seafields Stage 2 that is currently progressing. The current subdivision plan can be seen in Appendix E.

The current proposal for servicing Seafields Stage 2 is through the existing sewerage network south of Chapman Valley Road. This option has been checked with the Water Corporation and they have confirmed that they will approve a maximum of 50 lots to be connected to the existing network however a section of the downstream pipework is at capacity and will need to be upgraded. A concept design of this option can be viewed in Appendix F. This option is conducive to the current development programme for Seafields and allows construction to begin immediately. Option 1 of the Waggrakine sewer network proposals is based on this option and is attached in Appendix C.

Should the current development programme for Seafields be delayed then there may be an opportunity to service the development from the proposed Waggrakine sewer network and avoid the necessary upgrades to the existing sewer lines south of Chapman Road as per the current design. This would involve the construction of sections of the proposed Waggrakine sewer network to service this development and forms Option 2 of the Waggrakine sewer network proposals, as shown in Appendix D.

The cost of providing sewer infrastructure to this development right across the WREP area will be prohibitively costly unless other lots in between are also developed and serviced. Alternatively, if a sewer contribution strategy was created the developer would be able to prefund the sewer infrastructure and recover costs over time as more subdivisions are progressed.

If the Seafields development progresses rapidly and developer wants to develop any more of the subdivision, that is, greater than 50 lots, and connect this to the existing network to the south of Chapman Road then additional pipe upgrades will be required further along the network. This upgrade is additional to the upgrade required for the connection of the 50 Seafields lots described above. The Water Corporation has confirmed that this would require upgrading two sections of 225mm sewer to 300mm. The location of this upgrade can be viewed in Appendix G.

The options for servicing the Seafields subdivision with sewerage can be summarised as follows:

Option	Comments
<ul style="list-style-type: none"> <li>- <b>Connect 50 lots to the existing network and the remaining lots to the Waggrakine network once constructed</b></li> </ul>	<ul style="list-style-type: none"> <li>- Upgrade the existing sewer between MH's 0167 and 0216 to 225mm sewer</li> <li>- Allows the development to proceed in the near future</li> <li>- Cost effective (see section 4.4)</li> <li>- Remaining lots cannot be served without the installation of the Waggrakine network</li> </ul>

Option	Comments
- <b>Connect 174 lots to the existing network</b>	<ul style="list-style-type: none"> <li>- Upgrade the existing sewer between MH's 0167 and 0216 to 225mm sewer</li> <li>- Upgrade the existing sewer between MH's 2347 to 2326 and MH's 2378 to 2353 to 300mm sewer</li> <li>- Ineffective cost solution (see section 4.4)</li> <li>- Not dependent on the Waggrakine network</li> </ul>
- <b>Connect the entire subdivision to the proposed future Waggrakine network</b>	<ul style="list-style-type: none"> <li>- Most cost effective solution</li> <li>- Part of the sewer network would have to be paid for or prefunded by the Seafields Estate subdivision</li> <li>- Sewer would not be complete for some time</li> </ul>

Originally it was considered that another option for servicing this subdivision would be to connect only 16 lots now (Stage 2a) and the remainder on the estate would be connected to the Waggrakine Development. However, this option is no longer considered viable as even an additional 16 lots to the existing network would require upgrading the downstream pipework. As such, if this pipework is to be upgraded, it is far more economical to include the whole 50 lots for this option. This is further discussed in section 4.4.

#### 4.3.3 Subdivision of Lots 501, 2 and 3

The CGG has indicated that there is a possibility that Lots 501, 2 and 3 on the western end of the Waggrakine development may be subdivided in the near future. Development of these lots first is advantageous as it will support the staged development of Waggrakine sewerage scheme.

There are no apparent complexities with constructing sewer reticulation to the western end of Waggrakine first and then extending them eastwards as development occurs further east. However the developers of Lots 501, 2 and 3 will be paying for parts of the sewer system that will later be utilised by other developments further east. Once again, the developers may want to consider a prefunding arrangement and recover initial costs. A concept design for servicing this subdivision with sewer is included in Appendix H.

