

## 2 KEY EIS IMPACT PREDICTIONS

### 2.1 Introduction

This section of the audit report contains a review of the actual versus the predicted key impacts of the construction and the operational phases of the Upgrade, and details the extent to which actual impacts reflect the predictions. These impacts were identified in the EIS (1998), EIA (2002), and other supplementary environmental assessments including the REF for the Yelgun Rest Area, Batch Plant. They were also identified in the Director-General's Report (2003). Mitigation measures, and their suitability are discussed in detail in Section 3.

It is noted that during the construction phase, the key impacts were assessed for compliance with the Construction Environmental Management Plan (CEMP) on a six-month basis by Abigroup and RTA, and a report was provided to the DoP as required by the Minister's Conditions of Approval No. 14 (MCoA No. 14). Key impact predictions made in the EIS and supplementary studies and the actual impacts are presented in this section.

### 2.2 Noise and Vibration

Potential Impacts	Actual Impacts
<p>Residences near sections that require extensive fill or cut operations may be exposed to construction noise levels for extended periods.</p>	<p>At residence noise mitigation treatments required for the operational phase of the project were completed by the RTA at 56 neighbouring residents prior to the commencement of construction. These typically consisted of reglazing, ducted air conditioning, the construction of courtyard walls, and enclosure of balconies. Also, the noise barriers required for the operational phase of the Upgrade were constructed in the early phases of the project, and the barrier at the Ferry Road Caravan Park was left in place until the Upgrade was opened.</p> <p>The MCoA required the installation of a permanent noise wall near the Rajah Road area prior to the commencement of construction. It was not possible to fulfil this requirement due to physical constraints. Agreement was sought from the EPA for a temporary noise shield, as allowed under MCoA 31. Approval was included in the EPA's EPL variation issued in September 2005, and the temporary hoarding was installed relatively early in the construction phase at this location. Further mitigation measures included residents being offered temporary accommodation.</p>
<p>The predicted noise and vibration levels would exceed the DECC/EPA goals and construction noise levels would be clearly audible.</p>	<p>The monthly noise monitoring indicated that measured noise levels were above the DECC / EPA noise goals at most sites. This occurred on occasions when no construction activity was evident in the vicinity. This situation was predicted within the EIS, and noted in Section 4.2.3 of the Construction Noise and Vibration Management Plan. This information was also presented to the Community Liaison Group</p>

Potential Impacts	Actual Impacts
<p>Potential for vibration-related impacts upon buildings and residences.</p>	<p>during an early meeting prior to commencing construction.</p> <p>There were 21 vibration-related complaints made to Abigroup, from nine complainants. Monitoring was often performed in response to these calls, however on no occasion did the measured levels exceed the guidelines.</p> <p>There was never direct evidence to indicate that damage to properties was related to vibrational impacts. Vibrational monitoring was undertaken at several locations both in response to complaints, and as a proactive measure, and at no time was an exceedance recorded. Consequently, any damage repaired by Abigroup was as a gesture of goodwill. Some claims were forwarded to the insurance assessors for their determination. Only one resident is in the process of having a final payment made for a cracked pipe and cracked window, and payment again for this issue is as a gesture of goodwill. There has been one recent complaint relating to an outstanding vibrational damage concerning a swimming pool.</p>
<p>Appropriate noise mitigation measures would need to be provided to ensure that the noise levels would be reduced to achieve the relevant ECRTN Criteria, for the approved design corrected to 2016.</p>	<p>At residence noise mitigation treatments required for the operational phase of the project were completed by the RTA at 56 neighbouring residents prior to the commencement of construction. These typically consisted of reglazing, ducted air conditioning, the construction of courtyard walls, and enclosure of balconies. One property owner declined the offered noise treatments, and negotiations with the RTA are ongoing.</p> <p>The road surface was constructed of a low noise surface - Stone Mastic Asphalt to minimise the operational noise from the road / tyre interface.</p> <p>Noise barriers were erected in a number of other locations along the route as determined by the relevant noise assessments.</p> <p>An Operational noise report was prepared following the opening of the Upgrade to assess the adequacy of the provided noise mitigation measures in accordance with the Minister's Condition of Approval No. 34. In summary, Table 14 of that report shows that for the majority of the assessment locations, the 2017 post-construction noise levels comply with the EIA noise criteria. Where exceedances were found, the RTA had already architecturally treated the properties.</p> <p>The report concluded that the noise model used in the assessment process mostly over-estimated the operational noise levels and that <i>"there is a clear trend in the post construction noise levels being lower than the predictions made, . . . and that no additional noise mitigation measures are necessary."</i></p>

Potential Impacts	Actual Impacts
	<p>Following the opening of the Upgrade to traffic, the RTA and Abigroup received a total of 83 operational noise complaints from five residents living in the vicinity of the upgraded highway. These complaints have typically been related to the noise generated from three potential sources: profile line marking, engine / exhaust braking, and noise associated with vehicle / pavement wearing surface (tyre and different operational noise).</p> <p>A study on the noise impacts associated with vehicles going over the profile line markings concluded that the profile line-marking on the Upgrade meets with the EIA noise level objectives. Nevertheless, the RTA undertook to remove them – and this work has now been completed. Noise from other road sources also was compliant with the relevant noise criteria, however the RTA has also since erected 'No engine-braking' signs to address engine braking noise issues.</p>
<p>The REF for the batch plant indicated that that distance and topographic attenuation alone mitigate noise emissions during normal construction hours to within compliance levels at the nearest receivers.</p>	<p>No noise or vibration-related complaints were received during the operation of this facility, indicating concurrence with the predicted impacts.</p>

### 2.3 Air Quality

Potential Impact	Actual Impact
<p>Dust would be generated from earthworks associated with construction.</p>	<p>The results from depositional dust gauges reflected the expected increase in dust levels following the commencement of bulk earthworks. Generally dust deposition was measured at the boundary of the project, rather than at specific sensitive receivers. Consequently, measurements up to ten times the guideline of 4g/m<sup>2</sup>/month were recorded. This represented poor monitoring site selection, rather than impacts upon sensitive receivers. Other sources would also have contributed to higher readings, as high levels were occasionally measured at sites when there was a lack of work activity in that particular area. For example, dust gauges located adjacent to intersections along the existing highway regularly exceeded guideline values, a consequence of dust and emissions caused by, or from vehicles. Nearby street-sweeping or strong winds will mobilise dust. The lack of corresponding complaints associated with the individual high readings reflects the adequacy of controls for most sensitive receivers.</p> <p>A dust gauge was located outside the Billinudgel Pie Shop. The</p>

