Emu Swamp Supplementary Environmental Impact Statement –

Turtle Survey 2013

Prepared for:

Sinclair Knight Merz on behalf of Southern Downs Regional Council

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1 Introduction

1.1 Background

The proposed Emu Swamp Dam Project (the Project) is located on the Severn River, 15 km south-west of Stanthorpe and 5 km north of Ballandean, in south-east Queensland (SKM 2008) (Figure 1.1).

An Environmental Impact Statement (EIS) was prepared for the Project in 2007 and released for public comment in 2008.

Submissions on the EIS provided by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) and the Queensland Department of Environment and Heritage Protection (EHP) requested further information on Bell's turtles (*Wollumbinia belli*) in a Supplementary EIS. Specifically, these agencies required further information on:

- the range, extent (distribution) and population density (abundance) of Bell's turtles
- the extent of habitat suitable for Bell's turtles in and downstream of the inundation area of Emu Swamp Dam
- the potential impacts (including cumulative impacts) on the Bell's turtle range, movement and population, and
- the genetic relationship between the Bell's turtle downstream of the Project and the species found in northern NSW.

The EIS presented two options for the Project: an Urban Water Supply Dam; and a Combined Urban and Irrigation Dam. Southern Downs Regional Council (SDRC) have resolved to prepare a Supplementary EIS for the Combined Urban and Irrigation Dam option. The Combined Urban and Irrigation Dam has a storage capacity of 10 500 ML, a full supply level of 738 m AHD, with an associated inundation area of 196 ha (Figure 1.2).

This report has been prepared for Sinclair Knight Merz (SKM) on behalf of Southern Downs Regional Council for the Supplementary EIS. It provides an assessment of the potential impacts of the proposed Emu Swamp Dam on Bell's turtles.

1.2 Project Area

The proposed dam site is on the Severn River, between Fletcher Road and Emu Swamp Road in the Southern Downs Regional Council. The Severn River is in the Granite Belt

catchment, which is part of the Border Rivers Drainage Basin. The Granite Belt catchment is approximately 1 300 km^2 and includes the Broadwater, Cannon Creek, Quart Pot Creek, Four Mile Creek, Accommodation Creek and the Severn River. Cannon Creek and Four Mile Creek are tributaries of the Broadwater and Quart Pot Creek, which converge to form the Severn River west of Stanthorpe. The Severn River flows south-west and joins with Pike Creek to become the Dumaresq River then becomes the Macintyre River and Barwon River before flowing into New South Wales. Accommodation Creek is a tributary that flows into the Severn River approximately 12 km downstream of the proposed dam site.

Land use in the upper areas of the Granite Belt catchment comprises state forest and agriculture, while a large portion of the Accommodation Creek sub-catchment is in Girraween National Park. There are 26 barriers on the Severn River between the confluence of the Broadwater and Quart Pot Creek and Nundubbermere Falls, which are approximately 33 km downstream of the proposed dam site. Most of these barriers are private use weirs; their locations and heights were provided in Section 7 of the EIS.

For the purposes of this report, Project area refers to the dam site, the dam inundation area and the Severn River to approximately 17 km downstream of the dam site.

1.3 Objectives

This report provides:

- an overview of the current state of knowledge on the biology and ecology of the Bell's turtle
- an assessment of the turtle species present in the Project area
- information on the extent of habitat suitable for Bell's turtle in the Project area
- an assessment of potential impacts of the Project on Bell's turtle within and downstream of the Project area, and
- potential mitigation measures to reduce impacts and maintain continuity of populations, if required, and
- recommendations for on-going monitoring, if required.

A conservative approach has been taken with respect to potential impacts and their mitigation.

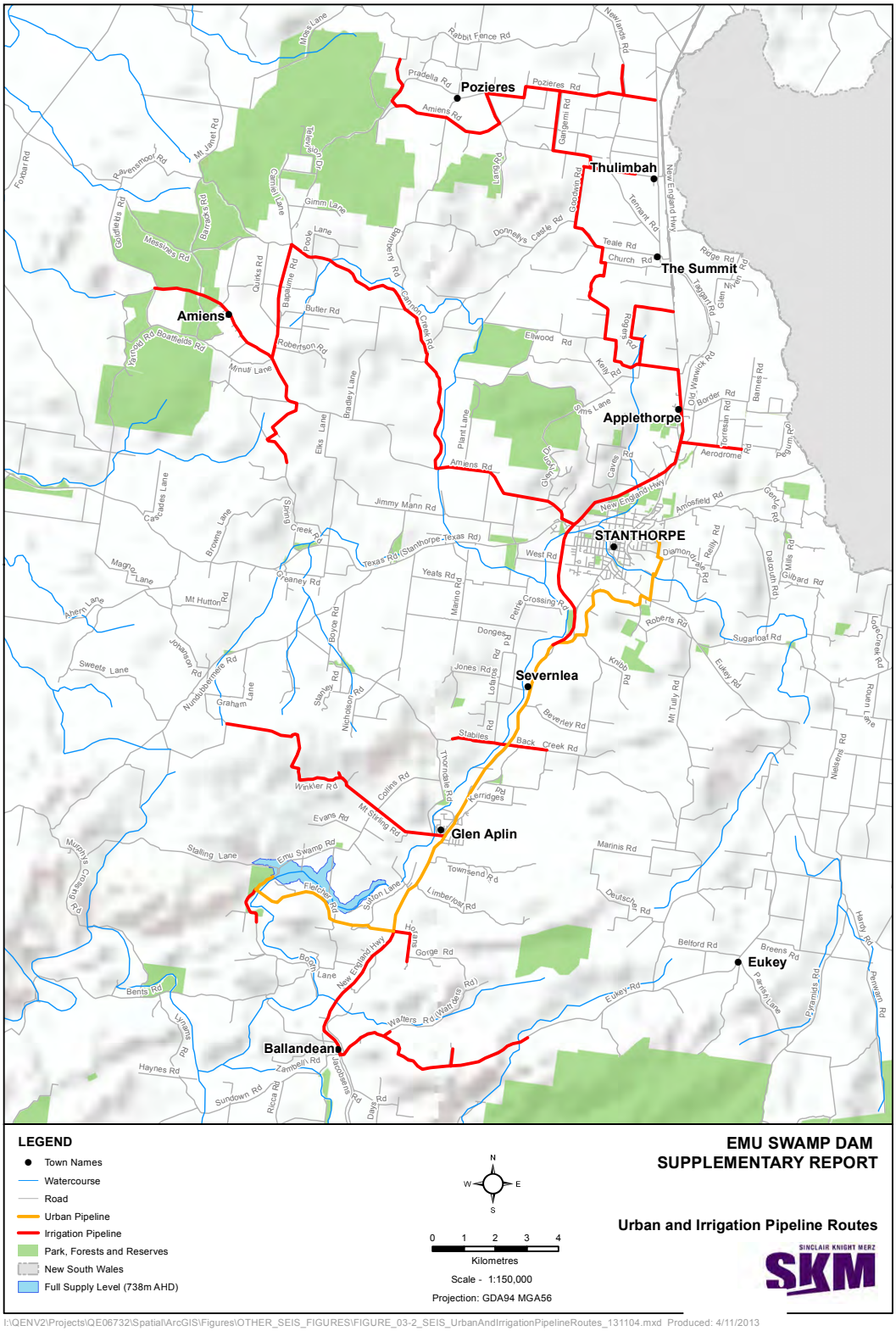


Figure 1.1 Location of Emu Swamp Dam Project.

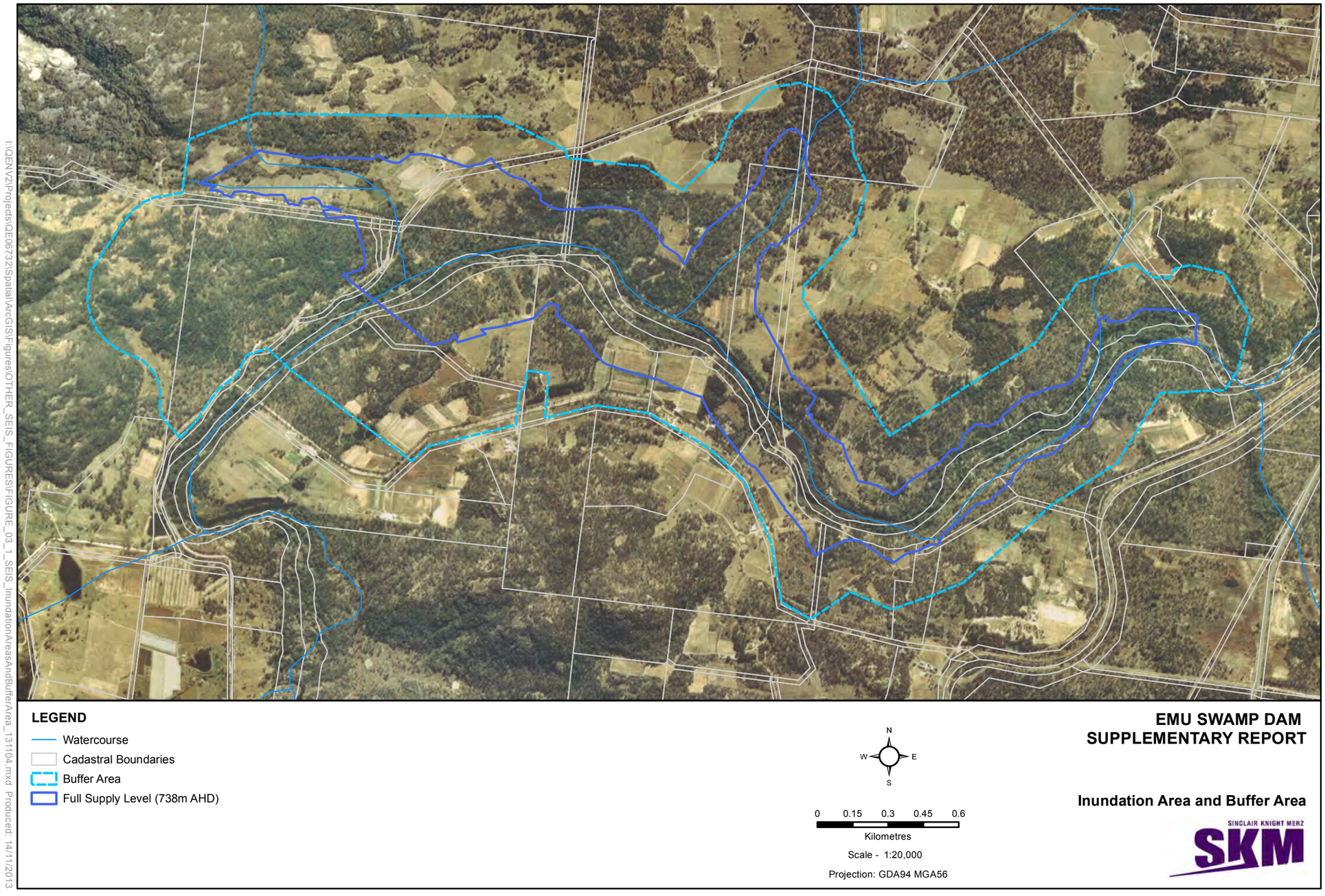


Figure 1.2 Full supply levels for proposed dam options.