#### 4.3.4 Water Corporation Servicing Suggestions

For the most part the Water Corporation agrees with the proposed design of gravity sewerage system. However they have proposed some changes to the alignment of some of the main sewers. The Water Corporation has suggested that the main sewer lines follow the existing property boundaries to allow unrestricted installation of these sewers. Whilst in principle AECOM agrees with this, as mentioned in Section 4.3.1, this is not seen as achievable from a hydraulics point of view. The Water Corporation suggestions can be viewed in Appendix I and they have suggested running sewer lines for a greater distance south before joining a straight collector main that runs east-west through the development. This proposed alignment, and future road, is an existing boundary and satisfies the preference of the Water Corporation. If this option were chosen, depending on the outcome of detailed design, a pump station may be necessary if the sewer falls too deep to be able to be connected to the existing network in Whitworth Drive.

The Water Corporation has also suggested moving the location of the final connection from the Waggrakine Development under the North-West Coastal Highway further south than the proposal to align with the future proposed road of the Glenfield Development. This would require an easement to be created though an existing block if it were constructed prior to the Glenfield restructure.

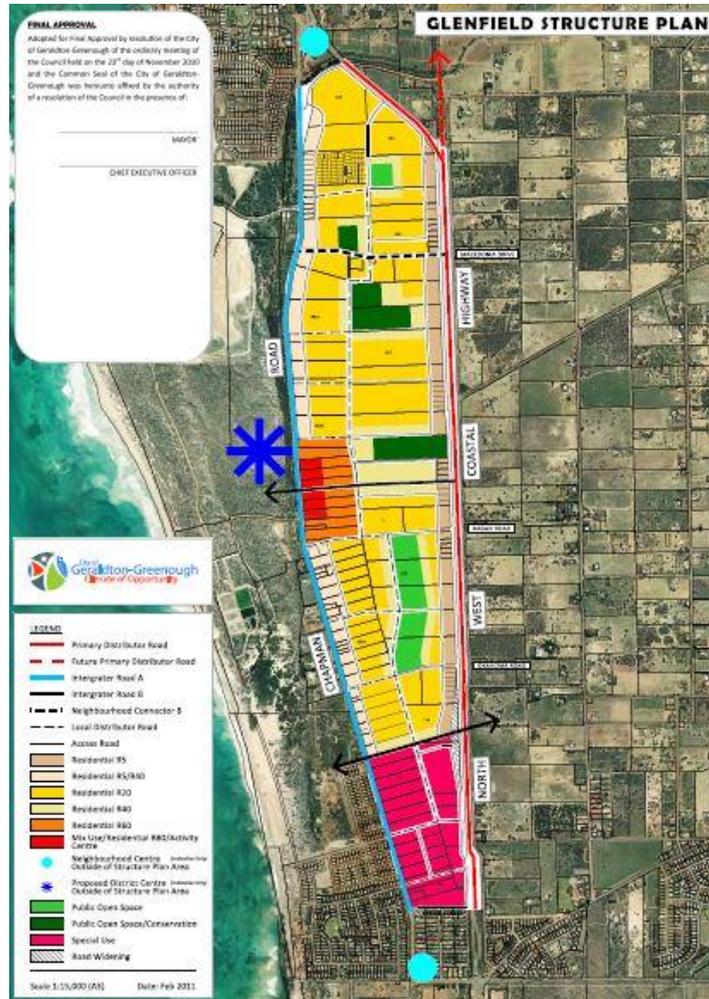
The Water Corporations current planning indicates that a 300mm sewer main will be required to connect the Waggrakine Development to the existing network on the western side of the North West Coastal Highway. This is due to the Water Corporations catchment area being greater than what has been assessed in this study. If further developments are considered outside the Waggrakine structure plan, and it is intended that they ultimately connect in to this network, then this 300mm main may be required. If this is the case, then this section of sewer main will be subsidised by the Water Corporation as further explained in Section 4.3.5 below. Extension of a study area further to the north and east of the area defined in the Brief as per Waggrakine Residential Development Plan is suggested. This can be undertaken if a request is made by CGG.

The Water Corporation has also identified that it would be beneficial to have an additional sleeve installed underneath the North West Coastal Highway at the time of construction of the sewer pipeline as a provision for

any potential future water mains required for Waggrakine. AECOM agree that this is beneficial, and should be covered within the 20% contingency allowance in the estimates.