Potential Impact	Actual Impact
	<p>recorded levels were generally within the guideline values. Of the, six exceedances, four were below 5g/m<sup>2</sup>/month, and there two of 8g/m<sup>2</sup>/month. These results are considered surprisingly low given the site's close proximity to such large-scale earthworks.</p> <p>Sanctum, a manufacturer of skin-care products in Billinudgel made numerous complaints to Abigroup and the RTA for dust exceedances. These included the contamination of product batches and consequent economic hardship. The local member for Ballina, Mr. Donald Page, raised this issue in parliament on 25/10/07. The matter was referred to the project insurers who consequently rejected the claim.</p> <p>Dust readings reduced considerably during the last twelve months of construction due to the sealing of pavements and the progressive revegetation of batters. In the final three months (June to August 2007) prior to opening, readings at sensitive receivers were all well below 4g/m<sup>2</sup>/month, with one as low as 0.2g/m<sup>2</sup>/month. No dust complaints have been received since the opening of the Upgrade.</p>
<p>On a hot, dry windy day the amount of dust from wind erosion could be much higher. It is possible that under some extreme wind conditions, construction activities would be stopped.</p>	<p>A combination of dry windy conditions, and intense movements of soil created issues for the project in the earlier stages, particularly in the section immediately south of Bilinudgel. Dust was managed with up to twelve water carts, enforcing slow vehicle speeds, and applying base-courses with a high content of coarse-gravel as soon as possible.</p> <p>Nevertheless, voluntarily shutting-down work areas until weather conditions eased, was required on several occasions.</p>
<p>Potential dust from the operation of the concrete batch plant.</p>	<p>The batch plant was of modern design, and fitted with filters to minimise the discharge of dust. Internal roads were gravelled and wet with water, which was recycled from adjacent sediment ponds. Consequently, there were no dust issues associated with this operation.</p>

## 2.4 Water Quality

Potential Impacts	Actual Impacts
<p>Soil erosion causing deterioration in water quality, damage to aquatic ecosystems and siltation of waterways.</p>	<p>Sediment basins required for the operational phase were constructed early in the construction phase. Initially twelve sediment basins were proposed with four of these being constructed prior to the commencement of substantial works. At the peak of earthworks construction there were 24 basins licensed by the NSW EPA (now DECC) and numerous sediment traps. Combined with extensive erosion, drainage, and other sediment controls, significant protection was provided to the receiving environment. Mitigation measures, and</p>

Potential Impacts	Actual Impacts
	<p>their suitability are discussed in detail in Section 3.3.</p> <p>None of the mangroves proximate to the Brunswick River bridges were adversely impacted by the works, nor were those along Marshalls Creek. This is not surprising given that they are found in areas of accretion, and therefore are relatively insensitive to sediment deposition. A combination of planting and natural settlement of seeds has resulted in a large number of mangroves establishing on the southern embankment under the bridge.</p> <p>The sea grass translocated from where the new southbound bridge is located was smothered shortly afterwards by a major flood event and did not recover. This sediment was naturally occurring bed load and did not result from construction activities.</p> <p>Despite silt fences along the edge of the works, and other controls such as batter chutes, sediment was released to the wetland just south of the Brunswick River as a result of storm runoff. Joanne Green, a post-graduate researcher from Southern Cross University/Wetland Care Australia, on behalf of DPI - Aquatic Research Unit, performed an investigation of this area. She was of the opinion that there would be no long-term impacts from this release (DPI-Aquatic Protection Unit <i>pers. comm.</i>).</p> <p>A major rain event in mid-February 2006 resulted in sediment-laden waters flowing from the Yelgun Rest Area and into a wetland in the adjacent Billinudgel Nature Reserve from earthworks in the vicinity of the Rest Area. DECC subsequently brought legal action against Abigroup Contractors who pleaded guilty in the Land and Environment Court and was fined under the POEO Act.</p> <p>The Ocean Shores Country Club claimed sedimentation of the ponds on their golf course. Without admitting liability, Abigroup consequently undertook to remove sediment from a number of ponds.</p> <p>The working platforms for the bridge sites at both Brunswick River and Marshalls Creek were constructed of clean rock, and sediment curtains were maintained along each bank through the duration of construction. Both of these techniques represent best practice environmental management and turbidity impacts were consequently minimised. The removal of this rock, and the associated fines which had accumulated within it as a consequence of the construction activities, was mostly removed during periods of low tidal velocity (high and low tide) when they could be effectively contained <i>in situ</i> by the curtain. However there were a number of occasions when the work extended beyond acceptable working velocities and intervention was required to stop the</p>

Potential Impacts	Actual Impacts
	<p>work and prevent fines from being mobilised beyond the work area.</p> <p>Following extensive consultation with the relevant stakeholders, and several trials, the demolition of the old bridge was undertaken by disassembly with barges located under neath the relevant sections. Divers undertook inspections throughout the process and used cutting equipment to remove the bridge piers. The footprint associated with this activity was small with very few fines were released into the river, or mobilised by the demolition activity.</p> <p>The erosion and sediment controls around the bridge construction works were of a high standard and ensured that no significant sediment release occurred. Consequently there was no visible impact upon marine communities in these areas.</p> <p>The project conditions required that a water quality monitoring programme be undertaken during construction. A monthly sampling interval was approved, and generally performed on set dates. It captured both wet and dry events, rather than specifically measuring the acute rainfall events. However, inspections of downstream terrestrial areas suggests that the controls were largely effective, as would be expected from the mostly high standard of erosion and sediment controls observed on this project. Turbidity was observed in the Brunswick River following significant rain events, where sediment basins were over-topped, or from the small component of the project where sediment basins were not constructable.</p> <p>Opportunities for sediment controls in the Marshalls Creek area were limited due to space constraints preventing the installation of sediment basins to capture all runoff. Controls were based around erosion prevention, keeping runoff velocities low, cutting riparian vegetation off at ground level to retain the roots intact, covering the creek banks with geofabric, extensive rock working platforms. These controls appeared to be quite effective.</p> <p>Minimising erosion and consequent sedimentation during the operation phase is largely a function of adequate revegetation to prevent raindrop impact, and to use vegetative or mechanical means to stabilise drainage paths. Inspections undertaken since the opening of the Upgrade indicate that ground cover is close to 100% with some minor exceptions. These are to be addressed under the 10-year maintenance programme.</p> <p>There were 26 water treatment basins and 10 wetlands designed to improve the quality of water discharged from the Upgrade, a number of which remain for the operational stage. The limited operational</p>