1.4 Conservation Significance and Ecology of *Wollumbinia belli*

The known populations of Bell's turtle (*W. belli*) are found in the Namoi and Gwydir Rivers in northern NSW and in Bald Rock Creek in southern Queensland, in the headwaters of the Darling River system. These populations were first discovered in the 1970s (Fielder 2010), but Gray first described the Bell's turtle in 1844. In the Emu Swamp Dam Project EIS, one Bell's turtle was also recorded in the Severn River near Somme Lane (Map 130402TM).

There has been confusion regarding the taxonomy of Bell's turtles, with multiple genus and species names proposed. *W. belli* was proposed in 2007, but rejected by the International Commission on Zoological Nomenclature; the currently recognised species name is *Myuchelys bellii,* which was proposed by Georges and Thomson (2010). However, as federal and state government documentation refers to *W. belli*, this species name has been adopted in this report.

The Bell's turtle is listed as 'vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is listed as 'least concern' under the Queensland *Nature Conservation Act 1992* (NCA) and is currently listed as 'not yet assessed' for the International *IUCN Red List of Threatened Species* 2013 (IUCN 2013). However, in 2010 it was included on the IUCN Red List (Fielder 2010).

There is a paucity of information on the biology and ecology of the Bell's turtle, with most information found in Cann (1998) and the PhD thesis completed by Fielder (2010). Due to some morphological differences with populations in NSW it was considered the population of Bell's turtle in Bald Rock Creek in Queensland was a distinct species. However, genetic analyses does not support this, and it is likely they are a separate population of the same species (Fielder 2010).

Bell's turtles only occur in riverine habitats at a minimum elevation of 700 m above sea level. They prefer permanent, cold flowing streams that are well oxygenated. The known populations of Bell's turtles are in areas where granite boulders and bedrock are common, with coarse sand deposits in slower flowing areas. The in-stream habitat is complex, with underwater caverns formed by boulders, large woody debris and overhanging banks, as well as fine silt, algal growth and / or aquatic plants. The waterways are typically 30 to 40 m wide in NSW and 10 to 20 m wide in Queensland. Permanent water is required for the Bell's turtle to persist at a local scale (Fielder 2010).

The population of Bell's turtle in Queensland is small (estimated to be less than 400 individuals) and occurs within an 8 to 10 km reach of Bald Rock Creek. Most individuals were found in permanent pools at either end of this reach, within areas approximately 1.4 km long. There has been substantial habitat modification in the lower reaches of Bald

Rock Creek. Fielder (2010) surveyed a variety of habitats, such as off-stream wetlands and private in-stream impoundments, at multiple locations in the Border Rivers catchment, including above and below Nundubbermere Falls on the Severn River, but did not catch any Bell's turtles in these areas. In contrast, 79 Bell's turtles were recorded in Bald Rock Creek using a similar searching effort (Fielder 2010).

Bell's turtles are medium-sized turtles with delayed age at first breeding, low reproductive effort (14.3 eggs per adult female) and a predicted lifespan of over 40 years. They nest between September and January, with annual breeding rates varying between years. Bell's turtles have similar diving behaviour as the Fitzroy River turtle (*Rheodytes leukops*), with extended aerobic dives of up to 15.5 days during winter hibernation. Diving patterns in spring and autumn are characterised by longer resting dives at night and shorter dives during the day, with the turtles more active during daylight hours than at night at these times. This pattern was reversed in summer with longer and deeper dives during the day than at night, with the turtles more active at night in summer compared to other seasons. There is not a lot of information on the range of distance travelled by Bell's turtles, but Fielder (2010) observed one turtle that travelled approximately 8 km within 12 months over flowing granite bed rock and granite cascades to reach a large permanent waterhole upstream.

Basking behaviour has been noted in spring and, to a lesser degree, in autumn, with turtles observed out of the water on boulders. There is evidence that Bell's turtles hibernate at submerged depth (>3 m) during winter, with extended periods of inactivity when water temperatures are lowest (range 5 – 8 ℃) (Fielder 2010).

Bell's turtles have a varied diet consisting of aquatic plants (semi-emergent and submerged), filamentous green algae, freshwater sponges, terrestrial fruits that overhang the stream or float in the water (including exotic blackberries), aquatic insects, crayfish, carrion such as terrestrial insects in the water and sometimes large amounts of sediment and terrestrial leaves.

In-stream changes associated with impoundments and agricultural development have extensively modified habitat for Bell's turtle across its known range. The main impacts are changed in-stream conditions from flowing to still water and the loss of riparian vegetation, which reduces food resources and suitable habitat for the turtle. There are also high numbers of exotic goldfish in Bald Rock Creek, which have an impact through habitat modification and predation of juvenile turtles. On-going threatening processes for Bell's turtles include:

- loss of riparian vegetation through grazing and clearing for agricultural development

- loss of in-stream habitat from water infrastructure (impoundments), through reduced flow, changed water depths and decreased oxygen
- predation from exotic fish or stocked native fish predators such as the Murray cod, and
- predation of nests by foxes and other animals.

2 Relevant Legislation

2.1 *Environment Protection & Biodiversity Conservation Act 1999*

The Bell's turtle is listed as 'vulnerable' under the EPBC Act and its conservation is therefore a matter of national environmental significance. Any action that will have, or is likely to have, a 'significant impact' on a matter of national environmental significance must be referred to the Federal Environment Minister for approval under the EPBC Act. A 'significant impact' is defined as: *an impact which is important, notable, or of consequence, having regard to its context or intensity*, under the EPBC Act. Under the Significant Impact Criteria, an action is likely to have a 'significant impact' on a vulnerable species if there is a real chance, or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

The Project has been determined to be a controlled action under the EPBC Act, with controlling provisions Sections 18 and 18a: Listed threatened species and communities.

2.2 *Nature Conservation Act 1992*

Native plant and animal species are protected in Queensland under the NCA; extinct in the wild, endangered, vulnerable, near threatened and least concern species are listed in the Nature Conservation (Wildlife) Regulation 2006 (NCWR). No listed endangered, vulnerable, or near threatened turtle species under the NCWR are known to occur in the Project area.

The Bell's turtle was reported downstream of the proposed dam site during the EIS, in Bald Rock Creek, a tributary of Accommodation Creek, and in the Severn River, where it has not previously been reported. It is listed as 'least concern' under the NCWR, but has been identified as a high priority for conservation in the species prioritisation framework for the Department of Environment and Heritage Protection (EHP).

2.3 *Queensland Environment Protection Act 1994*

The environmental values of waterways in Queensland are protected under the *Environment Protection Act 1994* and the *Environmental Protection (Water) Policy 1997*. The aquatic fauna, including turtles, of the Project area contribute to the environmental values (biological integrity and ecological interactions) of these waterways.

3 Methods

3.1 Survey Design

Survey Timing

Turtles and habitat were surveyed from 20 to 26 May 2013 and from 9 to 15 September 2013.