**4.3.5 Glenfield Development**

The Glenfield development is situated on the western side of the North West Coastal Highway and north of Stella Street. Figure 4.6 shows the Structure plan area Glenfield and Figure 4.7 shows this area in relation to Waggrakine.



**Fig 4.6 Glenfield Structure Plan**



Fig 4.7 Glenfield Locality

Whilst the majority of Glenfield structure plan area will be serviced by existing pump stations and networks to the north, the southernmost part has been identified as potentially contributing to the network that the Waggrakine development is proposed to be serviced from. This is in line with the current Water Corporation network planning which indicates this part of Glenfield will connect to the same point in the existing network that the Waggrakine network will connect to.

A standalone assessment of the Waggrakine development catchment indicates that a total system contribution of 21L/s can be expected. This flow would require a pipe size of 225mm to connect Waggrakine to the existing network west of Chapman Road. This however does not take in to consideration the additional flows contributed from the Glenfield development or catchments beyond the boundaries of Waggrakine. It is therefore reasonable to assume that the final flow contribution east of the North West Coastal Highway, and from the southern part of the Glenfield development, will be greater than the calculated 21L/s. A flow greater than 21L/s will require a pipe size of 300mm. This is supported by the current Water Corporation network plan which indicates that the sewer main connecting the Waggrakine development to the existing network will be 300mm.

The Water Corporation has confirmed that under their new regulations they are required to contribute to the cost of any gravity sewer main that is equal or greater than 300mm. The contribution is \$600/m and confirmation of this can be seen in Appendix K. Based on the current Water Corporation network plan, and subject to further planning and design, the developers of Waggrakine will be entitled to this reimbursement. This will further more reduce the cost per lot for Waggrakine as detailed in Section 4.4, subsequently making development in Waggrakine more affordable.

#### 4.4 Opinion of Probable Cost

The potential cost of the different servicing options has been assessed to determine which options are the most economic and which options should be averted. The following cost indications have been prepared:

Option	Comments
<p><b>1. Waggrakine – Option 1</b></p>	<ul style="list-style-type: none"> <li>- Includes the cost for the construction of sewer reticulation to the subdivision of the undeveloped sections of Waggrakine based on the current structure plan layout</li> <li>- Includes the cost of the 225mm main to connect the subdivision to the existing main in Whitworth Drive</li> <li>- Excludes the 50 lots from Seafields Estate</li> <li>- Allows for sewer headworks fees, overhead construction costs, engineering fees and a 20% contingency.</li> </ul>

Option	Comments
<b>Waggrakine – Option 2</b>	<ul style="list-style-type: none"> <li>- Includes the cost for the construction of sewer reticulation to the subdivision of the undeveloped sections of Waggrakine based on the current structure plan layout</li> <li>- Includes the cost of the 225mm main to connect the subdivision to the existing main in Whitworth Drive</li> <li>- Includes the 50 lots from Seafields Estate</li> <li>- Allows for sewer headworks fees, overhead construction costs, engineering fees and a 20% contingency.</li> </ul>
<b>Waggrakine – Lots 501, 2 &amp; 3</b>	<ul style="list-style-type: none"> <li>- Includes the cost for the construction of sewer reticulation to the subdivision of Lots 501, 2 &amp; 3 based on the current structure plan layout</li> <li>- Includes the cost of the 225mm main to connect the subdivision to the existing main in Whitworth Drive</li> <li>- Allows for sewer headworks fees, overhead construction costs, engineering fees and a 20% contingency.</li> </ul>
<b>Seafields – 50 Lots</b>	<ul style="list-style-type: none"> <li>- Includes the cost for the construction of sewer reticulation to Seafields Stage 2a and part of 2b to a maximum of 50 lots</li> <li>- Includes the cost of construction to upgrade the required section of 150mm sewer to 225mm sewer south of Chapman Valley Road</li> <li>- Allows for sewer headworks fees, overhead construction costs, engineering fees and a 20% contingency.</li> </ul>
<b>Seafields – 174 Lots</b>	<ul style="list-style-type: none"> <li>- Includes the cost for the construction of sewer reticulation to the entire Seafields subdivision of 174 lots</li> <li>- Includes the cost of construction to upgrade the required section of 150mm sewer to 225mm sewer south of Chapman Valley Road</li> <li>- Includes the cost of construction to upgrade the required section of 225mm sewer to 300mm sewer west of the North West Coastal Highway</li> <li>- Allows for sewer headworks fees, overhead construction costs, engineering fees and a 20% contingency.</li> </ul>
<b>Upgrading 225mm Sewer</b>	<ul style="list-style-type: none"> <li>- Includes the cost of construction for upgrading approximately 1000m of 225mm sewer to 300mm if the developer for the Seafields Estate elects to service the entire development from existing networks</li> <li>- This cost is shown separately to indicate the severe cost impact this has on “Option 5: Seafields – 174 Lots”. This cost is included in the total option cost.</li> </ul>