Potential Impacts	Actual Impacts
	<p>monitoring has revealed differences in water quality between upstream and downstream between monitoring locations, but these are minor, and considered to be attributed to tidal influences in these estuaries.</p>
<p>Acidic drainage due to disturbance of acid sulphate soils.</p>	<p>There were no incidents involving acidic runoff associated with construction. All ASS/PASS materials were removed to an old quarry or neutralised and incorporated into the fills.</p>

## 2.5 Hydrology

Potential Impacts	Actual Impacts
<p>The construction of the Upgrade must not impact upon the flood levels upstream or downstream for flood events up to and including the 1 in 100 year flood event.</p>	<p>Hydrological modelling was undertaken to ensure that the design would not worsen the flooding in the area. A significant flood event in June 2005, allowed the model prepared for the project to be more accurately calibrated. The re-modelling indicated that some additional waterway capacity was required at Marshalls Creek. This was achieved by lowering the invert level of the overflow area. The increased confidence in the model has allowed the engineers to confirm that the design would ensure that the actual impacts would match the predicted impacts, i.e. no worsening of flooding.</p> <p>The model also confirmed that the town's flooding issues were predominantly due to the influence of the upstream railway culvert, and the town being located within the Marshalls Creek floodplain. This information was relayed to the community at several CLG meetings. Byron Shire Council is now trying to address these issues.</p> <p>The extension of Riverside Crescent at Brunswick Heads was undertaken as part of this project. Byron Shire Council advised the EMR that it is concerned at the disruption to the surface stormwater flows towards the west from Riverside Crescent along the southern boundary of the caravan park. The storm water may cross the roadway after heavy rain, causing traffic and flooding issues. In the longer term the water stagnates in the drainage depression allowing mosquitoes to breed, smelling awful, and posing an alleged risk to the safety of small children who may be drowned. Abigroup have since undertaken some extra work associated with the drainage in this area, and Byron Shire Council are awaiting the outcome of further monitoring to see whether this addresses the problem.</p>

## 2.6 Indigenous And Non-Indigeneous Heritage

Predicted Impacts	Actual Impacts
<p>Seven "Potential Archaeological Deposit" Sites of Potential Archaeological Deposit (PADs) were identified as being impacted by the road alignment.</p>	<p>For all indigenous sites, representatives from the Tweed Byron Local Aboriginal Land Council were invited, and they were present during the initial site ground disturbance activities. Disturbance to these sites was permitted under the Consent to Destroy provisions provided by DEC (NPWS).</p> <p>No artifacts or relics of significance were found at any of these sites.</p>
<p>Protection of the Scar Tree identified in the EIS as site BH-ST-1.</p>	<p>This tree lost a limb in a storm. It was later assessed to be a function of its age. No other disturbance occurred.</p>
<p>Disturbance or potential disturbance to other sites of heritage significance.</p>	<p>A qualified archaeologist was present prior to and during initial site clearance at sensitive locations. These were documented and, in some cases records included in historic markers, or interpretive signage.</p> <p>An old growth cedar stump with logging cut outs was identified for conservation as a reminder of the area's logging heritage, and was put aside for later incorporation into the project. Persons unknown later took it. In recognition of the former Hainsville Site, the RTA has since erected an interpretive sign and old timber railing fence in a widening in between the old highway and new highway just north of Orana Road and south of the large basin.</p> <p>The old Brunswick River bridge plaque was presented to the local Historical Society. The new bridge was named Durungbil after the historical owners of this area.</p> <p>No sites of heritage significance were disturbed.</p>
<p>Damage to any unexpected items revealed during construction</p>	<p>The presence of an archaeologist during the initial clearing of the SEPP14 wetland enabled the uncovering and reporting on an old abandoned jetty structure which had not been identified by earlier studies. This structure was reported upon and assessed as having low heritage significance.</p> <p>On 22 August 2006 Kevin Mulcahy of the RTA discovered a stone artifact located on the surface of the Cut 10 road batter. This particular area was partitioned off until representatives of DECC and TBLALC inspected the next day. The stone implement was examined and then taken from the site by the DECC officer, Ashley Moran, in consultation with the TBLALC.</p> <p>An artifact was also discovered by a local aboriginal and representative of the Jali Land Council who happened to be working with Abigroup's landscaping crew. The find was in an area not previously identified as</p>

Predicted Impacts	Actual Impacts
	<p>having PADs. The Tweed Byron Local Aboriginal Lands Council were notified immediately and attended the site late that afternoon. They confirmed that it was a good example of a cutting tool and took the sample with them, with the indicated intention of placing the artefact back at the location where it was found just before this batter was topsoiled. The stone axe is with the Regional National Parks office. DECC have requested that TBLALC either (1) obtain a care and control permit for the object or (2) for the item will be relocated back on site in the presence of a DECC officer.</p>
<p>Despite a lack of physical evidence, the Ferry Reserve Area was important in the development of Brunswick Heads and it would be appropriate to record this history.</p>	<p>The redevelopment of the Brunswick River foreshore is one still to be undertaken by Byron Shire Council, and consequently there has been no visual display developed for this area as part of this work. In the interim, the RTA has included information with regard to the Ferry Reserve and associated history at the Yelgun Rest Area.</p>