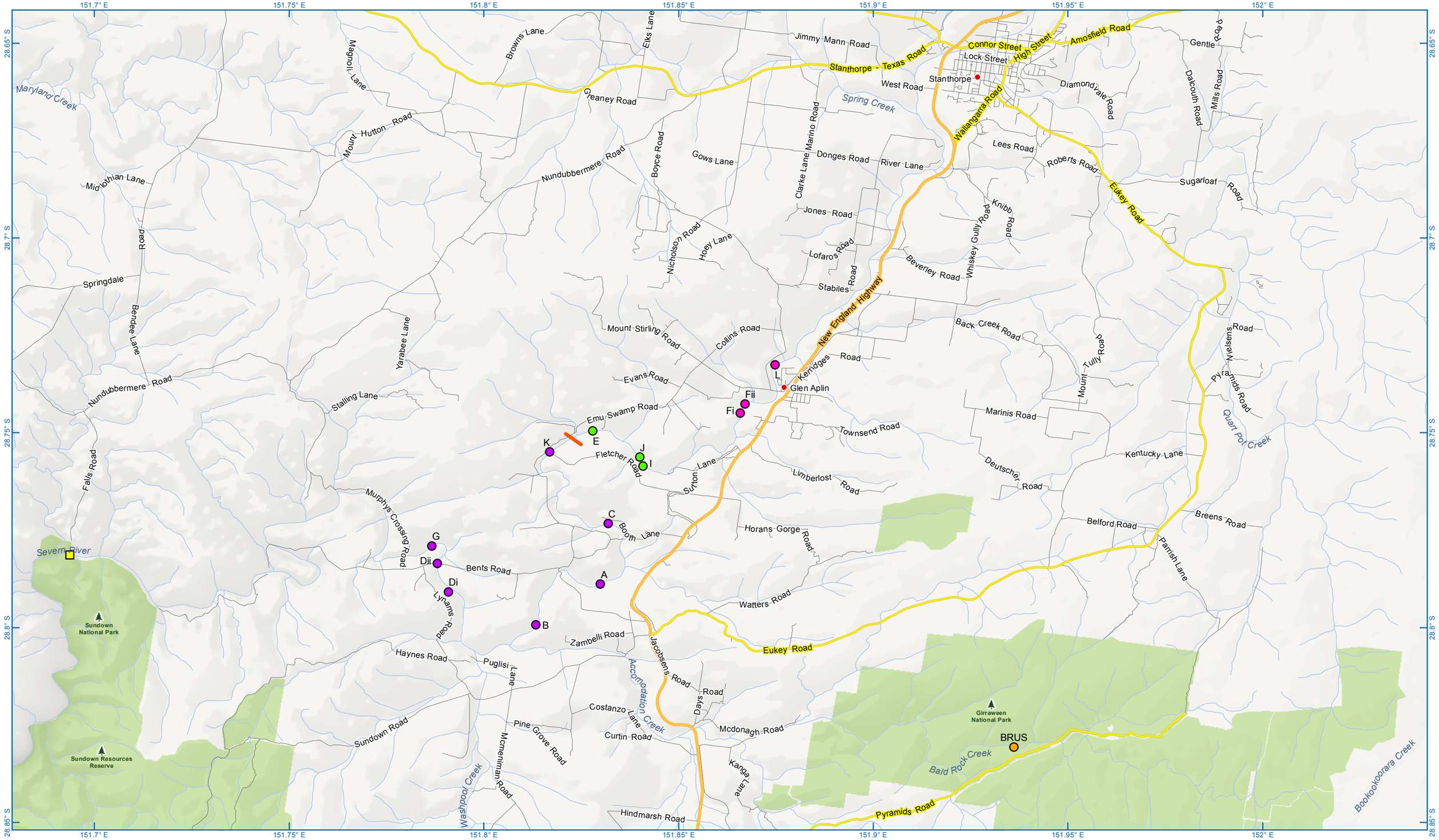
The weather was fine to overcast during both surveys, with light penetration of the water and visibility varying due to fluctuating overcast conditions. Air temperatures in Stanthorpe (the closest available weather station - 041095) ranged from approximately 1.2°C overnight, to 26.5°C during the day, whilst daily rainfall ranged between 0 and 0.6 mm (BOM 2013).

Survey Sites

A total of 12 sites were surveyed for turtles in the Project area (Table 3.1 and Map 130402SM). Site H was not surveyed in May due to land access restrictions and was relocated to site BRUS in September. Of the sites surveyed, sites F and D were moved slightly between the May and September surveys. Both sites were moved downstream in September, as access restrictions prevented a return to the locations surveyed in May.

Table 3.1 Site location details.

Site	Surveyed	Easting	Northing	Description
Upstream of the Proposed Dam FSL				
L	May and September	390118	6821121	Approximately 7 km upstream of the proposed dam site
Fi	May	389263	6819746	Approximately 5.9 km upstream of the proposed dam site
Fii	September	389376	6820006	Approximately 5.5 km upstream of the proposed dam site
Within Proposed Dam FSL				
I	May and September	386835	6818211	Approximately 2.1 km upstream of the proposed dam site
J	May and September	386753	6818469	Approximately 1.8 km upstream of the proposed dam site
E	May and September	385571	6819198	Approximately 0.5 km upstream of the proposed dam site
Downstream of the Proposed Dam				
K	May and September	384494	6818591	Approximately 1.6 km downstream of the proposed dam site
C	May and September	385977	6816579	Approximately 4.7 km downstream of the proposed dam site
A	May and September	385802	6814846	Approximately 7.6 km downstream of the proposed dam site
B	May and September	384199	6813675	Approximately 10.2 km downstream of the proposed dam site
Di	May	381996	6814586	Approximately 14.2 km downstream of the proposed dam site
Dii	September	381710	6815393	Approximately 15.3 km downstream of the proposed dam site
G	May and September	381568	6815888	Approximately 16.4 km downstream of the proposed dam site
Reference area				
BRUS	May and September	396211	6810315	Bald Rock Creek in Girraween National Park



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Emu Swamp Supplementary Environmental Impact Statement – Turtle Survey

Map 130402SM:
Turtle survey sites

SOURCES

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LEGEND

Turtle Survey Sites
- Upstream of the Proposed Dam FSL
- Within the Proposed Dam FSL
- Downstream of the Proposed Dam
- Reference Area
- Proposed Dam Site
- Watercourse

Road Network
- Highway
- Main Road
- Local Road

Protected Area
- National Park
- Nundubbermere Falls

N

SCALE

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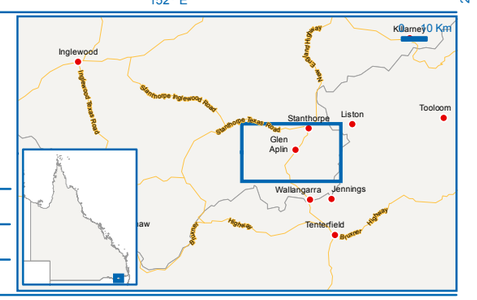

3.2 Turtles

Turtle surveys were conducted as per the recommendations in the 2011 Survey Guidelines for Australia's Threatened Reptiles for Bell's turtles (SEWPAC 2011), where possible. Explanations for any deviations from the Survey Guidelines are provided in Table 3.4. At each site, five custom-made turtle traps (cathedral traps designed to replicate the traps used by EHP's turtle group, and that allow turtles to surface and breathe) were baited with meat (heart) and set at each site for between six and ten hours.

In addition to traps, at each site turtles were also surveyed using a combination of:

- muddling
- dip netting
- snorkelling
- evening spotlighting
- fyke nets, and
- ad hoc observation.

These methods are also included in the 2011 Survey Guidelines for Australia's Threatened Reptiles and are used by EHP's turtle group. A combination of muddling, dip netting, snorkelling and / or spotlighting was conducted for 1 hour at each site in September. Fyke nets were used at site BRUS only. The sampling effort was lower in May than in September due to shorter days and less suitable conditions for turtle activity (i.e. colder water temperature).

A summary of the sampling methods and effort at each site is presented in Table 3.2 and Table 3.3.

All turtles sighted or captured (including species other than Bell's turtle) were identified and counted, and where practical their carapace length, weight and sex were recorded.

Figure 3.1

Turtle traps ready to be set from the canoe.

Figure 3.2

Turtle trap set at site K.

Table 3.2 Sampling effort for turtles in May 2013.

Site	Sampling Method	Date	Trap Time In	Trap Time Out	Total Effort
Upstream of the Proposed Dam Full Supply Level					
L	Traps (5), ad hoc observation	20/05/13	10:00	16:30	32.5 h
F	Traps (5), ad hoc observation	20/05/13	9:00	15:00	30.0 h
Within the Proposed Dam Full Supply Level					
E	Traps (5), ad hoc observation	21/05/13	9:00	16:00	35.0 h
I	Traps (5), ad hoc observation	22/05/13	9:00	16:30	37.5 h
J	Traps (5), ad hoc observation	22/05/13	10:00	16:00	30.0 h
Downstream of the Proposed Dam					
K	Traps (5), ad hoc observation	25/05/13	8:00	15:00	35.0 h
C	Traps (5), ad hoc observation	21/05/13	10:30	17:00	32.5 h
A	Traps (5), ad hoc observation	23/05/13	9:30	17:00	37.5 h
B	Traps (5), ad hoc observation	23/05/13	9:00	16:30	37.5 h
D	Traps (5), ad hoc observation	24/05/13	9:00	16:30	37.5 h
G	Traps (5), ad hoc observation	24/05/13	8:00	15:30	37.5 h
Reference Area					
H	Not surveyed	–	–	–	–

Table 3.3 Sampling effort for turtles in September 2013.

Site	Sampling Method	Date In	Trap Time In	Trap Time Out	Total Effort
Upstream of the Proposed Dam Full Supply Level					
L	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	09/09/13	0730	1530	42 h
Fii	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	11/09/13	0630	1630	52 h
Within the Proposed Dam Full Supply Level					
I	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	12/09/13	0700	1615	48.25 h
J	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	12/09/13	0630	1630	52 h
E	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	10/09/13	0630	1630	52 h
Downstream of the Proposed Dam					
K	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	10/09/13	0700	1630	49.5 h
C	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	09/09/13	0700	1500	42 h
A	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	13/09/13	0730	1650	48.66 h
B	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	11/09/13	0630	1630	52 h
Dii	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	14/09/13	0700	1600	47 h
G	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	14/09/13	0700	1700	52 h
Reference Area					
BRUS	Traps (5), muddling / dip netting / snorkelling / spotlighting at dusk, ad hoc observation	13/09/13	0930	1700	39.5 h
	Fyke nets	14/09/13	1300	0900	42 h

Table 3.4 Survey timing, method and effort for Bell's turtles in current surveys, compared to Commonwealth Guidelines (SEWPAC 2011).

Guideline Recommendation	Survey Timing, Method and Effort Employed	Comments
Assumed most active in late spring and through summer: surveys most effective at these times	Surveys conducted in May and September 2013	The May survey was to assess the suitability of habitat within the study area for the Bell's turtle. Bell's turtles were active during the September survey. One Bell's turtle was trapped at Bald Rock Creek during the survey period.
Snorkelling	Conducted at suitable sites	Where water depth and visibility allowed.
Traps baited with meat (liver)	Traps baited with meat (heart)	Fielder (2010) baited traps between 2002 and 2009 with meat (beef heart included) and successfully trapped 79 Bell's turtles in Bald Rock Creek.
Traps suspended from branches overhanging the water with sufficient trap out of the water to allow turtles to breathe	Traps set accordingly	
Traps checked several times during the first two hours, during the day, for several hours after sunset and early the following morning.	Traps set in the morning for a period of 8 hrs and checked upon retrieval, after dusk.	Site access and safety considerations constrained survey effort.
Seining	Not conducted	Water depths >2 m at most sites, being existing weir pools.

