11 September 2008

Silver Spirit Partners
Level 25, Chifley Tower
2 Chifley Square
Sydney NSW 2000

Attention: David Goodrich

Dear David,

Subject: Moruya East Village – Issues of Concern by Department of Planning

Thank you for providing me with copies of:

- A summary of issues raised in public submissions (Attachment 1 to the letter from the Department of Planning (DoP) dated 13 June 2008);
- Summary of other issues of concern raised by the Department of Planning (Attachment B to the letter from the Department of Planning dated 21 July 2008).

I understand that you wish me to provide a response to Issues 16 and 17 in Attachment B of the DoP letter dated 21 July 2008 and Issue 1 in Attachment 1 to the DoP letter dated 13 June 2008.

DoP Issue 16:

> *"Inadequate Assessment has been made with regard to sensitivity analysis for climate change on flood levels."*

The *Water Cycle Management and Flooding* report that was submitted to DOP specifically addresses the issue of climate change in a manner that is consistent with the draft guidelines issued by DECC that were current at the time of preparation of the report (October 2007). In particular the guidelines recognise that the underlying issue is the degree of vulnerability of a site and the measures required to manage vulnerability.

This approach has been followed in the *Water Cycle Management and Flooding* report. Specifically, Section 3.10.2 of the report provides an assessment of the vulnerability of the site to the effects of the most recent (2007) estimates of sea level rise published by the IPCC. The report also assesses the sensitivity of the site to flooding from both Racecourse Creek and Moruya River (see Table 2.3 of the report).

Shortly after the *Water Cycle Management and Flooding* report for Moruya East Village was finalised, DECC published its final set of guidelines entitled *Practical Consideration of Climate Change* (25/10/2007). The latest guidelines provide further detail in relation to possible increases in rainfall and sea level. For purposes of addressing the concerns of DoP, I have carried out further assessment of the sensitivity of flood level estimates and prepared an assessment of the vulnerability of the site to possible climate change effects in line with the 2007 DECC guidelines.

Sensitivity Assessment

The 2007 DECC Guideline suggests that the sensitivity of flood level estimates be assessed by consideration of a number of scenarios:

- The 2070 scenario for increased rainfall intensity and volume. As a general guide, increases of 10%, 20% and 30% are recommended which covers the full range of estimates for NSW river valleys prepared by CSIRO (Table 1 in the Guideline). However, the southern rivers region (which includes the Moruya River) is expected to only experience a 5% increase by 2070 while the maximum increase for other coastal rivers is 10%.
- 2100 scenarios for sea level rise as given by the IPCC (low estimate 0.18m, medium estimate 0.55 m and high estimate 0.91 m).

The *Moruya River Flood Study* (PWD Coasts & Estuaries Branch, 1992) provides details of the technical analyses undertaken in order to estimate flood levels along the Moruya River. The analysis included detailed consideration of 150 years of historical flood levels, and both hydrologic and hydraulic modelling. The modelling included an assessment of the sensitivity of flood level estimates to both rainfall and ocean levels as described below. This data has been used to undertake an assessment of the sensitivity of flood level estimates to climate change effects. While this assessment has not included detailed hydrologic and hydraulic modelling, such as would be undertaken by Council when updating the *Moruya River Flood Study*, the available data provides an appropriate basis for assessing the sensitivity of the site to possible climate change effects.

Rainfall Increase

The hydrologic analysis in the *Moruya River Flood Study* established that the 1% AEP "design" catchment rainfall together with an areal reduction factor of 0.94 (as recommended in *Australian Rainfall and Runoff)* led to a peak flood level at Moruya Bridge that was 0.3 m lower than that estimated from flood frequency analysis. In order to achieve a flood level equal to that predicted by the flood frequency analysis it was necessary to increase rainfall by 10% and eliminate the areal reduction factor; a total increase of 11%.

Figure 1 shows the sensitivity of the 1% AEP flood level at the Moruya East Village site based on:

- An increase in rainfall of 11% leading to a rise in flood level of 0.3 m at Moruya Bridge,
- The flood levels for various AEP floods set out in Table 8 of the *Flood Study,* and
- Flows for various AEP floods shown in Figure 44 of the *Floodplain Management Study* (Patterson Britton, 1999).