The final cost has been divided by the total number of lots for that subdivision to give an indication of the probable cost per lot for providing sewer reticulation. An allowance of 20% of the construction cost has been included to allow for overhead costs and a contingency of 20% added to allow for uncertainty in the design. Although the estimated value of the cost per lot may not be truly representative it does give an indication of the ratio of difference in cost between the various options. Previous estimates completed by AECOM in 2012 were used for the basis of the Seafields estimates and the rates were adjusted by 0.5% to allow for the inflation in costs since then. A previous estimate was also completed for the upgrading of the 225mm sewer to 300mm however this has been adjusted following further investigations and discussions with the Water Corporation. The cost of these works are considerable and have a large impact on the total cost per lot should this option be chosen.

The various opinions of probable cost are attached in Appendix J however a summary of the estimated cost per lot can be seen below.

Option	Comments
1. Waggrakine – Option 1	\$7,242 / Lot
2. Waggrakine – Option 2	\$7,138 / Lot
3. Waggrakine – Lots 501, 2 & 3	\$9,241 / Lot
4. Seafields – 50 Lots	\$11,222 / Lot
5. Seafields – 174 Lots	\$17,585 / Lot

*Note: Cost includes current headworks fees*

#### 4.4.1 Waggrakine – Option 1

The total cost per lot for this option is \$7,242/Lot. This option is very efficient as the cost of the infrastructure is shared amongst all developers. As explained in Section 4.4.3 above this relies on a prefunding agreement and a contribution scheme being developed.

This cost would be further reduced to approximately \$6,500/Lot if the Water Corporation's greater plan for the region is recognised. This is due to the mains connection from the Waggrakine development to the existing network needing to be 300mm as per the Water Corporations current plan. As discussed in Section 4.3.4 and 4.3.5 above, this part of the works would be subsidised by the Water Corporation and therefor reducing the overall cost to the developers of Waggrakine.

#### 4.4.2 Waggrakine – Option 2

The total cost per lot for this option is \$7,138/Lot. Much the same as "Waggrakine Option 1" this option is the most efficient as there is a higher lot yield for the development. Even though this option allows for a different design the cost works out to be fairly similar indicating that it is not the final detail design that will matter but more the staging and funding arrangements that are in place.

This cost would be further reduced to approximately \$6,500/Lot if the Water Corporation's greater plan for the region is recognised. This is due to the mains connection from the Waggrakine development to the existing network needing to be 300mm as per the Water Corporations current plan. As discussed in Section 4.3.4 and 4.3.5 above, this part of the works would be subsidised by the Water Corporation and therefor reducing the overall cost to the developers of Waggrakine.

#### 4.4.3 Waggrakine – Lots 501, 2 & 3

The total cost per lot for this option is \$9,241/Lot and is more within the range of the normal cost for the provision of sewerage infrastructure. This option is slightly more expensive than the options detailed below in Sections 4.4.4 and 4.4.5 as it requires the installation of the main trunk line and connection to the existing network on the western side of the North west Highway.

This cost would be further reduced to approximately \$6,900/Lot if the Water Corporation's greater plan for the region is recognised. This is due to the mains connection from the Waggrakine development to the existing network needing to be 300mm as per the Water Corporations current plan. As discussed in Section 4.3.4 and 4.3.5 above, this part of the works would be subsidised by the Water Corporation and therefor reducing the overall cost to the developers of Waggrakine.

#### 4.4.4 Seafields – 50 Lots

As previously discussed the Water Corporation has confirmed that a maximum of 50 lots can be connected to the existing system south of Chapman road if a portion of sewer is upgraded. The total estimated cost per lot for this option is \$11,222/Lot.