3.3 Habitat

Surveys of aquatic and potential nesting habitat were conducted during the day using observational searches. Aquatic habitat was assessed from a canoe or boat and /or while walking along the banks. At each site, the following was assessed:

- in-stream and riparian vegetation
- substrate composition (where practical)
- microhabitats present (e.g. run, riffle, pool)
- in-stream woody debris
- bank stability and slope, and
- the suitability of the habitat for Bell's turtles.

Where potentially suitable nesting habitat was identified, the area was systematically searched for evidence of nests, eggs, and predated eggshells.

3.4 Limitations

As the focus of this survey was to assess the presence, distribution and abundance of the Bell's turtle in and downstream of the Project area, the overall sampling effort was generally less than would be required to determine, for example, total abundance in the Severn River upstream of Accommodation Creek. The results of this survey are not intended to provide a detailed description of the population of Bell's turtles in the Severn River.

Survey timing and techniques were constrained by Project timing, site access and safety considerations.

Bell's turtles are more active, and consequently their catchability is highest, in warmer months. Both surveys were conducted in cooler months and consequently may under-represent the population of Bell's turtle in the study area. A single Bell's turtle was caught at the reference site in Bald Rock Creek. This turtle was caught using a fyke net that cut off a section of the creek and was set overnight; no Bell's turtles were caught at this site using cathedral traps or snorkelling. This suggests that the Bell's turtles were less active during the surveys.

Bell's turtles are most active in the early evening, and consequently it is recommended that traps are left over night. However, due to site access and safety constraints this was not possible. This is also likely to have resulted in lower catch rates.

4 Results and Discussion

4.1 Distribution

No turtles of any species were caught during the May survey.

In the September survey, a total of 26 turtles were caught (Table 4.1). One Bell's turtle (*W. belli*) was caught at reference site BRUS, in Girraween National Park (Figure 4.1). No Bell's turtles were caught in the Severn River within or downstream of the Project area. Map 130402TM shows the indicative locations of Bell's turtles caught in and near the Project area during this survey, surveys completed by Fielder (2010), and in surveys for the EIS.

The Bell's turtle caught was an adult male that weighed 2.4 kg and had a shell length of 22 cm (Figure 4.2).

Eighteen eastern long-necked turtles (*Chelodina longicollis*) were caught at sites upstream, within and downstream of the proposed dam, as well as at the reference site in Girraween National Park (Table 4.1, Figure 4.3). Seven Murray River turtles (*Emydura macquarii*) were caught at sites upstream and downstream of the proposed dam (Figure 4.4 and Figure 4.5). Eastern long-necked and Murray River turtles are common turtle species that are not protected under federal or state legislation.

An eastern long-necked turtle and two unidentified turtles were seen but not caught at site C, and two unidentified turtles were seen but not caught at site A.

Figure 4.1

Bell's turtle caught at Girraween National Park: site BRUS.

Figure 4.2

Bell's turtle being measured.

Figure 4.3

Eastern long-necked turtle being released at site BRUS.

Figure 4.4

Murray River turtle caught at site F.

Figure 4.5

Murray River turtle caught at site B.

Table 4.1 Turtles caught during the September 2013 survey.

Site	*Chelodina longicollis*				*Emydura macquarii*				*Wollumbinia belli*			
	Adult	**Intermediate**	**Juvenile**	**Total**	**Adult**	**Intermediate**	**Juvenile**	**Total**	**Adult**	**Intermediate**	**Juvenile**	**Total**
Upstream of the Proposed Dam FSL												
L	3	1	0	4	0	0	0	0	0	0	0	0
Fii	0	0	0	0	1	2	–	3	0	0	0	0
Within the Proposed Dam FSL												
I	0	0	0	0	0	0	0	0	0	0	0	0
J	0	0	0	0	0	0	0	0	0	0	0	0
E	2	1	0	3	0	0	0	0	0	0	0	0
Downstream of the Proposed Dam												
K	1	1	0	2	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0
A	1	1	0	2	1	1	0	2	0	0	0	0
B	0	1	0	1	1	1	0	2	0	0	0	0
Dii	0	0	0	0	0	0	0	0	0	0	0	0
G	0	0	1	1	0	0	0	0	0	0	0	0
Reference Area												
BRUS	3	2	0	5	0	0	0	0	1	0	0	1
Total	**10**	**7**	**1**	**18**	**3**	**4**	**0**	**7**	**1**	**0**	**0**	**1**

Emu Swamp Supplementary Environmental Impact Statement – Turtle Survey

Map 130402TM:
Indicative locations of known occurences of Bell's turtles in Queensland

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SOURCES

Fielder, D., 2010, 'Population ecology, ecophysiology, phylogenetics and taxonomy of the threatened western sawshelled turtle, Myuchelys bellii, from the Murray-Darling Basin of Australia'

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LEGEND

Project EIS Surveys 2006-2007
- Present
- Not caught

Fielder Surveys 2002-2009
- Present
- Not caught

Project SEIS Surveys 2013
- Present
- Not caught

- Proposed Dam Site
- Watercourse

Road Network
- Highway
- Main Road
- Local Road

Protected Area
- National Park
- Other Reserve

N

SCALE

0 1 2 4 6 8
Kilometres

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PROJECTION
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Datum: GDA 1994
Units: Degree

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2013-09-19

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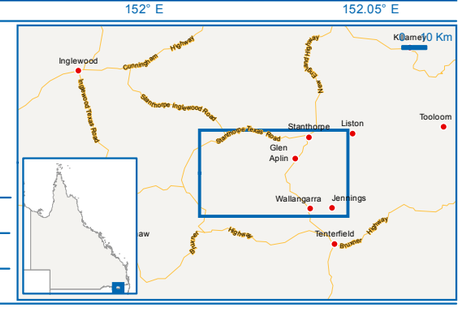


4.2 Habitat

Habitat assessments were completed at each site and descriptions of each site surveyed are presented in Table 4.2.

Aquatic habitat in the Project area was characterised by shallow and deep pools that were mostly associated with weirs, and shallow runs and riffles that would be prone to drying out in prolonged periods of little to no rain. Riparian vegetation was largely intact at all sites, except at site L upstream of the proposed full supply level, at site I within the proposed full supply level, and at sites A and Di downstream of the proposed dam site. There was evidence of historic clearing of trees on at least one of the banks at each of these sites. Banks were generally low and ranged from sloping to vertical within and between sites throughout the Project area. The banks typically comprised a combination of bedrock, cobbles, gravel, sand and silt / clay, and undercut banks were present at a number of sites throughout the Project area. Bed substrates were generally dominated by bedrock, boulders and sand, with cobble, pebbles, gravel and silt /clay often present in smaller proportions (Figure 4.6). Most sites had elements of large woody debris, though it was isolated or scattered at a number of sites (Figure 4.9). Submerged aquatic plants were also present at a number of sites, typically in the large pools (Figure 4.10).

There was potentially suitable habitat for Bell's turtles at sites Fi and Fii (upstream of the proposed full supply level), I and J (within the proposed full supply level), and K, Di, Dii and G (downstream of the proposed dam site). At these sites there were small, isolated areas of potential nesting habitat, except at site Fi (Figure 4.8). However, no Bell's turtles were caught during the surveys and no nests or eggs were found on the banks. This is consistent with surveys conducted by Fielder (2010) between 2002 and 2009, where no Bell's turtles were caught in the Severn River above or below Nundubbermere Falls.

There was also habitat suitable for turtle nesting in isolated patches at other sites throughout the Project area (Figure 4.7). Information provided by local landholders indicated that a number of the sand deposits on the banks moved substantially during floods in early 2011, which indicates that the location of nesting habitats in the area are subject to disturbance from high flow events.

Figure 4.6

Substantial bedrock at site B.

Figure 4.7

Sand bank suitable for nesting at site E.

Figure 4.8

Small area of suitable nesting habitat at site Fii.

Figure 4.9

Woody debris and overhanging bank at site J.

Figure 4.10

Submerged ribbonweed at site A.

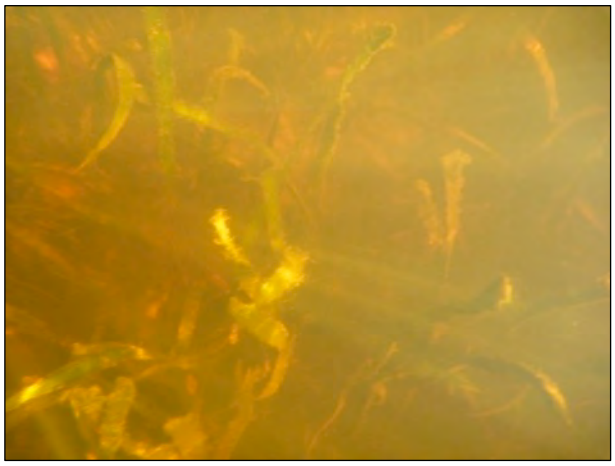


Table 4.2 Detailed habitat descriptions for each site

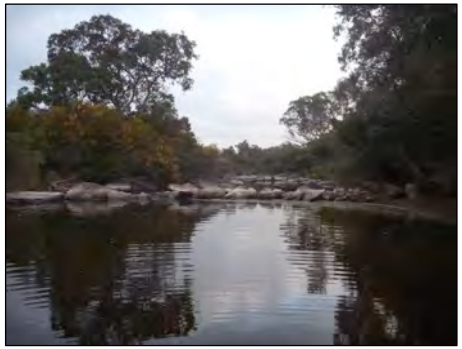
Site	Description	Photographs
Upstream of the Proposed Dam Full Supply Level		
Site L	***General Description*** This site comprised a mildly sinuous channel, with an average wetted width of 10 m and an average depth of 0.4 m. The banks were sloping and low (0.5 m), and stable. The riparian zone was ~20 m wide on each bank, with vegetation dominated by melaleuca and eucalypt trees and grasses with some shrubs. In-stream habitat comprised shallow pool and runs, with isolated woody debris, some detritus and beds of emergent aquatic plants. The bed substrate was dominated by bedrock and sand, with some gravel, boulders and pebbles. ***Suitability for Bell's Turtle*** This site was unlikely to be suitable for Bell's turtles as there were no undercut banks, little large woody debris and few boulders. No areas of potential nesting habitat were observed.	 View downstream in May 2013  View upstream in September 2013  Sandy substrate  Extensive reeds in shallow water