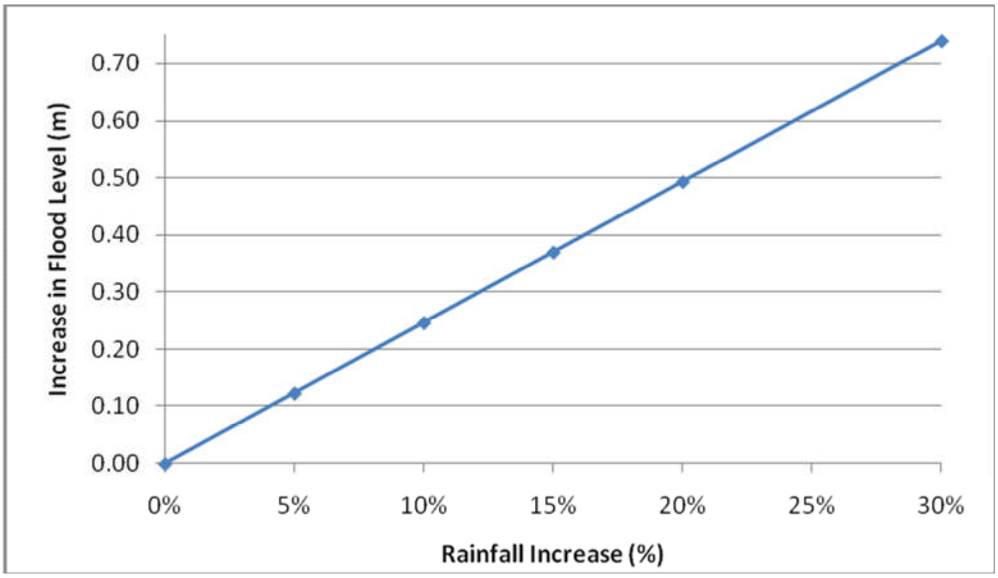

Figure 1
Sensitivity of 1% AEP Flood Level at
Moruya East Village to Increased Rainfall

Sea Level Rise

Table 10 in the *Moruya River Flood Study* shows the sensitivity of 1% AEP flood levels at various locations to changes in sea level. Figure 2 below has been derived from that data and shows the increase in 1% AEP flood level at Moruya East Village resulting from increase in sea level for a scenario in which the peak storm surge and wave setup coincide with the peak rainfall, and the peak astronomical tide coincides with the peak outflow at the mouth of the river.

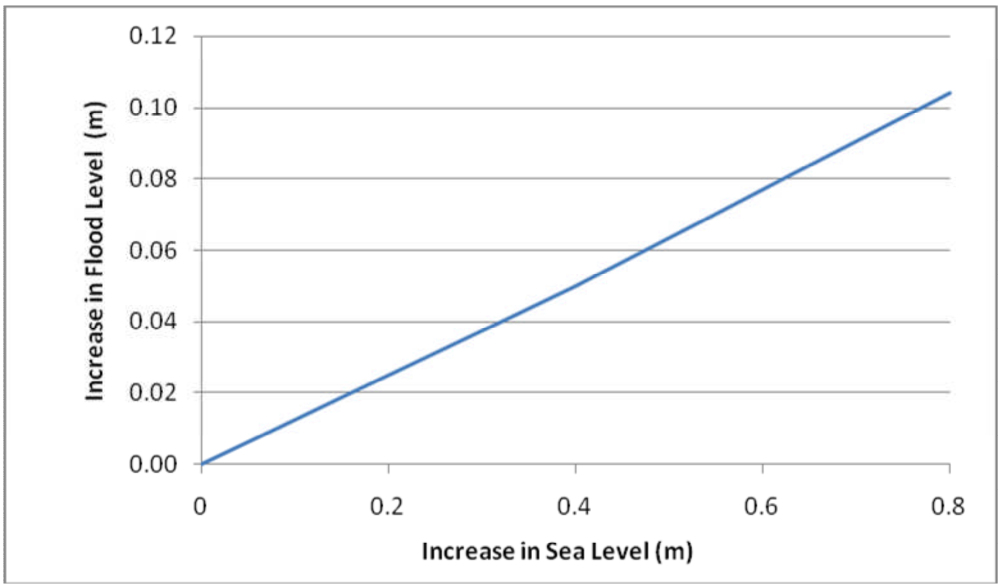

Figure 2
Sensitivity of 1% AEP Flood Level at
Moruya East Village to Increased Sea Level