## 2.7 Flora

Predicted Impacts	Actual Impacts
<p>Impacts on threatened flora species. A number of 'threatened' plant species were identified as being affected.</p> <p>A small area (0.1 hectares) of Lowland Rainforest on the Floodplain was identified as being affected.</p>	<p><u>Translocation</u></p> <p>Many threatened plants were identified within the road reserve and in some cases in close proximity to the road reserve. As a proactive measure, and more than a year before construction commenced, the RTA, in consultation with the project ecologist, arranged for the translocation all identified threatened plants within the proposed road footprint. Translocation was undertaken to minimise the loss of threatened species. A small number of additional plants were translocated as they were discovered during the construction phase.</p> <p>Seventy-seven Davidson Plums were translocated. After 36 months, 20 plants remained alive and showed signs of new growth at Site 1. Four of these 20 had also born fruit, with two seedlings the result. These four were the only medium to large trees. At Site 2, 48 of 51 translocated plants were alive with 40 showing signs of new growth. Five of these 40 had also flowered.</p> <p>Seventeen Green-leaved Rose Walnut were translocated. After 36 months, eleven of these plants (out of sixteen) remained alive at Site 1 with two flowering. One plant had been translocated to Site 2 and was alive and showing new growth after 22 months.</p> <p>Two Crystal Creek Walnuts were transplanted. After 36 months, one survived at Site 1, with new growth evident. This individual had also</p>

Predicted Impacts	Actual Impacts
	<p>flowered since transplanting. One plant was also transplanted to Site 2 and was showing signs of new growth after 22 months.</p> <p>Eleven Spiny Gardenia were translocated. At 36 months, five remained alive. Three flowered over the reporting period.</p> <p>One Xylosma was transplanted. After 36 months, this individual was still alive.</p> <p>Four White Yiel Yiel were translocated. After 36 months, one survived. This individual showed signs of new growth.</p> <p>Nineteen White Marblewood were translocated. None survived after 36 months.</p> <p>One Red Lilly Pilly was translocated and was surviving after 36 months.</p> <p>Three Stinking Cryptocaryas were translocated. One (of 2) was alive after 36 months at Site 1, however, no new growth was evident. At Site 2, the one translocated individual was alive, and showed signs of new growth.</p> <p>Two Coolamon Tree were translocated, with one planted at Site 1 and another at Site 2. The plant at Site 1 was alive after 36 months and exhibited new growth. The plant at Site 2 was also alive and showing signs of new growth after seven months.</p> <p>Ten Bush Nuts were translocated. After 36 months, four of five had survived at Site 1. Of those four, three had signs of new growth. At Site 2, three of the five translocated individuals had survived and were showing signs of new growth.</p> <p>Seventeen Black Walnut were translocated (13 at Site 1 and 4 at Site 2). After 36 months, all thirteen had survived at Site 1 with nine showing signs of new growth. The four at Site 2 were also alive and showing signs of new growth.</p> <p>Four Veiny Laceflower were transplanted. One survived after 36 months and showed signs of new growth.</p> <p>Three Medicosma transplanted, with all showing signs of new growth after 36 months.</p> <p>Six Thin-leaved Coondoo transplanted (three at Site 1 and three at Site 2), with all showing signs of new growth after 22 months.</p> <p>One Rose Marara was translocated and was showing signs of new</p>

Predicted Impacts	Actual Impacts
	<p>growth after 22 months.</p> <p>Two <i>Triumfetta</i> were translocated to Site 2 and showed signs of new growth after 22 months.</p> <p>Over 600 seedlings (including a small number of propagated from cuttings) of threatened and rare species (17 species) were propagated and planted into Sites 1 &amp; 2.</p> <p>The population enhancement program, which was designed to provide back-up plants in case of poor transplant survival and to facilitate establishment of functional translocated populations within the recipient sites, has achieved moderate survival rates and slow but steady growth during the monitoring period.</p> <p>Elsewhere on the project site threatened flora species were maintained <i>in situ</i> and were marked and fenced off for protection.</p>
<p>Edge effects were assessed to be between 4-16 metres</p>	<p>Widespread new shoot growth indicated that the great majority of species could adjust to the more exposed growing conditions on the road edge after clearing. The vigour of some trees may even have been improved by the removal of competing trees. Several new seedlings of Davidson's Plum were recorded indicating that disturbed conditions on the roadside do not inhibit all recruitment in this species. The project ecologist noted that some increase in weed levels is expected on a newly cleared forest edge, but this should not become problematic unless weed growth is allowed to become so dense that it inhibits native regrowth on the forest edge, or in adjacent tubestock plantings designed to grow over the exposed forest edge.</p> <p>It is considered that, the range of 4–16m is probably a fair guide to what was observed in the field.</p>
<p>Change in light regime for seagrass.</p>	<p>To minimise light impacts the new bridge was of a raised design, with few piers, and an arched soffit.</p>
<p>Proliferation of weeds.</p>	<p>A Weed Management Plan with maps of five classes, or levels, of weed infestation and soil weed seedbank content was prepared. Weed-free topsoil was to be separately stockpiled and re-used in the areas from which it originated. All suitable topsoil was saved however separation was limited, due to space constraints. Some weed-infested soil was buried.</p> <p>Topsoil from the southern and northern areas was stockpiled for reuse, but no attempt was made to separate the weed-free topsoil according to these classes. The large size of the stockpiles, and the long period of storage meant that they would have become anaerobic causing loss of</p>

Predicted Impacts	Actual Impacts
	<p>seed and soil biota.</p> <p>The impact is hard to assess as weeds occur following most soil disturbance. However the project ecologist has suggested that the landscape outcome might have been improved by better actively managing these seed banks.</p> <p>The project ecologist as an integral part of the native vegetation regeneration strategy prepared the weed strategy. It probably should have been titled as such to emphasise this point, but the consent condition was specifically about weeds, so the link between soil seedbank management and resultant vegetation may not have been fully realised.</p> <p>During construction, the RTA undertook a weed control programme in areas outside the construction footprint. An active program of weed control is included as part of the ongoing 10-year maintenance program for the project by which time it is anticipated that the managed vegetation will be prolific enough to suppress most weed growth.</p>
Compensatory habitat	<p>A package, which included 100 hectares of land, was developed. This included the following eight key components:</p> <ul style="list-style-type: none"> <li>- Acquisition of two large properties to the west of the road, and their subsequent dedication as a new Nature Reserve. The reserve is now owned and managed by DECC.</li> <li>- Acquisition of land to the east of the road, with its subsequent inclusion within the Marshalls Creek Nature Reserve. The reserve is now owned and managed by DECC.</li> <li>- Dedication of seven areas of residual land into the Brunswick Heads and Billinudgel Nature Reserves,</li> <li>- Rehabilitation of the saltmarsh adjacent to the northern interchange. A restoration plan has now been developed in consultation with relevant agencies, and works under that plan have commenced. This has included supplementary planting, and fencing of the area.</li> <li>- Acquisition of land on the northern side of the river which contains significant numbers of the Davidson' Plum. It was not possible to acquire this land, as the owner was unwilling to sell to the RTA. Alternative land (Lot 107) was acquired.</li> <li>- Rehabilitation of the southern foreshore of the Brunswick River and the area around the old bridge abutment. Rehabilitation works have now been undertaken in areas disturbed by the construction of the southern abutment.</li> </ul>