Site	Description	Photographs
Site Fi	***General Description*** This site comprised a weir pool with an average width of 12 m and an average depth of 1 m. The banks were steep and low (0.5 m), and moderately stable. The riparian zone was ~10 m on each bank, with vegetation dominated by melaleuca, callistemon and eucalypt trees, as well as shrubs and grasses. In--stream habitat included shallow and deep pools, scattered large woody debris, undercut banks, isolated emergent plants and some detritus. The bed substrate was dominated by sand and silt / clay, with some bedrock, boulders, cobbles and pebbles. ***Suitability for Bell's Turtle*** This site is potentially suitable for Bell's turtles, but unlikely to support a stable population due to the downstream weir and anthropogenic disturbance upstream towards site L. No areas of potential nesting habitat were observed.	 View upstream from weir  Heavily vegetated bank  Weir  Overhanging vegetation and woody debris

Site	Description	Photographs
Site Fii	***General Description*** This site comprised a mildly sinuous channel, with an average wetted width of 6 m and a bank full width of ~25 m. The average depth was 1 m. The banks were sloping and low (0.5 m), and moderately stable. There was some minor bank erosion. The riparian zone was ~10 m wide on each bank, with vegetation dominated by shrubs and melaleuca and eucalypt trees. In-stream habitat comprised a shallow pool, with scattered woody debris, emergent plants, and detritus. The bed substrate was dominated by sand, with some bedrock, boulders, cobble and pebbles. ***Suitability for Bell's Turtle*** Habitat at this site is potentially suitable for Bell's turtles but unlikely to support a stable population due to a lack of boulders and undercut banks and the absence of deep pools. There were isolated areas of sandy banks suitable for turtle nesting.	 View upstream  Sandy bank suitable for nesting  View downstream  Extensive woody debris

Site	Description	Photographs
Within the Proposed Dam Full Supply Level		
Site I	***General Description*** This site comprised a weir pool with an average width of 20 m and an average depth of approximately 2 m. The banks were sloping on the left bank and steep on the right bank vertical, with an average height of 0.5 to 0.8 m. Bank stability was high. The riparian zone was ~5 m on each bank, with vegetation dominated by eucalypt trees, shrubs and grass. In-stream habitat included large woody debris, overhanging vegetation, boulders, and isolated areas of submerged and emergent aquatic plants. The bed substrate was dominated by bedrock and boulders, with some sand and silt / clay. ***Suitability for Bell's Turtle*** Habitat at the upstream end of this site is potentially suitable for Bell's turtles. There were small isolated areas of suitable nesting habitat.	 View downstream  Sandy bank suitable for nesting  View downstream in May  View downstream

Site	Description	Photographs
Site J	***General Description*** This site comprised a mildly sinuous channel with an average width of 5 m and an average depth of 1 m. The average bank full width was 20 m. The banks were sloping and low (0.5 m), with high stability. The riparian zone was ~10 m wide on each bank. Melaleuca trees dominated riparian vegetation, with some shrubs and grasses. In-stream habitat included shallow and deep pools and shallow runs, with extensive woody debris, detritus, undercut banks and overhanging vegetation. The bed substrate was varied, with some bedrock, boulder, cobble, sand and silt / clay. ***Suitability for Bell's Turtle*** The habitat at this site is potentially suitable for Bell's turtles, and there were small isolated areas of potentially suitable nesting habitat.	 View downstream  Sandy bank  View upstream  Scoured bank and woody debris

Site	Description	Photographs
Site E	***General Description*** Site comprised an irregular channel, with an average width of 3 m and a maximum width of 10 m. A man made rock wall formed a pool in the middle of the site. The banks were sloping and low (0.5m). Bank stability was moderate. The riparian zone was ~5m wide on each bank. Melaleuca and eucalypt trees and shrubs dominated the riparian vegetation, with some grasses also abundant. In-stream habitat comprised shallow pools, runs and riffles, with sand bars. There was some detritus and little woody debris. There were isolated patches of emergent aquatic plants in-stream. The bed substrate was dominated by sand, with some bedrock and boulder. Overall disturbance was low. ***Suitability for Bell's Turtle*** This site is unlikely to support a stable population of Bell's turtle due to the shallow water, which may dry during periods of low to no rain. There were small areas of sandy bank suitable for turtle nesting.	 View downstream at lower end of reach  View downstream from upper end of reach  View downstream from middle of reach  Sandy bank

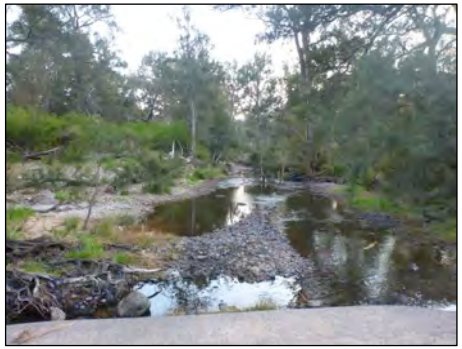
Site	Description	Photographs
Downstream of the Proposed Dam		
Site K	***General Description*** This site comprised an irregular channel with an average width of 15 m and an average depth of 1 m. There was a road crossing through the middle of this site and a weir at the downstream end. The banks were sloping to vertical, and low (0.5 m). Banks were undercut, but stability was high. The riparian zone was ~30 m wide on the left bank and ~20 m wide on the right bank. Melaleuca and eucalypt trees dominated riparian vegetation, with some shrubs and grasses. In-stream habitat included shallow and deep pools, runs and riffles, with some woody debris, detritus, undercut banks and overhanging vegetation. The bed substrate was dominated by bedrock and sand, with some boulders, cobble, pebble, gravel and silt / clay. ***Suitability for Bell's Turtle*** The habitat in the downstream end of this site is potentially suitable for Bell's turtles, and there were small isolated areas of potentially suitable nesting habitat. The upstream area is unlikely to support Bell's turtles.	 View downstream in September  Small area of sandy bank  View upstream in May  View upstream in September

Site	Description	Photographs
Site C	***General Description*** This site comprised a large weir pool with an average width of 25 m and an average depth of more than 2 m. The banks were gently sloping and low (0.5 m high), with high stability. The riparian zone was ~20 m on each bank, with vegetation dominated by eucalypt and callistemon trees, with shrubs and grasses. In-stream habitat consisted of a deep pool with isolated woody debris, scattered detritus and beds of submerged plants. Reeds lined the banks in many areas. The bed substrate was dominated by bedrock and boulders, with some gravel, sand and silt / clay. ***Suitability for Bell's Turtle*** Habitat at this site is unlikely to support a stable population of Bell's turtles. There was little large woody debris, trailing bank or overhanging vegetation, no undercut banks, and no flow. Suitable food sources (i.e. aquatic plants) were present. No areas of potential nesting habitat were observed.	 View upstream in May  Typical bank habitat  View downstream in September  Weir at downstream end of reach

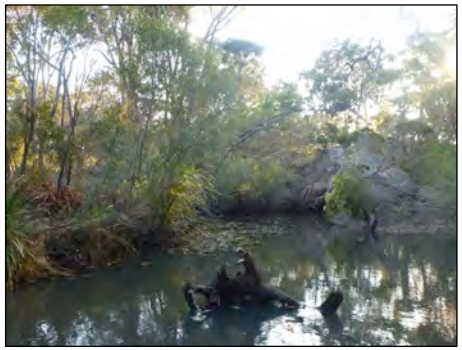
Site	Description	Photographs
Site A	***General Description*** This site comprised a weir pool with an average width of 43 m, and a bank full width of approximately 70 m. The average depth was approximately 1 m.The banks were gently sloping and low (<1 m), with high stability. The riparian zone was ~5 m on the left bank and ~10 m on the right bank. Grasses and discontinuous eucalypts and melaleucas dominated the riparian vegetation. There were areas cleared on both banks for grazing and cropping. In-stream habitat consisted of a pool with no visible flow, large beds of ribbonweed and scattered woody debris. The bottom substrate was dominated by bedrock, gravel and silt / clay, with some boulder, sand, cobbles and pebbles. ***Suitability for Bell's Turtle*** This site is unlikely to support Bell's turtles, unless in transit. There was little large woody debris or overhanging vegetation, few undercut banks or boulders, and no flow. Suitable food sources (e.g. ribbonweed) were present. No areas of potential nesting habitat were observed.	 View upstream  Weir at downstream end of reach  View downstream  Extensive reeds and grasses along bank

Site	Description	Photographs
Site B	***General Description*** This site comprised a wide irregular channel, with an average wetted width of 30 m (minimum 3 m and maximum 57 m). The average depth was approximately 1.2 m. The banks were low (0.5 m) and gently sloping to steep. The banks were stable, with no undercut areas. The riparian zone was ~15 m wide on each bank. Melaleuca, eucalypt and callistemon trees dominated the riparian vegetation, with some shrubs and grasses. In-stream habitat included shallow and deep pools with areas of shallow runs and cascades. There was abundant detritus, some algal growth, isolated woody debris and no submerged vegetation. The bed substrate was dominated by bedrock and boulders, with some finer sediments. ***Suitability for Bell's Turtle*** Habitat at this site is potentially suitable for Bell's turtles, but large woody debris was limited and there were no overhanging banks. Overhanging and trailing bank vegetation was limited. There were some isolated areas of sand on the banks, suitable for nesting.	 View downstream  Isolated area of sand on the bank  View upstream  Extensive bedrock at site