Although not the cheapest option to service these lots there may be other factors to consider here such as the timing of the development. This option would allow a portion of the development to proceed immediately should the developer require and the additional cost per lot for this option may offset any other cost should the development not proceed until the Waggrakine sewer network is installed. The remaining 124 lots would be connected to the Waggrakine sewer network once installed (see Section 4.4.4).

#### 4.4.5 Seafields – 174 Lots

The total cost per lot for this option is \$17,585/Lot and is considerably higher than the other options. This is mainly due to the requirement to upgrade the existing downstream 225mm sewer to a 300mm sewer west of the North West Coastal Highway. This is based on the assumption that the Water Corporation would not consider funding this upgrade as it would be the developer's choice and is not required providing the estate can be reticulated from the Waggrakine Development. The Water Corporation have already installed sufficiently size infrastructure at the current proposed connection point for Waggrakine in Whitworth Drive. For the size of the development this option is not considered viable and the developer should consider one of the other options.

If however the Water Corporation gave consideration to subsidising the upgrade of this section of existing sewer main this option would become viable with an estimated cost per lot of \$11,469/Lot. Once again however, this is considered very unlikely as this is not in line with the Water Corporation master plan and the preference would be towards funding the main connecting Waggrakine to the existing manhole in Whitworth Drive.

#### 4.4.6 Independent Sewage Treatment Plant

Where the cost of connection of a limited number of lots to the sewerage system is very high, an independent sewer system including a treatment plant and a disposal system could be considered. In this event, the actual cost should not only include the capital cost but also the operating and maintenance costs.

Typical small sewage treatment plant and their relative advantages and disadvantages are listed in the table below. Three common types of treatment plant, starting from lowest capital cost (lowest effluent quality) are listed.

Option	Ponds	Packaged Plant 1 Activated Sludge Extended Aeration	Packaged Plant 2 Activated Sludge with membrane Bioreactor
1. Area Requirement	Large (open ponds)	Small	Small
2. Buffer Zone	Large (due to odour nuisance)	Small	Small
3. Maintenance Requirement	Low	High	Very High
4. Consumables	Zero	Moderate	High
5. Capital Cost	High (including cost of land)	Moderate	High
6. Operating Cost	Low	Moderate	High
7. Effluent Quality – potential for re-use	Low (high in algae, no nitrification)	Moderate (partial nitrification)	High – (Nitrification and denitrification)

Disposal of the treated effluent will be an ongoing maintenance issue.

The options for disposal include:

- Evaporation ponds, however they require large areas of land.
- Re-use in controlled irrigation or spray fields.
- Carted and disposed in the Water Corporation's wastewater treatment pond.

The low rainfall and generally high temperatures indicate a preference for the wastewater to be treated in ponds and disposed in suitably sized evaporation ponds.

It is likely that the land for treatment may have to be sourced from land outside the WRESP area. This is likely to involve further complications for planning and future development of adjacent lands. Therefore this option has not been considered any further.

## 4.5 Potential Design Issues in the Structure Plan

The Structure plan of Waggrakine was analysed in the context of providing sewer infrastructure in a cost effective manner. The structure plan is generally satisfactory for the provision of major sewers. The extent of minor sewers could be reduced if the sewers are placed in the back boundaries of some of the R12.5 lots however this will require an easement running along lot boundaries. This may not be acceptable in terms of convenience of the property owner, cost of acquisition of easements and maintenance and is therefore not considered an option.

The current design of sewerage follows east-west roads where possible and passes through lots where roads do not exist. This is necessary to keep the sewer at a minimum depth. Creating easements within lots for main sewers will depreciate the land value and is therefore not desirable.

Several locations have been identified where a minor adjustment to the lot layout and minor roads could be made to provide corridors for sewer mains and avoid the need for easements. These locations of the proposed amendments are shown below in Figures 4.8 to 4.14.