Predicted Impacts	Actual Impacts
	<p>Rehabilitation was undertaken to improve the quality of adjacent areas. This included rehabilitation and active management of saltmarsh (4.3 ha) and swamp oak. The swamp oak included areas of surplus land that was to be joined near the Brunswick Heads north interchange and areas to the western side of the alignment. Rehabilitation of the old bridge abutment was also undertaken on the southern foreshore. This area currently has significant weed infestation and poor plant growth due to absence or lack of topsoil.</p> <p>Mangroves were removed from the bridge footprint to enable access for construction. Compensatory habitat included the propagation and planting of mangroves. As a result of the overall compensatory habitat package, a ratio of 10:1 was achieved. Replanting of mangroves was performed, and there is evidence of natural re-establishment under the bridge on the southern bank.</p> <p>An attempt was made to translocate the sea grass where the Brunswick River Bridge was to be located. While the translocation efforts were initially successful, unfortunately, a major flood event shortly afterwards smothered all of the transplanted seagrass and it did not recover. Abigroup consequently paid a sum of \$25,000 to DPI who are using the funds to stabilise a portion of the Brunswick River.</p>
<p>Disturbance and degradation of adjacent habitat</p>	<p>The disturbance to the adjacent vegetated areas was minimised with the delineation of clearing lines in the field, and the limitations to vegetation clearing lines were included in all Site Induction programs. This proved highly effective.</p> <p>Soil erosion and sediment control measures were implemented and maintained throughout the construction phase to minimise the associated impacts upon adjacent bushland areas.</p>
<p>Impact on Brunswick Heads Nature Reserve through edge effects including</p> <ul style="list-style-type: none"> <li>• Weeds</li> <li>• Changes in Biodiversity</li> <li>• Loss of habitat</li> <li>• Changes in microclimate</li> </ul>	<p>All construction areas adjacent to the Brunswick Heads Nature Reserve were fenced with a 3-metre high barrier fence covered with shade-cloth. This reduced the edge effects associated with wind, dust, sunlight, and vehicular movement. It also assisted in preventing accidental encroachment. Nevertheless, there was some unauthorised disturbance of an easement within the Brunswick Heads Nature Reserve associated with utilities works for the project. The area was consequently stabilised and rehabilitated with endemic species with guidance from DECC (NPWS).</p> <p>Since the road has been completed and the cloth removed, the concrete barrier on the edge of the road helps to reduce the consequent edge effect.</p>

Predicted Impacts	Actual Impacts
	<p>The project ecologist noted that the use of silt fences helped to minimise off site dispersal of soil and therefore seeds into adjacent areas.</p> <p>Weeding and mulching was undertaken in some land adjacent to the nature reserve to reduce the spread of weeds and the consequent edge effects.</p> <p>The RTA also initiated a major clean-up of weed species along the section of the reserve north of the Brunswick River. Planting of replacement species has been undertaken under the guidance of the project ecologist.</p> <p>An REF was prepared to deal with trimming of branches of trees within the reserve that encroach into the road easement. This provided stringent methods to minimise impacts at the time, and in the future for ongoing maintenance activities.</p>
Impact on SEPP14 coastal wetland areas	<p>On both sides of the Brunswick River, a 3-metre high barrier fence with shade-cloth cover at the clearing line was erected along the project footprint boundary. This has similar benefits to that outlined above.</p> <p>South of the Brunswick River, the design aimed to minimise the project footprint upon the wetlands located in this area. This limited the range of erosion and sediment controls that could be used as there was limited or no space available, or insufficient fall for the installation of sediment basins. The sediment fence installed along the eastern site boundary was effective at keeping coarse sediment and workers from encroaching into this area, however it was less effective at retaining the highly erodable fine-grained soil being used as fill, and a quantity of red clay was discharged onto the saltmarsh. The potential impacts were investigated for DPI - Aquatic Research Unit by Joanne Green, a researcher with relevant experience, from Southern Cross University/Wetland Care Australia, who advised that long-term impacts were unlikely.</p>

## 2.8 Fauna

Predicted Impacts	Actual Impacts
Removal of fauna habitat	<p>Vegetation within the road footprint containing habitat characteristics was cleared in a two-part process so that any fauna present could safely relocate.</p> <p>Logs and hollows were replaced at fauna movement corridor sites towards the completion of the project. However it is not known whether this included all of those identified during the clearing phase for reinstatement.</p> <p>Just prior to its demolition, a population of micro fishing bats was identified using the scuppers in the old Brunswick River Bridge. This species had not been identified in previous studies. New boxes were placed within the abutments of the new bridge and the scuppers closed off a few weeks later. There has been no use of these boxes to date. During the surveys it was found to be a wide-ranging species, and individuals been found roosting at other locations including underneath the new Marshalls Creek Bridge, and in the new compensatory boxes provided under the Orana Road Bridge.</p>
Hollows were indicated to be lost.	<p>A program of habitat nest box construction was initiated with the project Community Liaison Group to assist in offsetting the removal of habitat along the Upgrade alignment. A preliminary report found that the sugar glider was the most commonly encountered mammal, with usage by antechinus, and bats. Other fauna included owl nightjars, parrots, possums, and bees.</p> <p>Use of the boxes has increased over time with most use observed in the most recent box check (October 2008). This suggests that a longer period of monitoring may be required to more fully understand the use of these boxes by local wildlife (i.e. up to 3 years since installation). The low level of use of the boxes by some target groups of wildlife suggests that more research may be needed to understand factors that influence the level of use. At this stage, no data has been collected on the local abundance of hollow-bearing trees so it is unknown to what extent this has influenced box use.</p> <p>During construction, a pair of Pied Oyster-catchers nested in the work area south-east of the southern Brunswick River bridge abutment. The area was delineated as a no-go zone until the fledglings were several weeks old, and actively utilising areas away from the work site. The successful rearing was a good outcome.</p>
Formation of barriers to animal	<p>There were a number of dedicated fauna movement crossing locations identified on the project alignment. Many of the existing fauna crossing</p>