Site	Description	Photographs
Site Di	***General Description*** This site comprised a large weir pool with an average width of 35 m and an average depth greater than 2 m. The banks were sloping and low (0.5 m), except in areas where exposed bedrock comprised the bank. Bank stability was high. The riparian zone was ~10 m on each bank. Eucalypt, melaleuca and casuarina trees dominated the riparian vegetation, with some shrubs and grasses. There were small areas of cleared vegetation on each bank. In-stream habitat comprised deep and shallow pools and cascades. There were isolated areas of floating and submerged aquatic plants, scattered woody debris and some detritus. The bed substrate varied, with bedrock, boulders, cobble, gravel and sand all present. ***Suitability for Bell's Turtle*** Habitat at the upstream end of this site, above the cascade is potentially suitable for Bell's turtles, but the weir pool is less suitable. There were a few small, isolated areas of sand on the banks, suitable for nesting.	 View upstream  Woody debris  View downstream  Typical bank

Site	Description	Photographs
Site Dii	***General Description*** Site comprised an irregular channel, with an average wetted width of 4 m and a bank full width of 15 m. The average water depth was 0.5 m. The banks were gently sloping to vertical and low (0.5 m). Bank stability was moderate. The riparian zone was ~5 m on the left bank and ~10 m on the right bank. Melaleuca and casuarina trees and shrubs dominated the riparian vegetation. In-stream habitat comprised shallow and deep pools, with runs and undercut banks. There was scattered large and small woody debris, and no in-stream aquatic vegetation. The bed substrate was dominated by boulders, cobble and pebble, with some bedrock, gravel, sand and silt / clay. A road crossing with a culvert was in the centre of this site. ***Suitability for Bell's Turtle*** Upstream of the road crossing is suitable for Bell's turtles, but downstream is shallow and likely to dry out in periods of low or no rain. No areas of potential nesting habitat were observed.	 View upstream  Tree roots on bank  View downstream  Isolated sand and cobbles on left bank

Site	Description	Photographs
Site G	***General Description*** This site comprised a weir pool with an average width of 18 m and an average depth of more than 2 m. The banks were sloping to steep and an average height of 1 m. The riparian zone was approximately 3 m on the left bank and 10 m on the right bank. Eucalypt and casuarina trees and shrubs dominated the riparian vegetation, with some grasses. In-stream habitat was a deep pool with some woody debris and detritus. There were no in-stream aquatic plants. The bed substrate was dominated by bedrock, with some boulders, cobble, sand and silt / clay. ***Suitability for Bell's Turtle*** Habitat at this site is potentially suitable for Bell's turtles, but large woody debris was limited and there were no overhanging banks. There were shallow flowing areas less than 1 km upstream. There were some isolated areas of sand on the banks, suitable for nesting.	 View downstream  Weir at downstream end of reach  View upstream  Sandy bank suitable for nesting

Site	Description	Photographs
Reference Area		
Site BRUS	***General Description*** Site comprised a mildly sinuous channel, with an average width of 10 m and an average depth of 1.5 m. The channel was wide in the lower end of the reach and narrow at the upstream end. The banks were sloping to steep and low (0.3 to 0.5 m). Bank stability was high. The riparian zone was ~5 m wide on each bank. Eucalypt and casuarina trees dominated the riparian vegetation, with some shrubs. This site was in a national park, so riparian vegetation was largely undisturbed. In-stream habitat comprised deep pools with lots of large woody debris, large boulders, trailing bank vegetation and submerged aquatic plants (i.e. red milfoil). The bed substrate was dominated by sand, bedrock and boulders, with some cobbles. ***Suitability for Bell's Turtle*** This site supports Bell's turtles.	 View downstream  Typical bank habitat  View upstream  Woody debris where turtle was basking

5 Potential Impacts and Mitigation Measures

Construction and operation activities associated with the proposed dam have the potential to affect turtles through:

- the operation and maintenance of vehicles and other equipment
- vegetation clearing and earthworks
- quarrying and sand extraction
- inundation of the dam
- dam operation
- obstruction of flow and passage by the dam, and
- changes to the flow regime.

The potential impacts of these activities on turtles might include:

- loss of in-stream habitat through inundation or changes to water quantity and quality
- loss of nesting habitat
- a decrease in food sources
- more favourable conditions for predatory species, and
- isolation of populations.

A description of potential impacts of the Project activities on turtles and the associated mitigation measures are provided below. A summary and risk assessment are provided in Section 6.

5.1 Operation and Maintenance of Vehicles and Other Equipment

Fuel Spills

Both diesel and petrol are toxic to aquatic fauna at relatively low concentrations. A spill of either may impact freshwater turtles directly, or indirectly through the loss of food sources. However, the risk is likely to be low if controls meet required standards and drainage of refuelling and maintenance areas is directed into contained areas away from the river. Spilt fuel is most likely to enter the river via an accidental spill on nearby roads or when

there are construction activities adjacent to river. A significant fuel spill to the river (in the order of tens or hundreds of litres) is likely to have a locally significant impact on freshwater turtles, if present, with the quantity spilt and the volume of water in the river being the most significant factors influencing significance of the impact.

Water that is used for dust suppression and in the concrete batch plants has the potential to introduce contaminants, such as cement residues and hydrocarbons into waterways through runoff from the site. Increases in pH may occur if significant quantities of concrete slurry used to build the dam wall mixes with the storage water. Any such increase might impact freshwater turtles or their food sources in the affected reaches.

Risks associated with the spillage of fuels and other contaminants can be substantially reduced, if not eliminated, where:

- vehicle maintenance areas, portable refuelling stations and storage of fuels, oils and batteries are situated within bunded areas, designed and constructed in accordance with Australian Standards
- all spills of contaminants over 20 litres are reported to the Environmental Officer (or delegated person) for follow up action, and
- appropriate spill containment kits are available, and used for the cleanup of spills in the field. The kits should contain equipment for clean up of both spills on land or in dry creek beds, and spills to water.

Litter and Waste

With appropriate controls in place, such as bunded storage areas and direction of runoff to a contaminated water management system, the risk to freshwater turtles from litter and spilt waste from the Project is likely to be very low.

5.2 Vegetation Clearing and Earthworks

There is potential for soil erosion and sedimentation in the river following vegetation clearing and earthworks, particularly during periods of intense rainfall. This could lead to impacts on turtles, including Bell's turtles if present, via increased turbidity and contaminant levels in the river, and the alteration of preferred habitats. Small increases in turbidity would be unlikely to have a significant impact on freshwater turtles in the short term. However, significant increases in turbidity could have an adverse impact through increased sedimentation and loss of food sources (Limpus et al. 2007). Inputs of nutrients

or contaminants bound to sediment in runoff from disturbed areas may also have an impact.

Vegetation clearing and earthworks may result in the loss of in-stream and nesting habitat for turtles. Riparian vegetation provides a source of key in-stream habitat for Bell's turtles, and other freshwater turtles, in the form of fallen timber and tree roots (Fielder 2010). The loss of riparian vegetation may, therefore, reduce the presence of preferred habitat for turtles in the Project area.

Freshwater turtles generally nest in soft sand and soil within 20 to 30 m of the water's edge, but nests for some species have been recorded up to 60 m back from the water (Hamann et al. 2007). Any clearing or earthworks within this distance of stream margins may result in the loss of nesting banks. This habitat is likely to be of significant importance to turtles in the area. The loss of nesting habitat has the potential to reduce the distribution and long-term abundance of turtle populations.

To mitigate potential impacts, areas within 30 m of the river should be inspected by appropriately qualified professionals prior to vegetation clearing and earthworks to assess the presence of Bell's turtle at that location and check for nesting on the banks. If, during the course of works, nests are observed, access to the area restricted via temporary or permanent fencing. A suitably qualified turtle specialist should then be engaged to assess the area and check for the presence of Bell's turtles and the work required in the area reviewed and revised, if turtles or nests are present.

The risk of sedimentation in waterways from vegetation clearing and earthworks will be reduced where:

- areas of high value turtle habitat, such as sand banks, are avoided
- an erosion and sediment control management plan is developed and implemented
- sediment dams are constructed prior to vegetation clearing and earthworks
- vegetation clearing and earthworks are done in stages, and
- clearing and earthworks for construction of the dam is done in the dry season.

5.3 Quarrying and Sand Extraction

Quarry and sand extraction areas are located in the inundation area of the proposed dam, parallel to the river, and will be used during construction. The potential impacts of quarrying and sand extraction are similar to those described for vegetation clearing and earthworks in section 5.2, with loss of nesting habitat the primary concern. Depending on

the distance from the river, before quarrying and sand extraction begins, appropriately qualified professionals should assess the presence of Bell's turtles and check for nesting. The work required in the area should then be reviewed and revised, if turtles or nests are present.

5.4 Inundation of the Dam

During the filling phase, existing habitats will be inundated as the dam begins to fill. Ecosystems in the waterway will change from riverine (lotic) to lake (lentic) habitats, which are not known to be suitable for Bell's turtles. Initially, the lotic ecosystems will fill to bank full widths as if in flood, but then the area above the banks will be gradually inundated until the dam is at full supply level. The length of the filling phase is dependent on the rate of inflow, and the inundation area may fill during a single flood event or it may take several years. This will result in the loss of pool, run, glide, backwater, riffle and cascade habitat. Coarse sediment (boulders, cobbles, pebbles and gravel) present within the inundation area is likely to be smothered with fine sediment and sands once the inundation area is filled (as suspended fine sediments are likely to settle out of the water column in the relatively still waters of the inundation area). However, the aquatic habitat in the Severn River is similar upstream of, within, and downstream of the proposed dam site, so the inundation is highly unlikely to result in the loss of any unique aquatic habitat that supports freshwater turtles.

Water quality is likely to be degraded as the dam fills and the greatest risk to freshwater turtles is likely to be low levels of dissolved oxygen in the area that is inundated. The storage may also become stratified periodically, resulting in warm surface waters and cool deeper waters. Rapid changes of temperature during a 'roll over' event (where cool deep waters upwell to the surface) may be detrimental to freshwater turtles. Decreases in dissolved oxygen levels are also possible during such events.

Inundation of riffle-pool habitat will reduce the area of foraging and nesting habitat for freshwater turtles, particularly for Bell's turtles, if present, as they have a preference for well-oxygenated, flowing streams. However, Bell's turtles have not been recorded within or upstream of the proposed dam full supply level.