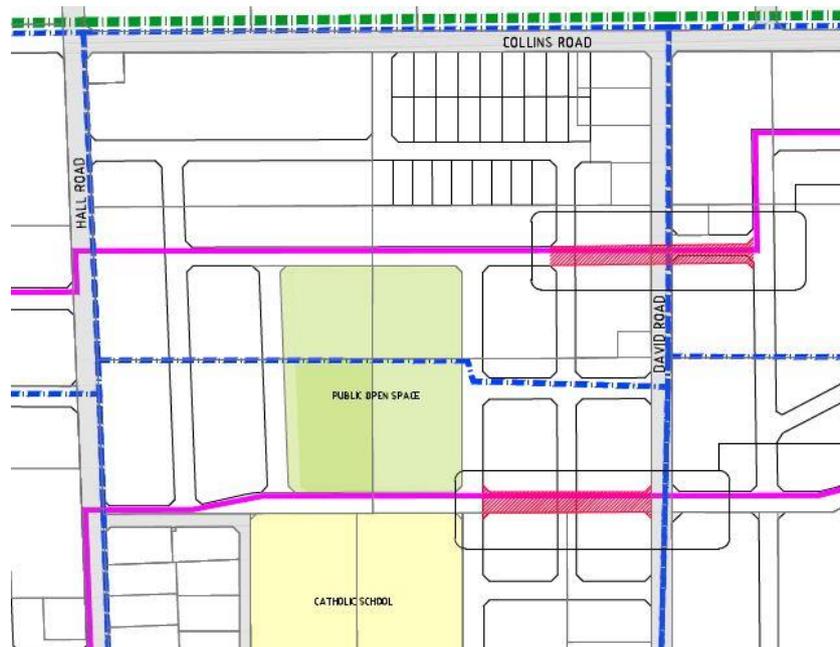


Figure 4.8



Figure 4.9



Figure 4.10



Figure 4.11



Figure 4.12

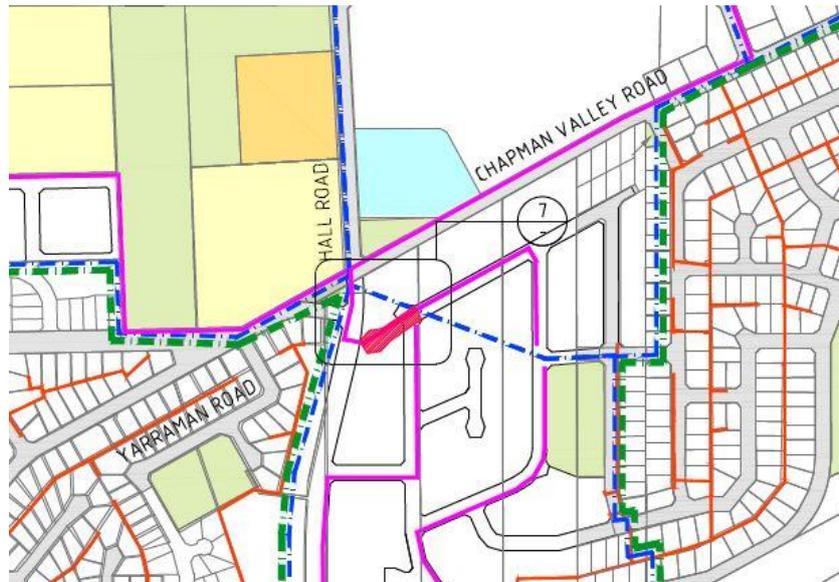


Figure 4.13



Figure 4.14

Alternatively if there were public open spaces or specific service easements to connect short lengths of east west roads, this would also be satisfactory.

Alternatively, the main sewers could be installed following the existing rural lot boundaries and paths as suggested by the Water Corporation. This option will reduce the disturbance to existing lots and facilitate a staged approach to development however the Structure Plan will need to be based on the existing boundaries. One issue with this is that it may preclude subdivision of the land in the most space effective way. It is also likely that this will result in longer length of sewers resulting in an increase in depth. The depth of the sewer crossing the North West Coastal Highway is critical for gravity flow to the access chamber on Whitworth Drive. If this were the case a pump station would be required. This, along with the increase in depth of the sewer, would make this option expensive.

## 4.6 Sewer Cost Recovery Options

The land ownership in the WRESP area is fragmented and it is recommended that the structure plan be reassessed with regards to a coordinated approach for development. Increased communication between the land owners and a coordinated approach to development will go a long way towards optimising servicing costs. If the structure plan were redeveloped with this in mind, like the suggested changes detailed in Section 4.5, a staged approach to development might be a more feasible option.