Predicted Impacts	Actual Impacts
<p>movement, and wildlife mortality.</p>	<p>points remained open in the Brunswick Heads Bypass area, and these were monitored during the construction phase. Fifteen fauna underpasses were constructed, in accordance with the RTA concept design and NPWS Concurrence Conditions for the modified project. These included requirements for fauna refuges to be placed at the ends of the dry crossings.</p> <p>There is also a designated fish passage culvert below the Coolamon Scenic Drive underpass, and a designated glider crossing (overpass) located at the southern end of the Upgrade.</p>
<p>Roadkill</p>	<p>The number of native ground dwellers killed is relatively low (<math>\approx 20</math>) for the 18-month monitoring period. Few of these are species for which the fauna exclusion fencing was designed suggesting the general success of this aspect. There were a few wallabies however, there doesn't seem to be any large cluster that might suggest a breach of fence integrity. The maintenance contractor has indicated that some members of the public were opening site access gates and then leaving them open, allowing free-movement of fauna. This has since been addressed through the locking of these gates.</p> <p>It is suggested that the relatively low number of fauna roadkills is a good outcome, and that the fauna fence has been effective.</p> <p>There has not been any monitoring yet of use by fauna of the underpasses. The Project Ecologist has indicated that this is likely to occur in February 2009.</p>
<p>Bird strike adjacent to the saltmarsh areas.</p>	<p>Planting of high trees was undertaken adjacent to the eastern boundary of the highway and the southbound on-ramp to direct birds into a high flight path over the roadway when departing/arriving at the saltmarsh.</p> <p>The majority (&gt;70%) of roadkill collected during the operational phase are species that fly. Mortality seems to be biased towards carnivores, perhaps being hit when they are feeding. Either they would be hunting or opportunistic feeders on roadkill. This is not necessarily a flight path issue, as it doesn't seem to be a major issue with the noise walls. Death associated with noise walls was higher in 2007 than 2008. This pattern of decreasing mortality / Impacts for birds from noise barriers has been observed at other locations including the Tugun Bypass, and the Pacific Highway south of the Byron Bay exit. Whether it is due to a learned response, a change to home ranges, or mortality of directly-affected birds is not known.</p> <p>The effectiveness of the planting taller trees near the saltmarsh in changing the flight path of birds and therefore reducing road strike is</p>

Predicted Impacts	Actual Impacts
	indeterminate from the available data.
Disturbance and degradation of adjacent habitat	<p>The disturbance to the adjacent vegetated areas was minimised with the delineation of clearing lines, and by including the limitations to vegetation clearing in all Site Induction programs.</p> <p>Soil erosion and sediment control measures implemented and maintained throughout the alignment helped to manage the discharge of stormwater runoff and erosion effects in adjacent bushland areas.</p>
Minimising the project footprint	<p>Efforts to minimise the footprint through design were undertaken. This included the construction of numerous retaining walls in particularly sensitive areas such as that just north of Brunswick River. Median trees were also retained for gliders.</p> <p>Improvement of flow patterns in the Brunswick River (removal of old piers/net loss of piers) was anticipated to provide a long-term benefit to the sea grass beds.</p>
Impact on Brunswick Heads Nature Reserve	<p>All construction areas adjacent to the Brunswick Heads Nature Reserve were fenced with a 3-metre high barrier fence covered with shade-cloth. This reduced the edge effects associated with wind, dust, sunlight and vehicular movement, and consequently, to wildlife utilising these areas during construction. The project footprint was very restricted through this area. Construction activities were required to be staged due to the lack of space, and the design included large retaining walls to minimise the operational footprint.</p> <p>The roadkill data for the operational phase shows no high mortality associated with the Nature Reserve. This may be a function of the species inhabiting this area being shy and not coming close to the road and/or the use of the northern bank of Brunswick River, under the bridge, as a fauna passage. The eastern side also has the service road that has vehicles operating at lower speed, giving wildlife and motorists more opportunity to avoid a collision.</p>

## 2.9 Geology and Soils

Predicted Impacts	Actual Impacts
<p>There is the potential for erodable and/or acidic soils along the route.</p>	<p>The fine-grained, and thus erodable, soils were addressed through extensive utilisation of sediment basins, and progressive stabilisation of cut and fill batters to encourage both short and long-term stability. Due to poor strike rates and yellowing of some of the stabilising grasses lime was later added to the hydro-mulching mix to address the acidity associated with the subsoils in the area. This resulted in notable improvements in plant performance over those areas that were not initially treated with lime.</p> <p>Revegetation with regard to erosion prevention has been successful across the project through the establishment of ground cover. There are some minor areas of poor growth throughout the alignment. In contrast, some of the pasture grasses used are out-competing the native grass species included in the seeding mix, and some of the tubestock. It is understood that these issues are being addressed during the ten-year maintenance phase.</p>
<p>Disturbance or acid sulphate soils, or potential acid sulphate soils.</p>	<p>Acid sulphate soils (ASS) were encountered at both Marshalls Creek and the Brunswick River. All ASS was transported to an ex-quarry on private land on Banana Road, treated, and re-tested. The land was subsequently shaped, seeded, and released to the landowner.</p> <p>There were no environmental incidents associated with the transport, storage, or treatment of ASS during the construction of the Upgrade.</p>
<p>Possible sources of contamination.</p>	<p>Two contaminated sites were identified prior to construction commencing on the Upgrade – a former cattle tick dip site (Hainsville) and a former service station site (Ocean Shores). A DECC-accredited contaminated site auditor investigated these sites, and subsequently detailed Remediation Action Plans were prepared in consultation with the DEC.</p> <p>Physical site works was undertaken in January 2007. The site of the original dip and former holding yards are all covered by the new road embankment. The Ocean Shores service station site had the five disused underground storage removed, and the surrounding soil was excavated and rehabilitated by a “land-farming”, a method involving intensive mechanical tilling. A Validation Report and a final Site Assessment Report documenting this activity was subsequently prepared by an external consultant and forwarded to DECC. This land is now suitable for general purposes.</p>

Predicted Impacts	Actual Impacts
Potential for landslip.	The only area considered to have the potential for landslip is near the intersection of the service and STP Access Roads. A geotechnical assessment was undertaken, and works were performed to address this potential.