5.5 Dam Operation

Water may exit the dam through a multi-level off-take structure, through a fishway, or over the spillway during periods of high flow. The multi-level off-take structure will allow water to be withdrawn from a range of depths or fill levels, ensuring that high quality water is

available. Potential impacts to freshwater turtles that may result from the operation of the off-take structures include changes to water quality in the downstream environment and entrapment in the off-take works. The use of screens to cover the multi-level off-take and direct turtles towards the fishway or passage would mitigate entrapment.

Downstream of the dam, the key water quality parameters that may be affected are dissolved oxygen, turbidity, temperature, and nutrient concentration. The quality of the water received downstream will depend on whether the impoundment is stratified, whether there are blue-green algae blooms in the impoundment, and the location of release valves. Water released from the dam may be low in dissolved oxygen and harmful to turtles if taken from deep within the dam. Surface waters of the dam will have a higher concentration of dissolved oxygen due to the action of phytoplankton and macrophytes, unless surface waters may become temporarily hypoxic (low in oxygen) after change in stratification or after extensive microbial decomposition (e.g. rotting vegetation). After filling and stabilising, sediments will drop out of suspension and as such, the dam will act as a trap for sediments and nutrients attached to the sediments. Impacts to downstream water quality will be mitigated if water quality in the dam and the source of releases are managed.

5.6 Obstruction of Flow and Passage

Dams create barriers that prevent or impede movements of freshwater turtles in waterways. The impediment to passage has the potential to isolate turtle populations and, in the long-term, could decrease genetic diversity in turtle populations upstream and downstream of the dam. No Bell's turtles have been caught within or upstream of the proposed dam. As such, although they have been caught downstream, impacts on the passage of this species are considered to be low risk, as there is no indication that the dam would separate an existing population. or that the range of Bell's turtles has expanded to include the upper reaches of the Severn River.

Potential impacts on turtle passage may be minimised through specific design features, such as moistened covered passages that would allow turtles to walk around the dam wall (SPRAT 2013), incorporated into the fishway. Turtles prefer to walk upstream rather than use fishways, and fish locks can be detrimental to turtles if they drown or become trapped in the hydraulic mechanisms of the lock, as has been observed at the Ned Churchward Weir fish lock (Hamann et al. 2004). Never-the-less turtles have been observed passing through fish locks, such as the Paradise Dam fish lock, however these were predominantly Krefft's river turtle (*Emydura macquarii krefftii*). Other species that used the river near the dam, including *Elseya* and *Chelodina* species, either did not use the fishway, or used it in very low numbers (QPIF 2009; DEEDI 2012). Where measures are

taken to prevent turtles from accessing high velocity water release sites and the hydraulic mechanism, negative impacts associated with fish locks will be minimised, and some turtle passage will be maintained. Specific design features to enable turtle passage for turtle species that may occur in the area, including Bell's turtle, will be designed in collaboration with appropriate experts, and agencies (including the EHP and Queensland Fisheries) and incorporate into the proposed dam. As no Bell's turtles have been recorded upstream of the proposed dam site, the risk of impacts to passage of this species are considered to be low. The proposed fish lock and aquatic fauna passage will provide opportunity for passage of other turtle species. As the other turtle species recorded in the area are common, the risk of impacts of altered passage on the population of these species is also considered to be low.

5.7 Changes to the Flow Regime

The proposed dam may change the current flow regime in the river by reducing flow in the river downstream of the dam site and altering the timing, frequency and size of seasonal flow events. The number of weirs downstream of the dam site could also exacerbate any decrease in flow downstream of the proposed dam. This could impact freshwater turtles by reducing the availability of suitable habitat, decreasing areas suitable for foraging and resting, creating conditions that favour some predators (e.g. goldfish) and decreasing the available food sources. Changes to the flow regime may also affect the availability of potential nesting habitat downstream, as most fine sediments will be trapped within the dam storage and not deposited on downstream banks and bars. If existing downstream nesting habitat is washed away during high flows, they may therefore not be re-established, or take much longer to re-establish.

Environmental flows from the dam will comprise a release equivalent to the inflow, up to 30 ML/day, in order to maintain the natural flow regime for low flows and the ephemeral nature of the Severn River. For example, if 8 ML/day enters the storage then 8 ML/day will be released downstream, but if flow greater than 30 ML/day enters the storage then 30 ML/day will be released downstream. Modelling for the SEIS indicates that the dam will spill for 46 days of the year, with an average of 0.4 of a year (i.e. 4-5 months) between spills. The average duration of spills is predicted to be 14 days. The proposed combination of environmental releases and spills will contribute to maintaining a flow regime consistent with the current flow regime and will mitigate impacts to freshwater turtles.

Modelling undertaken for the SEIS indicates that between the proposed dam site and the confluence of the Severn River and Accommodation Creek, changes to the stream flow would only represent a decrease in water depth of up to 100 mm. This change in water

depth is unlikely to have a substantial impact on the availability and suitability of aquatic habitat, except during periods of very low flow, in areas not within existing weir pools. Loss of habitat during periods of low flow will be mitigated by the proposed environmental releases. Impacts to freshwater turtles and their required aquatic habitat from altered flows are therefore expected to be minimal, as habitat persistence and connectivity downstream of the dam will be maintained.

5.8 Effects on Species of Conservation Significance

While the Bell's turtle has been recorded at one site in the Severn River downstream of the proposed dam site, it has not been recorded in or upstream of the proposed inundation area despite extensive searching. In contrast, 79 Bell's turtles were recorded in Bald Rock Creek using a similar searching effort (Fielder 2010). Although, there are no records of Bell's turtles upstream of the proposed dam, specific design features to facilitate the passage of Bell's turtle up and downstream will be incorporated into the design of the dam.

If undetected populations of this species are downstream of the dam, they may be impacted by changes to habitat availability and suitability, in particular due to the changed flow conditions. Although suitable habitat occurs in the study area, the likelihood of a stable population of Bell's turtle occurring in the Severn River downstream of the proposed dam is considered low, as extensive efforts undertaken between 2002 and 2009 by Fielder (2010) and the surveys described in this report did not catch any Bell's turtles in the river.

6 Risk Assessment

6.1 Methods

Based on the outcomes of a literature review and field surveys for the EIS and supplementary EIS, potential impacts to freshwater turtles have been identified. The value of each turtle species known from the Project area was identified and defined in accordance with the criteria outlined in Table 6.1 and

Table 6.2.

Risks to freshwater turtles as a result of the Project have been assessed based on the determined value and magnitude of impact.

Table 6.3 illustrates how the significance of a potential impact was derived.

Table 6.1 Value criteria for aquatic ecology attributes.

Value	Definition
very high	· an internationally important site (e.g. Ramsar wetland, or a site considered worthy of such designation)
	· a regularly occurring population of an internationally important species
	· a nationally designated site (e.g. Wetland of National Significance)
	· smaller areas of habitat which are essential for maintaining the viability of a larger whole area of national significance
	· areas of habitat that may support nationally important species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
	· aquatic species or communities listed under the EPBC Act
high	· habitat of state significance (e.g. wetlands of high ecological significance in the Great Barrier Reef catchments)
	· aquatic species or communities listed under Queensland's *Nature Conservation Act 1992*
	· aquatic habitat, species or communities that are rare or have a high conservation priority species within Queensland.
	· aquatic species or communities that are considered 'iconic' species within Queensland or Australia (e.g. platypus)

Value	Definition
medium	· aquatic habitat or site designated by a local authority as having local conservation status · aquatic habitat or species that has importance at a catchment-scale, e.g. refuge habitat or fish breeding habitat
low	· aquatic habitat not specifically protected under state or national legislation, but that supports native aquatic flora and fauna · common or widespread aquatic species or communities within the region that are not specifically protected under state or national legislation and that are relatively tolerant of a wide range of environmental conditions
negligible	· common or widespread aquatic habitat within the region that is highly disturbed and rarely supports aquatic flora and fauna · highly disturbed aquatic communities, e.g. that are affected by pollution or invasion of exotic species

Table 6.2 Thresholds for magnitude of impact for aquatic ecology receptors.

Magnitude of Change	Definition
major	· permanent or long-term effect on the extent or integrity of a habitat, a species or a community · likely to result in a direct effect on a habitat or a species, including mortality of a high value species that affects the viability of the population · likely to threaten the sustainability or conservation status of a habitat, a species or a community · if beneficial, likely to enhance the sustainability or conservation status of a habitat, a species or a community
moderate	· permanent or long-term effect on the extent or integrity of a habitat, a species or a community · likely to result in direct effect on a habitat or a species that does not affect the viability of the population · unlikely to threaten the sustainability of a habitat, a species or a community · if beneficial, likely to enhance the sustainability of a habitat, a species or a community

Magnitude of Change	Definition
minor	· medium or short-term reversible effect on a habitat, a species or a community · may be a small but measurable indirect impact on an aquatic habitat or on a native aquatic species or community · will not threaten the sustainability of a significant habitat, species or native aquatic community
negligible	· no direct impact to an aquatic habitat or a species · short-term and reversible indirect effect on habitat that is unlikely to lead to impacts on habitat integrity or a native aquatic community
no change	· no direct or indirect impacts to aquatic ecology

Table 6.3 Matrix used to estimate the significance of potential impacts after mitigation.

Significance of Effect		Magnitude of Change				
		Major	**Moderate**	**Minor**	**Negligible**	**No change**
Attribute Value	**Very high**	Very Large	Large/Very Large	Moderate/ Large	Slight	Neutral
	High	Large/Very Large	Moderate/ Large	Slight/ Moderate	Slight	Neutral
	Medium	Moderate/ Large	Moderate	Slight	Neutral/ Slight	Neutral
	Low	Slight/ Moderate	Slight	Neutral/ Slight	Neutral/ Slight	Neutral
	Negligible	Slight	Neutral/ Slight	Neutral/ Slight	Neutral	Neutral

Note: Shaded boxes indicate a significant effect in terms of EIA. Where a choice of two impact significance descriptors is available, only one should be chosen. This allows for professional judgement and discrimination in assessing impacts.