Combined Effects of Rainfall and Sea Level

Table 1 below summarises the combined effects of a number of possible combinations of increased rainfall and sea level on the 1% AEP flood level at the Moruya East Village site derived from the data in Figures 1 and 2. The combinations cover the following ranges:

- Sea level rise for low (0.18), medium (0.55) and high (0.91) scenarios;
- Rainfall increase of 5% to 15%. (This range has been adopted to reflect the fact that the CSIRO predictions for rainfall increase in the south coast rivers by 2070 is only 5% compared to 10% for all other coastal rivers. This contrasts with inland rivers such as the Murray and Lower Murray-Darling where the predicted rainfall increase is up to 29%.)

In Table 1, the shaded line shows the most likely future scenario (medium sea level combined with 5% increase in rainfall). It can be seen that this scenario could lead to an increase in the 1% AEP flood level of **0.19 m**. The worst combination (high sea level rise combined with 15% increase in rainfall – last line in Table 2) would lead to an increase in the 1% AEP flood of 0.49 m. Both these estimates are less than the freeboard of 0.6 m that has been adopted for purposes of establishing the flood planning level for the site. Accordingly, I consider that adequate provision has been made for possible impacts on flood levels of climate change.

Table 1: Combined Effects of Sea Level Rise and Rainfall on Flood Levels at Moruya East Village

Sea Level Increase (m)	Rainfall Increase (%)	Flood level Increase (m)
0.18	5%	0.15
0.18	10%	0.27
0.18	15%	0.39
0.55	5%	0.19
0.55	10%	0.32
0.55	15%	0.44
0.91	5%	0.24
0.91	10%	0.36
0.91	15%	0.49

Vulnerability to Possible Climate Change Effects

Table 2 below summarises the site characteristics in regard to the specific climate change issues identified in Section 2 of the DECC guidelines.

Table 2: Significance of Possible Climate Change

Issue	Response
1. Will climate change result in new floodways developing in the key design events?	No. Even if flows in Racecourse Creek doubled, the floodway would remain within the floodplain area.
2. Will climate change have significant implications for flood hazard in the study area?	No. The main flood hazard is relates to the depth of flooding within the rural zone. Climate change may slightly increase the area of high hazard, but this will not encroach into the development area.
3. Will climate change result in significant increasing frequency of inundation?	Low lying area of the floodplain is already subject to frequent flooding.
4. Will climate change result in significant increase in exposure to hazard?	Proposed development ensures that people are kept away from all high hazard areas.
5. Will climate change significantly impact on flood damages?	The adopted flood planning level will ensure that dwellings are constructed with a minimum freeboard of 0.6 m above the 1% AEP flood in order to avoid flood damages.
6. Is the effectiveness of existing or proposed management options vulnerable to climate change?	Design of the development ensures that minimum land levels for dwellings are at least 0.6 m above the 1% AEP ARI flood level and that appropriate flood free escape routes are available for residents to access higher ground above the extreme flood level.
7. Are existing or proposed development options or controls vulnerable to climate change?	No. Site design has been developed to ensure low vulnerability to any climate change effects.

The assessment in Table 2 indicates that the Moruya East Village site has only a minor vulnerability to possible effects of climate change.

Conclusions - Climate Change

After due consideration of the DECC's advice in relation to the assessment of vulnerability to flood impacts, the factors that affect flooding, and taking account of the topography of the site (sloping upwards at over 6%), the adopted flood planning level of 0.6 m above Council's designated 1% AEP flood level at the site is considered appropriate. It should also be noted that the extreme flood level (which is less susceptible to climate change effects because it is governed by the physical processes that generate rainfall) would not encroach beyond the first row of dwellings that adjoin the floodplain. Accordingly the adopted design of the proposed Moruya East Village and the minimum land levels for dwellings are consistent with DECC's *Practical Consideration of Climate Change*.