## 2.10 Present and Future Landuse

Predicted Impacts	Actual Impacts
There is the potential to impact upon the future land use of the area, particularly the Ocean Shore and Billinudgel communities.	<p>The Upgrade has provided for the old highway to be a service road that improves movement opportunities between the local communities and their associated facilities. It precludes the requirement to utilise the Pacific Highway Upgrade on a daily basis, an issue of concern raised at a number of community meetings.</p> <p>The Upgrade has the potential to improve the viability of these communities in the longer term due to the improved road access, and the new pedestrian and bicycle paths that provide a safer environment than existed prior to the Upgrade.</p>
Many businesses in Brunswick Heads and Billinudgel rely on passing trade.	<p>The impacts upon Brunswick Heads which is a tourist-related economy is probably minimal, as the town had its through-traffic volume significantly reduced by construction of a bypass some years ago.</p> <p>Ocean Shores is essentially a residential precinct, and the Upgrade is likely to have little effect, apart from improved amenity and ease of access to the service road.</p> <p>The construction of the new cycleway/footpath under the southern bridge embankment linking Brunswick Heads and Ocean Shores with the rehabilitated foreshore, Ferry Reserve Caravan Park and Riverside Crescent has enhanced accessibility within the locality. This may lead to increased business potential at the caravan park.</p> <p>To maintain easy access to the retail sector of Billinudgel, and minimise the associated economic impact of the Upgrade, a second access and egress was provided directly from the Upgrade at Wilfred Street. This was in response to community feedback during the design process. Access across the highway is now safer due to the new pedestrian bridge. These actions would have decreased the predicted impacts.</p>
Potential positive impact upon the industrial area of Billinudgel.	There is a plan to further develop the southern portion of Billinudgel as an industrial precinct. A new access to Billinudgel was provided through the industrial area from the service road via Bonanza Drive. Due to these improved access arrangements and the new one-way

Predicted Impacts	Actual Impacts
	<p>circuit traffic flows are now improved and reduced travel times associated with this area, and improved passing trade for these businesses.</p> <p>Some local businesses vetoed the proposed streetscape works including tree-planting and pedestrian-friendly improvements in front of their properties, whilst others accepted the offer.</p>
<p>The project would result in loss of access to the boat ramp on the northern side of the river, potentially impacting the oyster growers.</p>	<p>The growers have access to two local boat ramps, one 500m downstream near Brunswick Heads, and another near the caravan park on the opposite side of the river.</p>
<p>Residents of Stock Route Road would have a slightly more convoluted access.</p>	<p>The access to Stock Route Road from the service road is now labelled Billinudgel Road, which changes name several hundred metres later to Stock Route Road. This was performed following advice from BSC to the RTA. Residents have recently complained about this change and the lack of clear signage.</p>

## 2.11 Visual and Landscape Assessment

Predicted Impacts	Actual Impacts
<p>There is the potential for the Upgrade to impact upon visual amenity of both road users and the surrounding community.</p>	<p>This road has been designed to be in harmony with, rather than imposing itself upon, the landscape. The road traveller's experience is reflective of that design. This experience is in contrast with the straighter and/or more open sections of the Pacific Highway immediately to the north and south.</p> <p>Maintaining sightlines from the highway at key locations was also addressed during the design phase, through maintaining connection with the changing landscape.</p> <p>To minimise the visual impacts from the project as well as expand the user experience associated with the Upgrade, a Landscape Plan was developed through consultation with both regulatory agencies, and the local and wider community.</p> <p>For most of the route the aim of the landscape treatment was to integrate the road into the surrounding landscape by matching species used on the corridor with the adjacent flora. This was achieved using indigenous native flora, mostly from local seed stock, some used as seed in the hydro-mulch mix and others propagated in local nurseries, and planted as tubestock.</p>

Predicted Impacts	Actual Impacts
	<p>The landscaping planting has been largely successful at stabilising the soils softening the road footprint. It should be noted that it is still in its early years, and the final result will be dependent upon controlling the growth of some of the more aggressive grass species, and the dominance of wattles in some sections. It is considered that better results could have been achieved with more thorough soil testing and amelioration, however this was not a contractual requirement.</p> <p>More formal planting was undertaken to define the entrance to Billinudgel. The featured planting between the highway and Billinudgel may take several years to reach significant height, and thus create the desired impact.</p> <p>The bridges over the Brunswick River are balanced cantilever bridges. This design was partly chosen because of the need to cross the river at a slight angle, and maintain the open visual landscape. It incorporates design features and lighting to enhance its visual amenity. However the views for most car-users crossing the bridge are partially restricted by the steel safety rail at the top of the concrete barrier that is located at passenger eye-level. This is due to design criteria for road safety.</p> <p>A clear noise barrier was constructed near Rajah Road at Ocean Shores to maintain views to the south-west across the river to the mountains for residents. It also reduces the visual impact of the Upgrade from more distant locations.</p> <p>Landscape architects, HBO+EMTB, received a Commendation from the Planning Institute of Australia in 2008 for their design on this project.</p>
<p>Where possible noise abatement should be by earth mounding. Where this is not possible they should be screened with vegetation, or incorporates artwork.</p>	<p>Due to space and design constraints, vertical and angled noise walls were generally used. Adjacent to Billinudgel and vertical noise wall on top of a landscaped earth mound was used. To reduce visual impacts, as discussed above a clear noise wall was erected north of the Brunswick River. Noise amelioration used on the project also included treatment at the receiver, an option which was mostly less visually intrusive than a noise wall or mound.</p> <p>There is a large concrete noise wall at Rajah Road, which has an architectural finish in the upper portions. This element of the work consists of a retaining wall at the bottom with an architecturally finished noise wall at the top. The retaining wall at the bottom has a specific grooving pattern for aesthetics and matches that around the Brunswick River Bridge abutments. The Concept Plan indicates that the lower portions will be screened with plants. Some vegetation has been planted in front of the noise walls at Ocean Shores, however growth has been slow, and the outcome specified in the Landscape Management</p>