6.2 Impact Assessment

Table 6.4 shows the risk assessment for potential impacts to freshwater turtles species in the Project area. Based on the impact assessment presented above, without mitigation and management, the following activities have the potential to result in impacts to freshwater turtles:

- fuel and contaminant spills to the river, affecting water quality
- works such as vegetation clearing, earthworks, quarrying and sand extraction, resulting in decreased available habitat, and
- construction, inundation and operation of the dam, leading to habitat loss and decline in habitat suitability, a reduction in food sources and isolation of populations.

Once mitigation measures are implemented, all residual impacts on Bell's turtles are considered to be slight, except in relation to the restriction of passage in the river. The residual impacts for other turtle species from the area are slight. The restriction of passage has moderate residual impact for Bell's turtles using the impact assessment methodology due to insufficient information on effectiveness of aquatic fauna passages for these turtles; however, the restriction of passage is unlikely to threaten the sustainability of Bell's turtle in the region, as they are not known to occur upstream of the dam site.

The residual impacts classified as slight are not considered to be significant impacts in accordance with the impact assessment methodology described in Section 6.1.

Table 6.4 Summary of the potential impacts of the Emu Swamp Dam Project on freshwater turtles, the relevant mitigation and management measures and the residual risk.

Freshwater Turtle Species by Value Criteria	Potential Impact	Mitigation / Management Protocol	Objective	Magnitude of Change After Mitigation	Residual Impact
Very High					
Bell's turtle	· increased turbidity and sedimentation, and input of nutrients or other contaminants from works including vegetation clearing, earthworks, quarrying and sand extraction	· an erosion and sediment control plan will be developed and implemented during works and operation · sediment dams will be constructed before works begin · works will occur in the dry season, if possible	no increase in turbidity or general decline in water quality	negligible	slight
	· loss of in-stream and nesting habitat from works including vegetation clearing, earthworks, quarrying and sand extraction	· locations directly affected by works will be assessed for Bell's turtles and nests by a qualified professional before work begins · a localised impact assessment will be completed if Bell's turtles or nests are present	no direct or indirect impacts to listed threatened or near-threatened species	negligible	slight
	· loss of in-stream and nesting habitat from dam inundation	· nil – not known to occur in this area	–	negligible	slight
	· restriction of passage and isolation of populations by the dam wall	· inclusion of aquatic fauna passageways specifically designed to enable passage of Bell's turtle as proposed, with measures to restrict access to high velocity water release sites and the hydraulic mechanism	minimise restriction of passage in river	minor	moderate
	· loss of in-stream and nesting habitat due to a changed flow regime downstream of the dam	· managed environmental releases to maintain connectivity consistent with current conditions	no reduction in the number of existing pool-run/riffle sequences or connectivity	negligible	slight
	· improved conditions for predators from dam inundation and a changed flow regime downstream of the dam.	· management plan to control exotic and pest species such as goldfish within and downstream of the dam.	no increase in the populations of exotic or pest species	negligible	slight
	· reduction in food sources from changed water quality and flow conditions.	· managed environmental releases to maintain connectivity consistent with current conditions · management plan for water quality in the storage and environmental releases	no direct or indirect impacts to listed threatened or near-threatened species	negligible	slight
Medium - Low					
Murray River turtle and eastern long-necked turtle	· increased turbidity and sedimentation, and input of nutrients or other contaminants from works including vegetation clearing, earthworks, quarrying and sand extraction	· an erosion and sediment control plan will be developed and implemented during works and operation · sediment dams will be constructed before works begin · works will occur in the dry season, if possible	no overall decrease in water quality	negligible	slight
	· loss of in-stream and nesting habitat from works including vegetation clearing, earthworks, quarrying and sand extraction	· locations directly affected by works will be assessed for turtles and nests before work begins · turtles will be relocated from areas of direct impact by qualified professionals before work beings in the area	minimise impacts to aquatic habitat and turtle species	negligible	slight

Freshwater Turtle Species by Value Criteria	Potential Impact	Mitigation / Management Protocol	Objective	Magnitude of Change After Mitigation	Residual Impact
	· loss of in-stream and nesting habitat from dam inundation	· maintain riparian vegetation and in-stream woody debris along dam margins to provide shelter and basking habitat for turtles · check areas of nesting habitat yet to be inundated for nests once during each breeding season until the full supply level is reached; relocate nests if present.	–	moderate	slight
	· restriction of passage and isolation of populations by the dam wall	· inclusion of fishway and / or moistened turtle passages and / or other features specifically designed to enable passage of these species.	minimise restriction of passage in river	moderate	slight
	· loss of in-stream and nesting habitat due to a changed flow regime downstream of the dam	· managed environmental releases to maintain connectivity consistent with current conditions	minimise any reduction in the number of existing pool-run/riffle sequences or connectivity	negligible	neutral
	· improved conditions for predators from dam inundation and a changed flow regime downstream of the dam.	· management plan to control exotic and pest species such as goldfish within and downstream of the dam.	no increase in the populations of exotic or pest species	negligible	slight
	· reduction in food sources from changed water quality and flow conditions.	· managed environmental releases to maintain connectivity consistent with current conditions · management plan for water quality in the storage and environmental releases	minimise changes to flow regime and water quality	negligible	slight

7 Monitoring Requirements

The monitoring of freshwater turtles is recommended to:

- minimise impacts due to construction works
- monitor the potential presence of Bell's turtles
- monitor the efficacy of the fishway and aquatic fauna passageways
- inform the continual improvement of the dam's operations, and
- trigger the requirement for remedial action should an impact be detected.

The monitoring should include:

- localised site assessments to assess the presence of turtles and turtle nests before works begin in construction zones, and to enable relocation if necessary
- an assessment of the turtle populations in the Severn River upstream of, within and downstream of the proposed dam
- a targeted survey of Bell's turtles during a period of high activity (i.e. October–December), and
- recommendations for monitoring and management of impacts, if any.

The monitoring program should be designed and implemented by an appropriately qualified professional, and consider:

- completion of at least one more baseline survey before commissioning works, and at least two surveys after works begin (with the need for further surveys to be determined based on the results)
- survey of turtles using equipment appropriate to the conditions at each site, in periods of higher turtle activity
- the life-history stage (juvenile, intermediate, adult) of each species, along with the apparent health of individuals, and
- the richness, total abundance, abundance of key species.

General Fisheries and Animal Ethics permits will be required to complete the monitoring.

8 Conclusions and Recommendations

Turtle species recorded in or downstream of the proposed dam site include Bell's turtles, Murray River turtles and eastern long-necked turtles. Of these species, Murray River turtles and eastern long-necked turtles were caught upstream of the proposed full supply level, within the full supply level, and downstream of the proposed dam site. Only one Bell's turtle has been reported in the Project area: in the Severn River near Somme Lane, downstream of the proposed dam site, during the Project EIS in 2007. No Bell's turtles were caught by Fielder (2010) in the Severn River between 2002 and 2009, or during the 2013 surveys for the supplementary EIS.

Freshwater turtles in the proposed Project area may be affected by the Project through:

- the operation and maintenance of vehicles and other equipment
- works including vegetation clearing, earthworks, quarrying and sand extraction
- inundation and operation of the dam
- obstruction of flow and passage by the dam, and
- changes to the flow regime downstream of the dam.

Of the potential impacts, the inundation and operation of the dam, obstruction of flow and passage by the dam and changes to the downstream flow regime may have the greatest impact on turtles. Potential impacts of these, and other Project activities, can be minimised where mitigation measures are implemented.

While the Project area may provide suitable habitat for the EPBC listed Bell's turtle, where the recommended mitigation is implemented, the Project is unlikely to have a significant impact on this species.

Overall, the risk assessment indicates that there will only be a slight impact to turtles where the recommended mitigation measures are implemented.

9 References

BOM, 2013, *Bureau of Meteorology*, http://www.bom.gov.au, accessed September 2013.

Cann, J., 1998, *Australian Freshwater Turtles*, Beaumont Publishing Pty Ltd, Singapore.

DEEDI, 2012, *Paradise Dam Downstream Fishway Moniotring Program. Final V1.1 Report. February 2012. Report prepared by the Dept. of Employment, Economic Development and Innovation for Burnett Water Pty. Ltd.*, report prepared for Burnett Water Pty Ltd.

Fielder, D.P., 2010, '*Population ecology, ecophysiology, Phylogenetics and taxonomy of the threatened western sawshelled turtle,* Myuchelys bellii*, from the Murray-Darling Basin of Australian*'.

Georges, A. & Thomson, S., 2010, 'Diversity of Australiasian freshwater turtles, with an annotated synonymy and keys to species.', *Zootaxa* 2496: 1-37.

Hamann, M., Schauble, C.S., Limpus, D.J., Emerick, S.P. & Limpus, C.J., 2004, '*Management Plan for the Conservation of Elseya sp. [Burnett River] in the Burnett River*. (Queensland Environmental Protection Agency: Brisbane.)'.

Hamann, M., Schauble, C.S., Limpus, D.J., S.P., E. & C.J., L., 2007, '*Management Plan for the conservation of Elseya sp. [Burnett River] in the Burnett River Catchment*', *Queensland Environmental Protection Agency: Brisbane*.

IUCN, 2013, The IUCN Red LIst, http://www.iucn.org/about/work/programmes/species/our_work/the_iucn_red_list/, accessed September 2013.

Limpus, C.J., D.J., L., Parmenter, C.J., Hodge, J., Forrest, M.J. & McLachlan, J.M., 2007, *Proposal for raising Eden Bann Weir and construction of Rookwood Wier – An assessment of the potential implications and mitigation measures for Fitzroy Turtles (Elseya albagula and Rheodytes leukops)*, report prepared for Environmental Protection Agency, Queensland Government.

SEWPAC, 2011, '*Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Act 1999.*'.

SKM, 2008, *Emu Swamp Dam EIS prepared for Stanthorpe Shire Council*.

SPRAT, 2013, *Species Profile and Threats Database – Mary River Turtle*, http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64389 accessed September 2013.

QPIF, 2009. Paradise Dam Upstream Fishway Monitoring Program Annual Report September 2008 to September 2009