DoP Issue 17:

> *"Inadequate information/plans have been provided in relation to construction of drainage structures within the rural zoned portion of the site as are identified in the Water Cycle Management and Flooding report to allow for an appropriate assessment of impacts, in regard to EECs and flood storage"*

The landscape masterplan shows a series of ephemeral wetlands which reflect current locations of inundation/ponding within the floodplain. In some instances (e.g. the small wetlands to the east of the Stage 1 Project Application) areas of the floodplain are currently subject to high densities of the environmental weed Spiny Rush (*Juncus acutus*). To control this weed it is proposed to undertake discrete, shallow excavations, sufficient to substantially remove the weed and reduce high associated soil borne weed seed loads (the species seeds prolifically). These areas will then be reinstated with locally endemic marsh species and managed as small ephemeral wetlands, similar to those already occurring within the floodplain.

The wetlands shown within the northern portion of the floodplain reflect existing low-lying areas currently subject to frequent inundation and flooding. Subject to future detailed field investigations, areas within the northern portion of the floodplain may be subject to the same process of shallow excavation in order to create additional ephemeral wetland areas.

The proposed ephemeral wetlands will only involve relatively minor excavations within the existing floodplain. No associated formations such as bund walls or other built forms that could reduce the available floodplain storage are proposed. Further, these wetland areas will not have any effect on floodplain storage because:

- They will be created by excavation <u>below</u> the existing level of the floodplain;
- At worst they will be full (and will maintain existing floodplain storage); and
- Given that they will be ephemeral, when dry, they will provide a minor increase in floodplain storage.

As discussed above, the proposed ephemeral wetlands will be positioned in response to detailed site mapping of existing natural communities within the floodplain. No significant areas of either of the two endangered ecological communities within the floodplain (i.e. Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions, and Coastal Saltmarsh of the NSW North Coast, Sydney Basin and South East Corner Bioregions) will be subject to works. It is expected that the resilience (and potentially also the extent) of these endangered ecological communities will be increased in response to the proposed active management of the natural communities within the floodplain.

Submissions Issue 1: Water Cycle Management

Submissions made in relation to the proposed stormwater management system raise concerns as to whether the proposed facilities will be capable of achieving Council's stormwater management guidelines. These issues fall into four broad categories:

- Design and effectiveness of rain gardens and bio-retention swales;
- Effectiveness and maintenance of gross pollutant traps;
- MUSIC model data and assumptions;
- Hydrologic impacts on receiving waters.

Rain Gardens and Bio-retention Swales

There are a total of 198 rain gardens proposed for the development. As noted in the *Water Cycle Management and Flooding* report and shown in the drawings in Appendix A, these rain gardens will comprise small, approximately rectangular, areas located within the parking lane and verge of the relevant Access Roads and Collector Roads. It is intended that each rain garden would be constructed so as to be approximately level and detain water by means of kerbing on the down-slope side. As illustrated in the drawings in Appendix A, the largest sized rain gardens will be approximately 4.3 m wide and 5.5 m long. In order to meet accessibility requirements the maximum grade of the roads will be 1:20 (5%). Accordingly, even for a lateral grade of 5%, the fall across the length of the rain garden would only be 250 mm which will be accommodated by means of a kerb.

The proposed bio-retention swale along the eastern boundary of the site falls a total of 5 m over 200 m (2.5%). This grade is considered appropriate for a bio-retention swale. Notwithstanding, the swale will be constructed as a series of stepped terraces in order to provide additional extended detention of stormwater. As noted in the *Water Cycle Management and Flooding* report, a detention depth of 150 mm has been assumed for purposes of water quality assessment.

Gross Pollutant Traps

All gross pollutant traps (GPTs) would be maintained in accordance with the manufacturer's requirements.

The GPTs have been included in the treatment train primarily to capture any litter and oil that bypasses the rain gardens that surround all stormwater inlets. Within the MUSIC model the effectiveness of GPTs is only taken to account <u>after</u> the stormwater has been treated by the rain gardens and swale.

The trapping efficiencies adopted for the purposes of stormwater modelling have been derived from a review of manufacturers specifications and published literature including:

> Walker, TA, Allison RA, Wong, THF, and Wootton, RM (1999) *Removal of Suspended Solids and Associated Gross Pollutants by a CDS Gross Pollutant Trap,* CRC for Catchment Hydrology, Report 99/2.