Predicted Impacts	Actual Impacts
	<p>Plan has yet to be realised. The difficult growing conditions, and lack of supplementary watering means that there is doubt that the proposed outcome will be realised.</p> <p>A blue noise wall along the project boundary above this wall has not been screened and is visually obvious to northbound traffic. Screening is not possible in all locations because the tight project corridor means that the noise walls sit on top of concrete retaining walls with no space for planting.</p> <p>The noise wall in the middle of the road at Billinudgel has an architectural finish and the ends have been rolled-down to soften its visual impact.</p> <p>Minimal visual treatment has been undertaken in front of the noise wall at the White Dove Funeral Parlour at Billinudgel. The colour of the wall is quite visually intrusive. However, given that it is located at the top of a retaining wall on private property, the RTA has little control over this aspect. The property owner has undertaken planting on his property and once planting on the highway batters grows and establishes itself the impact should be reduced.</p>
<p>Mitigation of visual impacts would be addressed by a Landscape Concept Plan</p>	<p>The detailed outcome of the Concept Plan has yet to be realised, predominantly because of the early stages of the planting.</p>
<p>The streetscape improvements in the Billinudgel commercial and industrial would have important community and business improvements.</p>	<p>Some of Billinudgel's business owners vetoed the planned streetscape improvements in the industrial precinct, preferring to maximise parking to the proposed extensive tree planting. Consequently, the character of the area is harsher than if the Concept Plan had been implemented.</p>
<p>High visual impact of the Yelgun Interchange.</p>	<p>The Interchange has been significantly incorporated into the landscape so that very little is visible to users of the Upgrade.</p> <p>The Rest Area is not visible to passing motorists on the Upgrade, nor to any residents because of its geographic location. The grassed terraces behind the facility soften the setting.</p>
<p>Visual impact of the major cuts.</p>	<p>The landscaping of the batters significantly softens the visual impact.</p>
<p>Visual impact of the overpass at Billinudgel</p>	<p>The curved shape, and winding form of the pedestrian overpass significantly softens the visual impact compared with more common designs that are squarer and travel straight across such roads.</p>

## 2.12 Community Impacts

Predicted Impacts	Actual Impacts
<p>Health and psychological impacts from noise and uncertainty regarding construction activities which might disrupt travelling patterns, timing of activities, feedback mechanisms for complaints/concerns. And design issues which may affect them, in particular flooding and landscaping.</p>	<p>A Community Liaison Group was established early in the construction phase to allow feedback from, and information to, the local community. Formal presentations were given regarding construction progress, and activities for the following month. Particular attention was given to construction activities which might disrupt travelling patterns, either during the week, or associated with week-end school sporting events.</p> <p>Design issues were also discussed at these meetings, and changes were made as a consequence of input from the community.</p> <p>Presentations were given by technical specialists regarding issues of particular concern, especially flooding and landscaping.</p> <p>Impacts from noise associated with after-hours work was considered to be the potential biggest impact, and this was managed by early advice in advance of the works with the reasons for, and the proposed duration of any required night-works which were also managed to limit audible noise after 10pm. There were some early complaints relating to non-advice, however, once all potentially affected residents were on the register, the community proved tolerant of such work with few complaints.</p> <p>Because of the relatively small size of the communities along the route, the dissemination of information through the CLG appeared to be highly effective, as judged by the demeanour of the participants, and lack of complaints.</p> <p>Following the opening of the Upgrade there was a number of complaints regarding noise from the project, and consequent impacts upon sleep. Measurements indicate compliance with noise criteria, however the RTA undertook to remove the profile line-marking from the highway.</p>
<p>The Upgrade required the acquisition of 31 freehold properties, either wholly, or of a portion. Where a partial acquisition of a property was required, and there were significant impacts upon amenity or viability of the residue parcel of land, the land owner had the option of requesting purchase of the whole of the property.</p>	<p>The RTA addressed acquisition during the concept phase, with all property acquisitions being resolved prior to the commencement of construction.</p>
<p>Impacts upon amenity such as access, noise, and dust need to be managed. Apart from noise, no significant impacts</p>	<p>These issues are addressed in the relevant sections of this report.</p>

Predicted Impacts	Actual Impacts
<p>are expected. Traffic volumes would decrease on local roads.</p>	<p>It is considered that the predicted and actual impacts are in agreement.</p>
<p>There is the opportunity for improvements to the Brunswick River foreshore area.</p>	<p>Pedestrian and cyclists' needs have been addressed through designated pathways and access through the area to adjacent residential areas. Safety has been addressed through design including night-time lighting on the bridges.</p> <p>Some minor revegetation occurred on the southern bank as part of construction, but this area is now been dominated by weeds.</p> <p>Revegetation on the northern bank was limited to planting in the upper foreshore area, the lower portion having outcrops of rock. The longevity of the plantings under the bridge was considered questionable due to the resultant rain-shadow. However, recent inspections revealed a high survival rate. This outcome is probably due to a combination of good plant selection and the large height of the bridge that allows driven rain to all plants.</p> <p>The lower portion of the northern bank is protected with rock. It is possible, but unlikely that mangroves will be able to establish in this area.</p> <p>The southern foreshore has improved public amenity through the provision of a boardwalk</p> <p>Further enhancement to the foreshore will be the responsibility of Byron Shire Council.</p>
<p>Impacts upon local businesses.</p>	<p>The Upgrade is designed to minimise travel times and therefore designed to bypass townships. Whilst there was a new, designated access to and from Billinudgel onto the service road, the proposed design was modified at the approval stage to also allow direct access and egress north-bound to and from Billinudgel to minimise the impact upon local businesses.</p>