Alternatively the government entity or an investor may elect to prefund the works required to provide the necessary sewer infrastructure to the development. The idea being that as developers subdivide their land, they pay a contribution cost towards the initial works and the investor recoups their money over time. However, given the size and cost of the sewer network required, this may be too great a risk for any investor.

As has been previously mentioned, for sewers 300mm or larger, the Water Corporation is required to subsidise the works at a rate of \$600/m. If it were shown that a 300mm main is required to feed the Waggrakine Development based on the current Structure plan, and the surrounding future developments, then the developers will not be required to fund this part of the works resulting in a significant cost saving for their developments. Whilst a prefunding arrangement may still be required for some of the internal sewer mains as mentioned above, the contribution will be significantly less if the Water Corporation funds the section of main from Whitworth Drive to Beattie Road.

There may also be some intermediate options available to deal with the staged development until such a time that sufficient sewerage infrastructure has been installed. Individual septic tanks are not an option as the lot size is less than 2000m<sup>2</sup> so the sewerage would have to be treated, stored and tanked away. This sort of option however is typically expensive and may not prove viable should other options be available.

## 5.0 Recommendations for Development

There are no major factors that will prevent the construction of a gravity sewer system to service the Waggrakine Development. Fortunately as the ground slopes from east to west, a gravity system can be designed and installed without too many issues and at minimal cost. It is however, the staging and Structure Plan that will have the greatest effect on the design complexities and cost.

From the costs outlined in Section 4.4, the development of 50 lots in the Seafields Estate is a viable option. The solutions presented for this case would allow the developer to proceed with Stage 2a and a portion of 2b without delay and with minimal additional cost. This would also allow more time for an ultimate solution to be developed to service the remaining lots through the Waggrakine sewer network.

It is apparent that the option of developing the entire 174 lots of the Seafields Estate is not a viable option. The developer would be exposed to a sewer cost twice that of the other options presented and it is recommended that this option is not selected. Although this cost would be drastically reduced if the Water Corporation contributed to the cost of the downstream sewer upgrade, as indicated in Appendix E, there is no confirmation that they would entertain this proposal as it is not ultimately required should the Waggrakine redevelopment go ahead.

The development of existing lots 501, 2 & 3 is recommended as it can be constructed with minimal sewer infrastructure installed up front. Development of these lots is conducive to the staged development of Waggrakine. If the greater catchment surrounding Waggrakine is assessed, and it is shown that the sewer main from Beattie Road to Whitworth Drive needs to be 300mm in size, then the cost of this development will be further reduced. This will bring the cost of development for these three lots closer to the Waggrakine Options 1 and 2. It is strongly recommended that the greater development area be further discussed with the Water Corporation to develop the option for installing this 300mm sewer main. If this can be suitably justified to the Water Corporation, and given that it aligns with their current master plan, installation of this main may proceed in the near future through Water Corporation funding. Installation of this main will encourage potential developers to develop as their overall cost per lot for sewerage infrastructure will be minimal. It should be noted that the Water Corporation will not be able to fund these works until they have been allowed for in the next financial year's budget however they do have a prefunding agreement available to developers so there is not delay to the works.

Finally, as detailed in Section 4.5, it is highly recommended that the overall area covered in the Structure Plan of Waggrakine be reassessed with respect to the potential staging of the development as various lot owners decide to subdivide their lots. This would include re-aligning roads to match existing boundaries in an east-west direction which would allow a sewer main network to be established throughout the entire development with minimal disruption to the existing lots. This network is something that would ideally be prefunded and developers pay a contribution cost as they develop. This would allow lots to be developed at any stage over the Waggrakine development and removes pressure from other lot owners to develop in the near future.

If the Structure Plan was to stay as currently designed there are a number of lots that would have to be deleted, or POS added, to allow passage of the sewer mains. This may be a viable option as the overall reduction in lots would be minimal and the cost per lot for sewer infrastructure would only be slightly altered. Alternatively if the Structure Plan cannot be altered, and the deletion of some lots not acceptable, it is highly likely that the sewer will be at a greater depth and one or two pump stations install. Not only would this have a negative impact on the cost per lot for sewer infrastructure, the Water Corporation would not be likely to accept this as it is not entirely necessary.