That report indicated the following annual removal efficiencies:

- Suspended solids 65%;
- Total nitrogen 13%;
- Total phosphorus 21%.

The values above for removal of total nitrogen and total phosphorus are comparable to values adopted for the assessment for Moruya East Village, while the adopted value of suspended solids removal is only 20% (compared to 65% quoted above). Notwithstanding the relatively low removal efficiency of GPTs for nitrogen reduction, the main nitrogen reduction processes will occur within the rain gardens and bio-retention swale, rather than the gross pollutant traps. As their name suggests, GPTs are designed to primarily remove gross pollutants. In this instance, the specified type of trap also has the capacity to retain hydrocarbons.

MUSIC Modelling

The climate data for Nowra was adopted for purposes of water quality modelling because of the similarity of rainfall to Moruya Heads and the fact that the data contains contemporaneous evaporation data (necessary for MUSIC modelling) as well as rainfall. Prior to adopting the Nowra data, the rainfall data for Nowra was compared to the rainfall data for Moruya Heads. That analysis indicated that Nowra has similar seasonal pattern of rainfall with approximately 15% more average annual rainfall. In view of the fact that stormwater pollutant loads are a function of rainfall depth, it was considered that the use of the Nowra data would add an element of conservatism to the analysis by over estimating the pollutant loads.

The criticism that short duration rainfall data is required in order to characterise runoff from small catchments cannot be sustained because of the way that MUSIC internally disaggregates daily rainfall. Evans & Peck has carried out a number of analyses using both daily and short duration rainfall. In our experience there is very little (if any) change between a model run using daily rainfall data compared with the same model run with 6 minute rainfall data. This indicates that the MUSIC model algorithms deal adequately with the disaggregation for rainfall and evaporation data.

In the absence of rainfall-runoff monitoring, Evans & Peck calibrated the soil parameters to generate an annual average runoff for the undeveloped site that would be consistent with site yield as defined by *NSW Farm Dams Assessment Guide*, which identifies typical runoff yield for undeveloped catchment areas across NSW. Rather than arbitrarily adopting default soil parameters for the pervious surfaces, the MUSIC parameters were adjusted to give surface runoff comparable to the average annual runoff for the local undeveloped catchment conditions.

Because of the size of the MUSIC model for the post-development conditions and the limitations of the available computing resources at the time the analysis was undertaken, the pos-development stormwater quality model was split into two sections comprising:

a) Sub-catchments 1-7 and 13-15;
b) Sub-catchments 8-12.

Unfortunately, the schematic diagram and results for part b) were inadvertently omitted from the original report. An updated version of Figure 4.2, which includes all sub-catchments, is appended to this letter. An updated version of Table 4.5 is included below.

Table 4.5: MUSIC Model Results

Parameter	Pre-Development	Post-Development (No Treatment)	Post-Development (With Treatment)	Treatment Reduction
Flow (ML/yr)	50	138	121	12%
Total Suspended Solids (kg/yr)	13,900	26,800	6,700	75%
Total Phosphorus (kg/yr)	36	55	20	64%
Total Nitrogen (kg/yr)	196	394	216	45%
Gross Pollutants (kg/yr)	0	2,900	21	99%

Note that the data for the pre-development conditions set out in the original version of Table 4.5 correctly reported the loads for the entire development area. Only the post-development data in the table above have been amended to include sub-catchments 8-12. Whilst the absolute numbers in Table 4.5 now reflect the addition of pollutant loads from sub-catchments 8-12, the table shows that the proposed stormwater treatment train would still achieve the following key objectives:

- A reduction in average annual stormwater pollutant loads compared to pre-development conditions (compare Column4 with Column 2);
- Achieve the level of treatment required by Council's *Urban Stormwater Quality Management Plan* (all reductions in the last column are equal to or greater than Council's requirements).

Hydrologic Impacts

All stormwater from the development will discharge into the existing low-lying swampy floodplain area that also receives runoff from:

- Two external rural catchments upstream of the Princes Highway (122 ha);
- Racecourse Creek (540 ha) that that carries runoff from the existing Moruya urban area.

The runoff from the development only represents a small fraction of the runoff that reaches the swampy floodplain area and, accordingly, will not have any significant impact on the area compared to the existing wetting and drying regime associated with episodic runoff from the external catchments.

Conclusions - Water Cycle Management

Based on the responses to each of the issues raised in the submissions, it is considered that the proposed facilities will be capable of reliably achieving Council's stormwater management guidelines and having no negligible impact on the hydrology of the receiving waters and ecosystems.

Yours faithfully
EVANS & PECK PTY LTD

Dr Steve Perrens
Principal

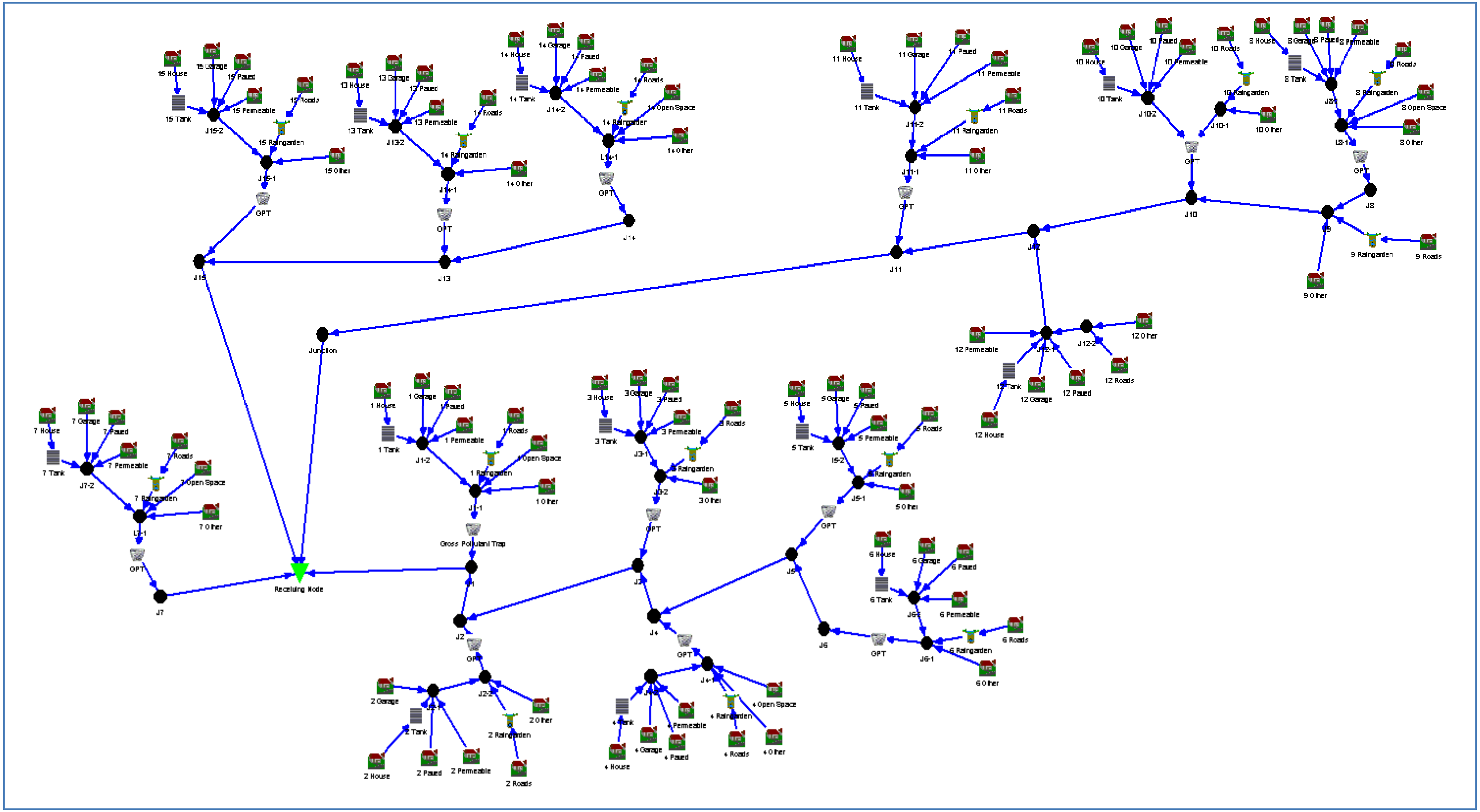

Figure4.2
MUSIC Model Layout